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Distal Radius Fracture Rehabilitation

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health From the Academy of Orthopaedic Physical Therapy and Academy of Hand and Upper Extremity Physical Therapy of the American Physical Therapy Association

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Summary of Recommendations

PROGNOSIS

C Clinicians may use older age (>65 years), high baseline levels of disability, third-party compensation, and comorbid psychosocial factors (particularly depression) as predictors of poor outcomes related to functional disability in individuals with distal radius fracture (DRF).

C Clinicians may use female sex, high baseline levels of pain, and comorbid psychosocial factors (particularly depression) as predictors of poor outcomes related to the development of persistent pain symptoms, including type 1 complex regional pain syndrome in individuals with a DRF.

EXAMINATION – OUTCOME – ACTIVITY LIMITATIONS; SELF-REPORTED MEASURES

A Clinicians should administer joint-specific measure of the patient-rated wrist evaluation to assess pain experience and functional disability of the wrist or administer either the Disability of the Arm, Shoulder, and Hand or the Michigan Hand Questionnaire to assess region-specific disability of the upper extremity at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

C Clinicians may use the Jebsen-Taylor Hand Function Test to assess the performance in completing activities of daily living tasks that require wrist/hand use at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

EXAMINATION – OUTCOME – MEASURES ASSESSING IMPAIRMENT IN BODY FUNCTION

A Clinicians should use wrist and forearm range of motion assessments at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

A Clinicians should use grip strength assessment, as long as there are no contraindications for assessing it, to assess strength deficits of the wrist/hand muscles at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

C Clinicians may use pinch strength and wrist joint position sense in assessing precision in handling small objects and proprioceptive ability, respectively, at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

EXAMINATION – OUTCOME – FALL RISK SCREENING

F Clinicians may administer the timed up and go test (TUG) for fall risk screening in individuals with DRF and consider TUG scores of >12 seconds as the threshold for increased fall risk.

F Clinicians may administer the Activities-Specific Balance Confidence Scale (ABC) for screening fear of falling in individuals with DRF and consider ABC scores of <67% as the threshold for increased fall risk.

F Clinicians may administer the five-times chair stand test (CST) for screening lower extremity muscle strength in individuals with DRF and consider the scores of >12 seconds as the threshold for impaired lower extremity muscle strength.

INTERVENTIONS – THERAPY INITIATION TIMING

A Clinicians should initiate early therapy that consists of hand, wrist, and shoulder active range of motion (AROM) exercises along with light daily activity within the first 3 weeks after a surgically repaired DRF to improve short-term (up to 3 months) outcomes for pain, wrist AROM, grip strength, and functional, and long-term (≥6 months) outcomes for wrist AROM and grip strength.

B Clinicians should initiate submaximal progressive strengthening, such as towel and putty squeezing and light-load gripping exercises at 2 weeks following a surgically repaired DRF or during the second week of cast immobilization (only the uncomplicated individuals with stable DRF, satisfactory radius-ulna articular alignment, and no ulnar-sided pain) to improve short-term (up to 6 months) outcomes for pain, wrist AROM, grip strength, and functional capacity with negligible risk of compromising proper fracture healing.

INTERVENTIONS – THERAPY SUPERVISION AND DOSAGE

B Clinicians should have older (≥60 years) individuals or those with complications and comorbidities following operative and/or nonoperative treatments after a DRF attend a supervised therapy program at a frequency of ≥1 weekly session, supplemented with an independent home exercise program, to improve short- and long-term wrist pain, AROM, grip strength, and function.

A Clinicians (physical or occupational therapists) should be the primary instructors of independent home exercise programs following operative and/or nonoperative treatment for individuals with DRF to improve short- and long-term outcomes for wrist pain, AROM, grip strength, and function.

D Conflicting evidence prevents making a recommendation for or against supervised therapy, an independent home exercise program, or no therapy for younger individuals with no complications

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or comorbidities following nonoperative or operative treatment for optimum short- and long-term outcomes of their DRF.

INTERVENTIONS – EDEMA CONTROL METHODS

C Clinicians may perform a combination of edema control techniques, including manual lymph drainage and other manual edema mobilization, exercises, elevation, compression gloves, low-stretch bandaging, and/or independent home exercise program instruction, to induce short-term (2-6 weeks) benefits on hand swelling, AROM, function, and pain following nonoperative and operative DRF management.

INTERVENTIONS – MANUAL THERAPY TECHNIQUES

B Clinicians should use manual therapy procedures (mobilization with movement, accessory joint mobilizations, oscillations, sustained stretching) based on individual tolerance and fracture stability levels as part of multimodal management strategies for short-term improvements in wrist pain, AROM, and upper-limb function following operative and nonoperative DRF treatments.

INTERVENTIONS – THERAPEUTIC EXERCISES

B Clinicians should use properly timed therapeutic exercises based on fracture treatment type and fracture stability level, including PROM, AROM, tendon gliding, motor control, functional and progressive bilateral resistance exercises that address the scapular and glenohumeral musculature to improve pain, AROM, strength, and function following DRF.

INTERVENTIONS – SENSORIMOTOR TRAINING

A Clinicians should integrate graded motor imagery as part of a multimodal management strategy to improve short-term outcomes in pain, AROM, and individual-reported function during the early rehabilitation stage (6-8 weeks) following nonoperative and operative treatment for DRF.

C Clinicians may integrate a multimodal sensorimotor training approach consisting of sensory stimulation techniques (eg, vibration) and other proprioceptive exercises in conjunction with conventional therapy to improve short-term outcomes in pain, AROM, and function during the initial rehabilitation stage (6-8 weeks) following operative treatment for DRF.

INTERVENTIONS – ORTHOSIS MANAGEMENT FOR STIFFNESS

F Clinicians may utilize dynamic and static progressive orthoses in conjunction with standard care to improve wrist PROM primarily for certain subgroups of individuals with DRF who present with difficulty reaching their functional goals due to persistent wrist stiffness.

INTERVENTIONS – THERAPEUTIC MODALITIES

B Clinicians should utilize physical agents, including laser therapy, pulsed electromagnetic field, warm whirlpool, hot packs, and cold packs as part of multimodal management strategies to improve short-term outcomes in pain, edema, sensation, wrist AROM, grip strength, and function for individuals following nonoperative and operative treatment for their DRF.

D Conflicting evidence prevents making a recommendation for or against mechanical agents, including continuous passive motion, intermittent pneumatic compression, and blood flow restriction, to improve pain, edema, AROM, grip strength, and functional outcomes for individuals following nonoperative or operative management of their DRF.

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List of Abbreviations

AAOS: American Academy of Orthopaedic Surgeons
ABC: Activities-Specific Balance Confidence Scale
ADLs: activities of daily living
AHUEPT: Academy of Hand and Upper Extremity Physical Therapy
AOPT: Academy of Orthopaedic Physical Therapy
AROM: active range of motion
ASIF: Swiss Association for the Study of Internal Fixation
AUC: area under the curve
BFR: blood flow restriction
CA: Cronbach's alpha
CES-D: Center for Epidemiologic Studies Depression scale
CHT: certified hand therapists
CI: confidence interval
COPM: Canadian Occupational Performance Measure
CP: cold pack
CPG: clinical practice guideline
CPM: continuous passive motion
CRPS-1: complex regional pain syndrome (type 1)
CST: chair stand test
DASH: Disabilities of the Arm, Shoulder, and Hand questionnaire
DRF: distal radius fracture
DRUJ: distal radial ulnar joint

ES: effect size
FOF: fear of falling
GDG: guideline development group
GMI: graded motor imaging
HEP: home exercise program
HP: hot pack
ICC: intraclass correlation coefficient
ICF: International Classification of Functioning, Disability, and Health
iHEP: independent home exercise program
IPC: intermittent pneumatic compression
JOSPT: Journal of Orthopaedic & Sports Physical Therapy
JPS: joint position sense
JTHFT: Jebsen-Taylor Hand Function Test
LEMS: lower extremity muscle strength
LT: laser therapy
MCID: minimal clinically important difference
MD: mean difference
MDC: minimal detectable change
MEP: movement-evoked pain
MHQ: Michigan Hand Questionnaire
MLD: manual lymphatic drainage
MMWS: Modified Mayo Wrist Score
MOS: medical outcomes study
MSK: musculoskeletal
MWM: mobilization with movement
NPRS: numeric pain-rating scale
NRS: numerical rating scale
OLS: one-leg stand test
OR: odds ratio
ORIF: open reduction and internal fixation
OT: occupational therapy/therapist
PAR: pain at rest
PCL-C: Post Trauma Stress Disorder Civilian Checklist
PEMF: pulsed electromagnetic frequency
PROM: passive range of motion
PRWE: Patient-Rated Wrist Evaluation
PRWHE: Patient-Rated Wrist/Hand Evaluation
PSFS: Patient-Specific Functional Scale
PT: physical therapy/therapist
QDASH: quick disabilities of the arm, shoulder, and hand questionnaire
QoL: quality of life
r: Pearson correlation coefficient
RCJ: radiocarpal joint
RCT: randomized controlled trial
ROM: range of motion
RR: relative risk
rs: Spearman's rank coefficient
SEM: standard error of measurement
SF: Short Form
SM: sensorimotor
SRM: standardized response means
SupT: supervised therapy
TENS: transcutaneous electrical nerve stimulation
TFCC: triangular fibro-cartilaginous complex
TUG: timed up and go test
UCJ: ulnocarpal joint
UEMSK: upper extremity musculoskeletal conditions
UVLT: ultraviolet light therapy
VAS: visual analog scale
WWP: warm whirlpool

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Introduction

AIM OF THE GUIDELINES

The Academy of Hand and Upper Extremity Physical Therapy (AHUEPT) and Academy of Orthopaedic Physical Therapy (AOPT) of the American Physical Therapy Association (APTA) have an ongoing effort to create evidence-based practice guidelines for the management of individuals with musculoskeletal (MSK) impairments described in the World Health Organization's International Classification of Functioning, Disability, and Health (ICF).[74]

The purposes of these clinical guidelines are to:

- Describe evidence-based practice including diagnosis, prognosis, intervention, and assessment of outcomes of MSK disorders commonly managed by orthopedic, sports, and hand physical therapists
- Classify and define common MSK conditions using the World Health Organization's terminology related to impairments of body function and body structure, activity limitations, and participation restrictions
- Identify interventions supported by current best evidence to address impairments of body function and structure, activity limitations, and participation restrictions associated with common MSK conditions
- Identify appropriate outcome measures to assess changes resulting from physical therapy interventions in body function and structure as well as in activity and participation of

the individual
- Provide a description to policymakers, using internationally accepted terminology, of the practice of orthopaedic, sports, and hand physical therapists
- Provide information for payers and claims reviewers regarding the practice of orthopaedic, sports, and hand therapy for common MSK conditions
- Create a reference publication for clinicians, academic instructors, clinical instructors, students, interns, residents, and fellows regarding the best current practice of orthopaedic and sports physical therapy and hand rehabilitation

STATEMENT OF INTENT

These guidelines are not intended to be construed or to serve as a standard of care for physical therapists (PTs). Standards of care are determined on the basis of all clinical data available for an individual patient and are subject to change as scientific knowledge and technology advance and patterns of care evolve. These parameters of practice should be considered guidelines only. Adherence to them will not ensure a successful outcome for every individual, nor should they be construed as including all proper methods of care or excluding other acceptable methods of care aimed at the same results. The ultimate judgment regarding a particular clinical procedure or treatment plan must be made in light of the clinical data presented by the individual, the diagnostic and treatment options available, and the individual's values, expectations, and preferences. However, we suggest that significant departures from accepted guidelines should be documented in the patient's medical records at the time the relevant clinical decision is made.

SCOPE AND RATIONALE

Distal radius fracture (DRF) is one of the most common fall-related fractures in middle-aged and older adults[216,225,255,285] with incidence ranging between 18% and 44% of all fractures seen in emergency orthopedic settings.[46,255,305] Females 50 years of age and older have a projected 16% life risk of sustaining an osteoporotic wrist fracture with an incidence ratio over 6:1 as compared to similar-aged males.[125] Given the projected increase in the elderly (or aging) population, the number of individuals expected to sustain a DRF is likely to increase, thereby adding to the costs associated with managing this condition.[270] While most individuals fully recover following a DRF,[101] as many as 15% to 20% of individuals continue to experience chronic pain and functional deficits after DRF.[186,208] Distal radius fracture resulting from low energy trauma is also a sign of poor bone health and a predictor of subsequent hip fracture, especially in older adults.[59,126]

This clinical practice guideline (CPG) synthesizes the literature concerning physical therapy management of DRF (**APPENDICES A**, **B,** and **C** reflect the strategy for literature search) using a systematic review methodology and provides practice recommendations for the management of DRF in outpatient rehabilitation settings. Often, individuals with DRF are managed by occupational therapists (OTs) who are credentialed as certified hand therapists. While this CPG intends to equip PTs with the required evidence to provide state-of-art rehabilitation to their patients with DRF, this CPG will assist the hand therapy community at large to provide evidence-based care to individuals who seek rehabilitation following DRF. Specifically, aspects of DRF management including epidemiology, pathophysiology, orthopedic classification of DRF injury, clinical course, prognosis, outcome measurement, and interventions are included. This CPG included literature concerning extra-articular and intra-articular DRF managed using operative or nonoperative approaches. This CPG excluded literature that described the management of "wrist fracture" with no specific emphasis on DRF being the patient group. The literature where patient groups had a DRF along with other fractures in the wrist or had concomitant injuries to the distal radial ulnar joint (DRUJ) was also excluded. This CPG also excluded literature on DRFs occurring in the pediatric population. Lastly, this CPG excluded literature focusing on orthopedic surgery or pharmacological management of DRF, since they are beyond the domain of PT practice.

Methods

This guideline integrated published literature from January 1995 to November 30, 2023. This CPG will be subject to revision in 2029, or earlier if a large volume of crucial literature becomes available. Updates to this CPG will be shown on the AOPT and AHUEPT of the APTA websites: www.orthopt.org and www.handpt.org.

LEVELS OF EVIDENCE

Individual clinical research articles were graded according to criteria adapted from the Centre for Evidence-Based Medicine, Oxford, UK (**http://www.cebm.net**) for the studies related to prognosis and interventions (Oxford CEBM 2011). In teams of two, each reviewer assigned a level of evidence

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and evaluated the quality of each article using a critical appraisal tool (see **APPENDICES D** and **E** for the levels-of-evidence table and details on procedures used for assigning levels of evidence, available at **www.jospt.org**). If the 2 content experts did not agree on a level of evidence for a particular article, a third content expert was used to resolve the issue. The evidence update was organized from the highest level of evidence to the lowest level of evidence. An abbreviated version of the grading system is provided in **TABLES 1** and **2**.

STRENGTH OF EVIDENCE AND GRADES OF RECOMMENDATION

The strength of the evidence supporting the recommendations was graded according to the established methods provided below (**TABLE 3**). Each team developed recommendations based on the strength of evidence, including how directly the studies addressed the question relating to DRF. In developing their recommendations, the authors considered the strengths and limitations of the body of evidence and the health benefits, side effects, and risks associated with the interventions.

GUIDELINE REVIEW PROCESS AND VALIDATION

The AOPT selected consultants from the following areas to serve as reviewers throughout the development of these CPGs:

- Claims review
- Coding
- Guideline methodology
- Medical practice guidelines
- Manual therapy
- Movement science
- Occupational therapy clinical practice
- Orthopaedic physical therapy clinical practice
- Orthopaedic physical therapy residency education
- Orthopaedic surgery
- Outcomes research
- Individuals with DRF
- Physical therapy academic education

TABLE 1 Levels of Evidence for Intervention Studies

I	Evidence obtained from systematic reviews, high-quality diagnostic studies, prospective studies, or randomized controlled trials
II	Evidence obtained from systematic reviews, lesser-quality diagnostic studies, prospective studies, or randomized controlled trials (eg, weaker diagnostic criteria and reference standards, improper randomization, no blinding, less than 80% follow-up)
III	Case-control studies or retrospective studies
IV	Case series
V	Expert opinion

TABLE 2 Levels of Evidence for Prognostic Studies

I	Evidence obtained from systematic reviews of inception cohort studies
II	Evidence obtained from high-quality inception cohort studies
III	Cohort studies or control arm of randomized trials
IV	Case series, case-control studies, or poor quality cohort studies
V	Expert opinion

Identified reviewers who are experts in the management and rehabilitation of those with DRF reviewed a prepublication draft of this CPG content and methods for integrity, accuracy, validity, usefulness, and impact. Any comments, suggestions, or feedback from the expert reviewers were delivered to the author and editors for consideration and appropriate revisions. These guidelines were also posted for public comment on the AOPT website (www.orthopt.org), and a notification of this posting was sent to the members of the AOPT. Any comments, suggestions, and feedback gathered from public commentary were sent to the authors and editors to consider and make appropriate revisions to the guidelines, prior to

TABLE 3 Grades of Recommendation

Grades of Recommendation		Strength of Evidence	Level of Obligation
A	Strong evidence	A preponderance of level I and/or level II studies support the recommendation. This must include at least 1 level I study	Must or should
B	Moderate evidence	A single high-quality randomized controlled trial or a preponderance of level II studies support the recommendation	Should
C	Weak evidence	A single level II study or a preponderance of level III and IV studies, including statements of consensus by content experts, support the recommendation	May
D	Conflicting evidence	Higher-quality studies conducted on this topic disagree with respect to their conclusions. The recommendation is based on these conflicting studies	
E	Theoretical/ foundational evidence	A preponderance of evidence from animal or cadaver studies, from conceptual models/principles, or basic sciences/bench research supports this conclusion	May
F	Expert opinion	Best practice based on the clinical experience of the guideline development team	May

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TABLE 4 Planned Strategies and Tools to Support the Dissemination and Implementation of This CPG

Tool	Strategy
JOSPT's "Perspectives for Patients" and "Perspectives for Practice" articles	Patient- and clinician-oriented guideline summaries available at www.jospt.org
Mobile app of guideline-based exercises for patients/clients and health care practitioners	Marketing and distribution of the app via www.orthopt.org and www.handpt.org
Clinician's Quick-Reference Guide	Summary of guideline recommendations available at www.orthopt.org and www.handpt.org
JOSPT's Read for Credit℠ continuing education units	Continuing education units available for physical therapists at www.jospt.org
Webinars and educational offerings for health care practitioners	Guideline-based instruction available for practitioners at www.orthopt.org and www.handpt.org
Mobile and web-based app of guidelines for training of health care practitioners	Marketing and distribution of the app via www.orthopt.org
Non-English versions of the guidelines and guideline implementation tools	Development and distribution of translated guidelines and tools to JOSPT's international partners and global audience via www.jospt.org
American Physical Therapy Association's CPG+	Dissemination and implementation aids
International Guidelines Library (https://g-i-n.net/international-guidelines-library)	Dissemination and implementation aids

submitting them for publication to the *Journal of Orthopaedic & Sports Physical Therapy* (JOSPT).

DISSEMINATION AND IMPLEMENTATION TOOLS

In addition to publishing these guidelines in the *JOSPT*, these guidelines will be posted on the CPG (free access) areas of the *JOSPT* and AOPT websites and submitted for free access on the ECRI Guidelines Trust (guidelines.ecri.org) and the Physiotherapy Evidence Database (www.PEDro.org.au). The planned implementation tools for individuals, clinicians, educators, payers, policymakers, and researchers, and the associated implementation strategies are listed in **TABLE 4**.

ORGANIZATION OF THE GUIDELINE

When systematic reviews were conducted to support specific actionable recommendations, summaries of studies with the corresponding evidence levels were followed by evidence synthesis and rationale for the recommendation(s) with harms and benefits statements and gaps in knowledge. Topics for which a systematic review was conducted and recommendations provided include prognosis, examination, and interventions during physical therapy episodes of care for individuals following a DRF. A summary of the literature is provided for other topics where a systematic review was outside the scope of this CPG. This includes injury mechanism and epidemiology, biomechanical and pathoanatomical features, and clinical course. The management of DRF from the perspective of orthopedic and hand surgeons is also briefly summarized, including the DRF classification, diagnosis, imaging considerations, and operative versus nonoperative management to stabilize a fracture.

Injury Mechanism and Epidemiology

A DRF is a metaphyseal bone fracture that occurs within the distal 3 to 5 cm of the radius[39,70] and affects mostly active functionally independent adults.[70,245] Those with a DRF comprise approximately 1.5% to 2.5% of all emergency orthopedic-care cases[16,216] and encompass nearly 18% of all adult fractures.[16] There are also over 643 000 DRF claims with an estimated $385 to $535 million annual health care cost in the United States.[195] It is considered the second most frequent fracture, only behind hip fractures, and the most prevalent upper extremity fracture among adults.[195] DRF affects mostly women with a 4:1 female-male age-adjusted ratio.[224,292]

The incidence of DRFs presents in a bimodal distribution among younger (peak at 10-18 years) and older (peak at 70-80 years) populations.[16,136,281] A DRF is caused by both high- and low-energy injury mechanisms,[102] which involve an abruptly applied impact or compression force at the wrist.[39] High-energy trauma is the leading cause among pediatric and young adult groups, especially among males[16,39] who sustain a DRF while playing sports, falling from heights, driving a motorcycle, sustaining a car accident, or engaging in activities with high physical demands. Low-energy trauma is the leading cause among older aged groups,[39,102] especially females with poor balance and decreased bone mineral

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density[70,227] who unexpectedly fall on an outstretched arm from a standing height.[102] It should be noted that each year in the United States, 30% of older (> 65 years) adults sustain a standing-height fall. These falls are associated with DRF rates of 237/100 000 and 58/100 000 among females and males, respectively.[271] Following a DRF, the odds for significant functional decline increase by 48%,[70] and although death is an infrequent consequence in this population, a 6%, 7%, and 8% mortality rate has been documented at 1, 3, and 5 years, respectively, among older adults.[271]

Overall, DRF incidence is influenced by sex and advancing age.[276,292] The incidence of a DRF is the lowest among young adults (18-39 years) with incidence rates of 9 to 23 and 6 to 10 per 10 000 cases among males and females, respectively.[224,276] Among young adults, males might be up to 2 times more likely to sustain a DRF than females.[276] This trend reverses during mid-adulthood (40-65 years) when the incidence of DRF among females sharply rises to 71% as compared to males.[16] During this time, male and female DRF incidence rates are estimated to be 6 to 10 and 17 to 46 per 10 000 cases, respectively.[224,276] By the age of 50 years, females present a 51% remaining lifetime probability of having a DRF as compared to 20% for men.[171] For older adults (> 65 years), the gender-based DRF incidence disparity increases further with females being 85% more likely to sustain a DRF than males, attaining an incidence rate of 57 to 116 per 10 000 cases.[142,224,276,305] By the age of 85, the DRF incidence for females may peak at 120 per 10 000 persons.[292] In contrast, DRF incidence rates for adult males are relatively stable (6 to 23 per 10 000 person years), then slightly increase at the age of 65 to nearly 30 per 10 000 cases[224,276] and peak by the age of 85 to near 33 per 10 000 persons.[292]

Biomechanical and Pathoanatomical Features

The distal radius forms an important base of support for the wrist joint, which is a multiarticular system involving the radiocarpal joint (RCJ), ulnocarpal joint (UCJ), and DRUJ.[25] Ultimately, the wrist joint encompasses an important anatomic bridge between the hand and the forearm, allowing axial compressive loading to be effectively transmitted during the upper extremity open and closed kinetic-chain function.[68] The RCJ and UCJ are anatomically adjacent joints between the distal radius and ulna and the proximal carpal row, allowing for normal wrist flexion-extension and ulnar-radial deviation AROM.[25] Both are supported by a contiguous synovial joint capsule, which is formed by strong extrinsic volar and dorsal radiocarpal and ulnocarpal ligaments.[300] At the ulnar sigmoid notch, the distal radius articulates with the ulnar head, forming the DRUJ and supported by strong volar and dorsal DRUJ capsular ligaments, as well as the triangular fibro-cartilaginous complex (TFCC).[9,35,301] Besides its role as a strong DRUJ connective tissue, the TFCC allows the RCJ and UCJ to share a continuous articular relationship with the proximal carpal row. It also isolates the DRUJ to function as a separate synovial articulating system outside the RCJ confines.[25] In normal DRUJ alignment, the ulna head is positioned within ±2 mm relative to the distal radius articular surface.[35] This normal ulnar variance greatly depends on forearm position and usually increases with pronation and decreases with supination.[9]

Axial force distribution at the wrist is largely dictated by its unique articular geometry along its RCJ, UCJ, and DRUJ. At the DRUJ, the distal radius articular surface slopes 22° ulnarly (radial inclination angle) and 11° palmarly (palmar tilt angle) between the radial styloid process laterally and sigmoid notch medially. The radial styloid also extends distal to its medialmost articular surface by 11 mm, a distance known as the distal radius height.[35] Within these articular margins, wrist axial force distribution follows a 3-column system. The lateral column at the scaphoid fossa forms an osseous buttress due to its greater cross-sectional articular surface and ligamentous strength. The intermediate column at the lunate fossa is a central articular point for the greatest compressive force propagation.[244] Both of these columns are aligned with the radiocarpal articulation and accept nearly 80% of compression forces during wrist function.[25] Lastly, the medial column at the distal ulna supports the forearm rotation mechanism with the DRUJ[244] and accepts only 20% of axial force transmission.[25] Because of these complexities, a DRF may greatly impact the biomechanical role and disrupt the normal force distribution through this intricate column system.[244]

A DRF occurs at the inertly weaker metaphyseal region of the distal 3 to 5 cm of radius.[39,102] Within this region, a 2-mm thin subchondral bone plate shields the distal radius subarticular surfaces from incoming axial loads.[18] The majority (50% to 70%) of its remaining metaphyseal bone mass normally consists of a weaker core of trabecular bone,[57] which is designed to absorb and transmit articular impact. This weaker bone region is filled with a network of trabecular bone arches that resemble a bridge. The apexes of these arches support the

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subchondral bone plate and their bases conjoin with a more proximal cortical diaphyseal region.[18] The dorsal metaphyseal region of the distal radius contains a greater amount of trabecular bone as compared to its volar region, forming another vulnerable zone to fracture.[57] This distal radius trabecular region is significantly weaker, especially among premenopausal and postmenopausal women.[19,253] In contrast, its adjacent diaphyseal cortex consists of 95% stronger cortical bone mass and offers greater bone-yield resistance to incoming axial compressive forces.[275] Based on the distal radius bone morphology, abrupt compressive forces can elicit distinct fracture lines through its thin subchondral bone plate and more cancellous metaphyseal region,[18] where various extra-articular or intra-articular fracture patterns may form within a 10-mm region from the articular surface.[275]

The mechanism of a DRF involves the transmission of axial forces through the radio-carpal articular surface, commonly due to a fall with a pronated and hyperextended wrist. This frequently results in a dorsally displaced and comminuted DRF with or without articular involvement and is known as a "Colles" fracture.[39,101] A less frequent mechanism of a DRF entails a wrist bending moment with a hyperflexed wrist at the impact point, leading to a palmar fragment displacement known as a "Smith" fracture.[194] A shearing axial force with a laterally bending moment could also occur, causing either a volarly or dorsally subluxed articular fragment known as a "Barton" fracture.[27,238] Such a shearing force may also induce an oblique and radially displaced fracture of the radial styloid known as a "Chauffeur" fracture.[238] Radial styloid fractures could be further complicated by an unopposed brachioradialis muscle proximal-directed force.[180] Regardless of the mechanism, a DRF would occur when 1% to 7% of the distal radius bone-tissue yield strain point (1000-2000 N of force) is surpassed at the impact point.[233] At the fracture site, various extra-articular and intra-articular complex fracture line patterns may form and propagate proximally depending on the injury-force severity and existing bone-density quality.[306] Fracture patterns may implicate and compromise the stability of the RCJ, UCJ, and DRUJ[33,252] affecting the dynamic[114,213] and static wrist stabilizing structures, rendering them vulnerable to future potential injury.[39,85]

DRFs are frequently associated with significant wrist deformities and complications that vary between 6% and 80%, depending on the injury severity and type of fracture treatment. Such complications may lead to abnormal wrist biomechanics, as well as persistent pain and disability.[193] Following a DRF, a common anatomical deformity is dorsal radius angulation combined with various degrees of radial shortening.[52,273] This deformity is frequently associated with loss of normal radial height, and distortion of normal radial-inclination and palmar-tilt angles,[51,52] which can potentially disrupt normal joint congruency and cause abnormal force distribution through the wrist during functional loading.[4,236] Radial shortening due to dorsal radial angulation alters the balance of normal axial forces transmitted through the RCJ and UCJ.[236,273] More specifically, a dorsal angulation of 10° to 45° disrupts normal ulnar variance mechanics and increases UCJ axial loading up to 67%.[273] Thus, it may cause increased TFCC strain,[39] greater potential for TFCC compression injury,[4] and DRUJ instability.[170] Dorsal angulation of ≥10°, along with loss of a normal radial palmar-tilt angle may further disrupt normal intercalated carpal biomechanics,[39,231] promoting mid-carpal joint strain and instability.[289] Radial shortening with dorsal angulation may also distort the wrist extrinsic muscles' normal length-tension relationships,[302] resulting in a long-term grip strength deficit.[54] Wrist articular congruency alteration is another important concern following complex intra-articular DRFs[39] due to implications for developing posttraumatic osteoarthritis.[36,236] Considering that the average radiocarpal joint cartilage thickness is <1 mm,[237] an intra-articular step-off deformity of ≥2 mm has been associated with a greater risk of developing long-term RCJ arthrosis.[236] It should be noted that reliably measuring this step-off deformity has presented challenges.[110] Malunion associated with one of the aforementioned fractures may create undesirable anatomical deformities and is considered the most common post-DRF complication. This may be especially problematic following conservative treatment,[193] with an incidence of deformity as high as 35% to 50%.[268,324]

Complications, other than malunion and anatomical deformities, have been reported following DRF. These complications vary depending on the injury severity and selected treatment methods and may be influenced by individual factors such as lifestyle, age, mental attitude, social support, compliance with treatment,[193] and socioeconomic status.[43] Type 1 complex regional pain syndrome (CRPS-1), infections, and wrist tendon attrition may be encountered following DRFs, regardless of the treatment mode. The incidence of CRPS-1 has been reported to vary between 1% and 32% and may be more prevalent among females.[64,123,296] Soft-tissue or bone infections might occur with mostly postoperative DRF interventions and vary between 1% and 33% depending on whether the treatment mode entailed an internal or external fixation option.[193,296] Tendon complications may present various severity levels and encompass injuries that range from minor tendon irritation to tendon attrition and complete rupture.[13,14,193] Although such injuries may be induced both by prominent malunited bone fragments or surgical hardware components, an internal fixation approach may induce nearly 6 times higher tendon attrition injuries than conservative management.[193] Overall, the incident levels of tendon compli-

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cations following DRF may vary between 1% and 16%.[13,282,296] A TFCC tear is a very frequent complication following DRF[84] with reported incident rates near 40% and 50% depending on the type of DRF pattern.[254] Other common complications following DRF might include wrist ligament sprains,[33] with the scapholunate and lunotriquetral ligaments being affected most frequently;[87,323] nerve injury, with the median nerve being the most commonly injured structure;[50] and loss of wrist and hand mobility due to persistent edema, pain,[155,228] and arthrofibrosis.[89,260] Incidence rates for ligament sprains, nerve injury, and joint hypomobility following DRF have been reported to be as high as 98%, 17%, and 31%, respectively.[296]

Fracture Classification and Diagnosis

Assessment after a DRF involves a multifaceted process that aims to determine the best overall management for optimal functional outcome.[39] In this process, orthopedic surgeons need to consider not only the level of fracture severity, but also individual functional demands, and concomitant individual comorbidities.[116] Management of a DRF has been traditionally guided by radiological assessment to diagnose, classify, and grade fracture severity. In addition to standard anteroposterior, oblique, and lateral x-ray film views, advanced imaging techniques (eg, 3-dimensional computed tomography) have also led to enhanced interpretation of DRF morphology and characteristics, ultimately guiding clinical decisions toward more sophisticated and advanced postfracture interventions.[275] Radiological findings (eg, altered radial inclination, loss of palmar tilt, radial shortening, increased dorsal angulation, presence of articular step-off, and level of distal radius comminution) are commonly used by orthopaedic surgeons to guide postfracture treatment decisions.[162]

The early DRF classification included the term "Colles" fracture. This was described as a dorsally displaced and comminuted fracture, resulting in a shortened radius with a dorsal wrist angulation known as "dinner fork deformity."[162] In 1838, the "Barton's fracture" description was introduced to describe a dorsally displaced unstable intra-articular DRF with carpus subluxation. A "reverse Barton's fracture" classification was reserved for only the volarly displaced Barton's fractures.[291] Volarly displaced nonarticular DRFs without carpus dislocation were later subclassified as "Smith fracture."[218] Advancing radiological techniques have been used to describe other DRF patterns. Improvements in the description of the DRF morphology were intended to determine severity levels and better guide after-fracture management.[39,116] These include the Gartland and Werley,[88,91,130,169,203,223] Swiss Association for the Study of Internal Fixation (AO/ASIF) group,[226] Universal Classification,[51,52] and Fernandez[82] classification systems. The Frykman and AO/ASIF classification systems are the most frequently documented in current literature as they reflect a broader framework of fracture characteristics, including fracture types through the distal ulna, various degrees of distal radius comminution, and displacement through both extra-articular and intra-articular patterns.[322]

Overall, the DRF classifications are primarily used for academic research purposes and are not typically used in clinical practice by an orthopaedic surgeon. The most practical classification would be the AO/ASIF, whereby fractures are broadly classified as (A) extra-articular, (B) partial articular, or (C) intra-articular. Each of these is further subclassified based on the degree of comminution, namely, simple (1), fragmentary (2), and multifragmentary (3). As the alphanumeric order increases, the complexity of the fractures also increases.[322] The overall reliability of this system is considered to be moderate. However, the reliability of this system decreases as further categories of subclassification are added.[234] Despite the distinct advantages of the AO/ASIF classification system, limited and/or equivocal evidence exists to substantiate its predictive value for functional recovery following DRF.[43,138] Karnezis et al found no correlation between the AO/ASIF classification system and individual-reported outcomes (eg, Patient-Rated Wrist Evaluation [PRWE] questionnaire) following DRF treatment.[138] The other commonly used classification, Frykman, was found to have a moderate correlation with the PRWE questionnaire when a radiographic assessment was conducted upon fracture union following after-fracture treatment.[21] However, the poor intrarater and interrater reliability of the Frykman classification system has negatively impacted its clinical usefulness as a prognostic and diagnostic tool.[11] Using radiological evidence to determine whether proper anatomy has been restored, postfracture intervention is more clinically meaningful. Attaining a satisfactory anatomic reduction and joint congruency has been positively linked to improved long-term functional outcomes following DRF treatment interventions.[43,196,280,294]

DIAGNOSTIC CRITERIA AND USE OF IMAGING

Fracture management decisions are multidimensional. While individual characteristics are considered, in most cases, imaging criteria play the most important role. Imaging can be used to assess important factors such as alignment parameters,

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fracture comminution, and degree of articular involvement.[313,322] While the relevant components are captured in the classification systems, alignment parameters are assessed individually as a potential predictor of outcome. Both the prereduction and postreduction radiographs are assessed to determine the optimal treatment strategy. They allow the surgeon to appreciate the degree of deformity and overall fracture stability.[109,322] To determine whether the alignment is acceptable, articular incongruity or step deformity is considered, as is the degree of dorsal tilt, loss of radial height, radial inclination, and comminution.[116] Many clinical guidelines have been published regarding the acceptable cut-off for each of these measures, with age being often used as a modifier of the alignment criteria.[221]

The American Academy of Orthopaedic Surgeons (AAOS) utilizes the following guidelines[132] as indications of surgical fixation for DRFs:

1. In nongeriatric patients (<65 years), moderate-level evidence supports that operative intervention can improve outcomes for fractures with >3 mm of postreduction radial shortening, > 10° dorsal tilt, and/or >2 mm of intra-articular displacement or step-off.
2. In geriatric (≥65 years) patients, strong- to moderate-level evidence supports that operative treatment may lead to only short-term (3-6 months) improved patient-reported outcomes, mainly with volar locked plating. However, no long-term (>1-year post fracture) advantage to operative fixation was detected among this aged-based population.

In these guidelines, the nonoperative arm of many of the studies considered in this CPG included only stable fractures. These studies did not necessarily represent malunions or suggest that malunited DRFs have a similar long-term outcome as compared to well-aligned fractures. There is conflicting evidence related to the correlation of alignment and outcome in the population aged >65 years. Also, the terms "geriatric" and "nongeriatric" were simply used as a proxy for functional demand. A high-functioning individual with high functional demands may benefit from operative fixation based on the literature, regardless of their chronological age. Thus, treatment decisions should be based on an understanding of the individual's functional demands.[132] In addition to the postreduction alignment of a DRF, the stability of the fracture also needs to be considered. LaFontaine's criteria[156] have been well established and are used to determine fracture stability. Five basic criteria suggestive of instability have been identified: (1) dorsal angulation >20° at presentation, (2) dorsal comminution, (3) extension of the fracture into the radiocarpal joint, (4) associated ulnar fracture, and (5) age over 60 years. In cases where 3 or more of these criteria are present, the fracture is considered unstable. This suggests that although the alignment of the fracture may be acceptable at the time of radiographic evaluation, the likelihood of losing reduction is high, and this may direct the surgeon toward early operative intervention.[132]

Once the initial images are assessed and a management plan devised, serial radiographs can be used to monitor bone healing and ensure the DRF remains well aligned.[39] When treating fractures with casting only, there can be a risk of redisplacement. The decision to accept a certain degree of malunion needs to be made with the individual based on their functional demands.[132,138] At times, based on the results of subsequent radiographs, a decision may be made to abandon cast treatment and shift to operative intervention.[158,252] Radiographs are also used to confirm union and, once union is achieved, to confirm the degree of union.[116,313] This becomes relevant when making decisions that may be useful to guide the timing of therapy initiation, the intensity of therapy exercises, and other clinical decisions such as return to work and contact sports.[63,150]

Clinical Course

The clinical course following a DRF requires a multidisciplinary approach to management and is typically divided into 2 periods: initial fracture treatment period and the rehabilitation management period. The initial fracture and rehabilitation periods are primarily directed by the orthopedic medical team. The rehabilitation management period involves a team of rehabilitation specialists, which may include PT and/or PTs, most of whom usually specialize in hand and upper extremity rehabilitation and collaborate with the orthopedic medical team.[101,150]

ORTHOPAEDIC SURGERY MANAGEMENT

Initial treatment of a DRF depends on the overall bony alignment.[158] If the alignment is deemed acceptable, immobilization is indicated and typically achieved with the use of a short arm cast for 4 to 6 weeks. If the alignment is not acceptable, a closed reduction will be performed before casting. If reduction can be maintained with casting alone, 6 weeks of immobilization is typically sufficient to achieve bony union.[109] If the alignment postreduction is not acceptable, or the fracture is deemed unstable, then surgical intervention

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is required to maintain the alignment.[156] Surgical approaches vary and depend on the severity of the injury, the underlying bone stock, and associated injuries. Surgical techniques range from closed reduction and percutaneous pinning with or without an external fixator to open reduction and internal fixation with a volar locking plate.[322] The AAOS CPG[267] states that there are no significant differences in radiographic or long-term patient-reported outcomes between fixation techniques for complete articular or unstable DRFs. However, volar locking plates typically lead to earlier recovery of function in the short term (3 months). Although fixation methods other than the volar locking plate are still used (ie, pins and plaster, dorsal plating, arthroscopic assisted fixation, external fixation, and bridge plating) they are not as common as the volar locking plate.[109,221] For severely comminuted or unstable fractures, external fixation may also be included as an intervention. However, the dorsal spanning bridge plate is seen as an alternative to external fixation as it allows for all fixation to remain internal, thereby reducing the risk of pin site infections. Also, unlike a traditional external fixator, it is possible to bear weight through a bridge plate.[221,267] Regardless of the method of stabilization chosen, rehabilitation following a DRF is key to ensuring a full recovery for most individuals.[101,150]

REHABILITATION MANAGEMENT

Although therapy has been variable,[101] traditionally DRF rehabilitation follows a similar paradigm regardless of the fracture-treatment approach used by an orthopaedic surgeon. In either nonoperative or operative DRF cases, most individuals are first managed with an early protective mobilization phase. Then, they progress into a wrist-mobilization phase, before they initiate the final strengthening phase, which extends until they are discharged from therapy and transition to an independent home exercise program (iHEP).[53,277] The early protective mobilization phase is often initiated during the initial fracture-treatment protection period. Such a protective period allows for proper bony tissue physiological healing to occur at the fracture site following nonoperative and operative DRF treatment approaches. During this time, the wrist is fully immobilized either in a cast or a splint with any wrist ROM being contraindicated.[241] Yet, patient education for self-directed active or passive ROM at the digits of the affected hand and other proximal joints at the elbow, forearm, and shoulder is advised.[155] This early protective mobilization phase may start immediately after surgery or cast immobilization to prevent unwanted stiffness that may adversely affect the rehabilitation outcomes.[240] The utilization of an edema compression glove may also be advisable during this early protective phase[204] for select DRF individuals whose hand mobility and pain levels are negatively affected by persistent edema.

The wrist mobilization phase is initiated when a satisfactory DRF healing level has been confirmed by the orthopaedic surgeon. This allows for exercise loading to be safely imposed across the involved wrist fracture site. At that time, an individual may be referred to supervised therapy (SupT) or monitored via an independent HEP, based on the orthopaedic medical team's clinical discretion. For DRF individuals who are managed conservatively, this phase is initiated immediately after their 4 to 6 weeks cast immobilization period.[53,134,150] For surgically repaired DRF individuals with rigid internal fixation, this phase may start at an earlier time point and within the first 2 weeks (ie, accelerated rehabilitation approach)[240,283] or at 4 to 6 weeks (ie, delayed-standard rehabilitation approach)[31,174] following surgery, depending on fracture healing and stability. Thus, a distinct difference in the therapeutic management approach following DRF treatment is the duration of the early protective mobilization phase and the time when the wrist-mobilization phase is initiated. Regardless of whether there is an accelerated or delayed-standard rehabilitation approach, at minimum, early digital range of motion should be emphasized. Early wrist ROM should also be considered in the setting of operative stabilization. If there are any signs of extreme digital stiffness, hand hypersensitivity, and/or trophic changes in the skin, an urgent consult with therapy, preferably a hand therapist, should be initiated.

The focus of the wrist-mobilization phase is to manage pain and edema while optimizing active and passive ROM at the wrist, in addition to the hand, elbow, and shoulder.[98,287,288] In this phase, emphasis is also given to improving wrist and hand sensibility and sensorimotor (SM) control via improving conscious proprioception.[318] Submaximal isometric exercises can be used to improve pain, joint dynamic stability, and motor control in all joints. During this phase, therapy goals are achieved via both active- and passive-mobilization methods, which may include joint[206,293] and soft-tissue mobilization techniques,[149] as well as patient education for a daily HEP.[32] If excessive joint stiffness persists and wrist ROM goals are not satisfactorily met, the application of static or dynamic mobilization splinting[128,176] might be used for select individuals despite its weak evidence. For the implementation of this treatment option, a physician's approval is typically required for insurance coverage purposes. Thus, through this entire rehabilitation phase, communication and collaboration between the therapist and the orthopaedic surgeon are critical to ensure effective therapy continuity and optimum outcomes.

The strengthening phase typically starts around 6 to 8 weeks following the initiation of fracture treatment and requires adequate fracture healing and stability.[42,47] It usually encompasses progressive resistance exercises via isotonic, eccentric, power gripping, and perturbation training with increasing loading levels through the wrist and the entire upper extremity. Such exercises should

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be performed with caution when there is positive ulnar variance, malunion, or ulnar-sided wrist pain. A focus of the strengthening phase is to promote optimal neuromuscular control, unconscious proprioception, and functional retraining, which is aimed at each individual's specific functional expectations.[133] This phase prepares individuals to resume full daily and vocational activities safely. It is important to note that the aforementioned rehabilitation progression timelines may vary among individuals and be dependent on physical demands and functional impairment levels, as well as comorbidities and postfracture complications.

Currently, there are several debated questions in the literature regarding the initial course of DRF rehabilitation. First, there are no clearly delineated criteria on which subgroups of DRF individuals would benefit from a referral to supervised rehabilitation services as compared to being managed via an iHEP alone or having no therapy at all. The latest AAOS CPG on DRF medical management[267] concluded that, based on insufficient evidence, supervised rehabilitation does not benefit all individuals with DRF, and only a subset of individuals might benefit from SupT services. However, these guidelines do not offer any insights into the subgroups of patients who would benefit from therapy, nor do they offer any information concerning specific patient or injury-related factors that orthopaedic surgeons should consider when determining the appropriateness of unsupervised therapy versus supervised rehabilitation. Often, supervised rehabilitation is elected for individuals with significant hand and wrist ROM limitations who require a greater level of supervision. Current literature has indicated several prognostic factors that may influence short- and long-term functional outcomes in individuals with DRF and, therefore, should be considered in the guiding of clinical decisions in this debated issue. These prognostic factors are discussed in the "Prognosis after DRF" section of this CPG. It should be noted that the presence of 1 or more of these factors could adversely affect an individual's outcomes after DRF[179] and therefore trigger a referral to supervised rehabilitation. The evidence synthesis and recommendations for the comparison between SupT versus iHEP are presented in detail within the intervention section of this CPG.

Another issue related to DRF rehabilitation is determining who should be directing and monitoring the iHEP during the early protective phase. In several studies, an iHEP is directed primarily by the supervising orthopaedic surgeon with or without any contribution of a participating therapist.[44,153,284] Yet, most other studies have implemented iHEP education strictly using dedicated hand therapists.[32,48,100,141,298] There is also a lack of information on how an iHEP is best monitored and assessed over time. Thus, the available evidence is insufficient to derive clear conclusions on these issues due to study design heterogeneity and methodological limitations. Rational clinical judgment suggests that patient education toward any iHEP provision should be directed and monitored by therapists (PTs or OTs), preferably certified hand therapists or orthopaedic physical/occupational therapy specialists.

Finally, the optimum time to initiate the wrist-mobilization rehabilitation phase following DRF surgery is not fully agreed upon among surgeons. Several studies have compared the accelerated to delayed standard rehabilitation approaches following DRF surgery.[31,61,240,283,312,325] The evidence synthesis and recommendations for this important topic are also presented in detail within the Intervention section of this CPG.

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CLINICAL GUIDELINES

Prognosis

There are important outcomes that need to be considered when attempting to predict an individual's prognosis after a DRF. These outcomes include function and disability, chronic pain/CRPS-1, wrist/hand related impairments, general health/quality of life, and return to work.

OUTCOME PREDICTORS FOR WRIST/HAND-RELATED ACTIVITY LIMITATIONS/PARTICIPATION RESTRICTIONS

Age

I Based on multivariable regression analysis, Roh et al[247] reported in a prospective cohort of 157 individuals (mean age, 62 years; 63% female) that older age (β = −0.75; 95% confidence interval [CI]: −1.08, −0.42) was significantly associated with poorer functional recovery at 12 months after DRF treated with volar plate fixation.

II In a systematic review, Babatunde et al,[17] included 7 prospective and 6 retrospective cohort studies and identified age greater than 65 years as a risk factor for poorer functional outcomes with a moderate level of evidence. Within this systematic review, however, a large prospective study (n = 360; mean age, 59 years; 78% female) reported a low correlation between age and Disabilities of the Arm, Shoulder, and Hand questionnaire (DASH)

scores at the 3-month (r = 0.33) and 12-month (r = 0.28) follow-up.[2]

III Four lower-level prospective cohort studies,[20,43,72,79] 1 cross-sectional study,[208] and 2 retrospective studies[54,159] found significant associations between age and function at 12 to 18 months after DRF. In a sample of 2571 individuals (mean age, 62 years; 80% female), Landgren et al[159] reported a correlation coefficient of r = 0.24 (P<.001) between age at fracture and 1-year DASH score. Using multivariable regression analysis, Barai et al[20] estimated that function decreased by 0.14 (95% CI: 0.02, 0.26) points on the DASH for every 1-year increase in age. Similarly, Chung et al[43] found a 0.29-point (95% CI: 0.04, 0.53) decrease in Michigan Hand Questionnaire (MHQ) score for every 1-year increase in age.

Female Sex

I A prospective cohort study of 364 individuals (73% female; median age, 65 years) reported that the female sex was a strong predictor (β = 3.35; 95% CI: 1.80, 4.63; P<.001) of functional limitation at 6 to 9 months post injury as measured by the QuickDASH.[120] In the study by Roh et al,[247] univariable analysis revealed that female sex was not a significant predictor of outcome based on MHQ scores at 12 months after surgery.

II The systematic review by Babatunde et al[17] found moderate-quality evidence from 12 studies (5 prospective and 7 retrospective) indicating that being female is a predictor of poorer functional outcomes after wrist fracture. Two other prospective cohort studies not included in that systematic review[96,97] reported no influence of gender on functional outcome in individuals after wrist fracture. In the largest study, no significant association between gender and PRWE (P = .45) scores was found among 222 individuals (78% female; mean age, 55.2 years) followed for 12 months after extra-articular DRF.[97]

III Results from 3 retrospective studies[129,159,207] indicated that female sex was significantly associated with poorer outcomes. Using logistic regression, Jung et al[129] in a sample of 54 individuals (57% female; mean age, 51 years) assessed individuals 12 months after operatively treated DRF and found women were at much greater risk of poor Modified Mayo Wrist Score (MMWS) than men (odds ratio [OR] = 27.75; 95% CI: 2.88, 267.29; P = .004). In contrast, 1 retrospective study of 386 individuals (72% female; mean age, 52.4 years) reported no significant association between gender and 1-year PRWE scores (P = .18).[326] A lack of association (P = .50) was also reported between sex and QuickDASH scores at 12 months after operative treatment for DRF in a case-control study of 211 individuals by McQuillan et al.[197]

Baseline Pain or Function

III One prospective study (n = 250, 66% female, mean age not reported) found that baseline scores for both the DASH and PRWE questionnaires during the first visit to a hand clinic (within the first week after primary care) were significant predictors of 1-year scores on those same questionnaires.[184] However, the regression model explained only 21% of the variability in 1-year scores for these measures.[184]

III In a secondary analysis of a prospective cohort (n = 229; mean age, 52 years; 69% female), Farzad et al[81] reported that higher movement-evoked pain (MEP) assessed at 2 months after injury was significantly predictive of higher disability at 6 months after DRF (OR = 2.28; 95% CI: 1.18, 4.42; P = .014). MEP was defined by the mean score on 2 pain-related items on the function subscale of the PRWE, including pain during repetitive wrist motion and while lifting heavy items. A cutoff score of ≥7/10 for these 2 items was found to be 58% sensitive and 81% specific (area under the curve [AUC] = 0.79) for ongoing disability, defined as a PRWE function subscale score of ≥12.5/50 at 6 months. Pain at rest (PAR) ≥3/10 was also associated with disability at 6 months (AUC = 0.82; sensitivity = 0.51; specificity = 0.91).

III Iitsuka et al[115] retrospectively divided a sample of 45 individuals (mean age, 54 years; 67% female) into 2 groups based on whether the minimal clinically important difference (MCID) for the DASH (17 points) was achieved by 8 weeks postoperatively. Logistic regression analysis found that baseline scores obtained at 4 weeks were independent predictors of DASH scores at 8 weeks (OR = 1.193; 95% CI: 1.046, 1.360; P<.01)

Psychosocial Factors

I Among 140 individuals (mean age, 67 years; 70% female) followed prospectively, Luk et al[177] found that psychological status measured at the time of cast removal (mean duration = 38.7 days) was the most important predictor of self-perceived disability after nonoperative treatment for DRF. Multivariable analysis revealed that scores on the Hospital Anxiety and Depression Scale explained 16.8% (P<.001) of the variance in DASH scores at 24 weeks post injury.

I Goudie et al[95] measured symptoms of psychological distress prospectively using the Post Trauma Stress Disorder Civilian Checklist (PCL-C) in 129 individuals (mean age, 57 years; 71% female) within 3 weeks of injury.

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PCL-C scores were significantly associated with DASH scores at 6 months (β = 0.3; *P* = .011). In a more recent study by the same authors, multivariable regression analysis identified several psychological factors as potential predictors of higher disability after DRF.[96] Among 216 individuals (mean age, 57 years; 75% female) followed for 9 months, increased levels of depressive symptoms (β = 0.2; *P*<.05), social deprivation (β = 0.2; *P*<.05), and a belief in an external locus of control (β = −0.1; *P*<.05) measured within 4 weeks of injury were associated with higher scores on the DASH.[96]

I In a study of 364 individuals (median age, 65 years; 73% female), use of antidepressants (β = −9.79; 95% CI: −12.78, −6.79; *P*<.001) and higher scores on the Pain Catastrophizing Scale (β = −1.71; 95% CI: −2.81, −0.64; *P* = .002) at less than 1 week after injury were correlated with greater functional limitations at 6 to 9 months as measured by PROMIS-UE scores (β = −9.79; 95% CI: −12.78, −6.79; *P*<.001).[120] In the same study, greater fear of movement scores on the Tampa Scale of Kinesiophobia-11 scale contributed to lower function on the PROMIS-UE (β = −1.86; *P*<.001), QuickDASH (β = 5.8; *P*<.001), and PRWE (β = 3.21; *P*<.001) outcome measures.[120]

II A baseline depression score of ≥16, measured within 10 days of injury using the Center for Epidemiologic Studies Depression (CES-D) scale, was one of the strongest predictors of DASH scores in a prospective sample of 228 individuals (mean age, 67 years; 89% female) 1 year after injury (β = −2.7; 95% CI: −6.4, −1.0; *P* = .0078).[321]

III In a prospective study of 291 individuals (mean age, 56.1 years; 68% female), higher baseline levels of self-reported social support, as measured by the Medical Outcomes Study Social Support Survey, were found to be significantly correlated (r = −0.22; *P*<.05) with improved PRWE ratings 12 months after injury.[286]

III Changes in anxiety scores (β = 0.42; *P* = .049) and change in self-efficacy scores (β = −0.45; *P* = .044) from 1 to 4 weeks were significantly associated with a change in PRWE scores from 1 to 12 weeks in 21 individuals (mean age, 60 years; 67% female) after volar plate fixation.[111] In a retrospective study of 319 individuals (mean age, 60 years; 81% female) by Modarresi et al[207] latent growth curve analysis of PRWE scores indicated that the proportion of individuals with depression was higher in the nonrecovery class (24%) than in the slow- (16%, *P* = .04) or rapid-recovery (8%, *P* = .03) classes. In a case-control study of 211 individuals (mean age, 59 years; 86% female), McQuillan et al[197] reported that receiving active treatment for depression at the time of injury (n = 50) was associated with a small increase (β = 6.53; 95% CI: 1.31, 11.75; *P* = .01) in QuickDASH scores at 12 months after surgery.

Compensation Status

II In a prospective study of 120 individuals (mean age, 52 years; 70% female) by MacDermid et al,[182] injury compensation accounted for 16% of the total variance in PRWE scores at 6 months. Grewal et al[97] also found that 12-month mean PRWE scores for subjects involved with third-party claims were 35.5 points compared to 15.0 points for those not involved in any claims (*P* = .006). Overall, injury compensation contributed 10.6% of the total variability in 1-year PRWE scores.

III Two studies, 1 low-level prospective[184] and 1 retrospective,[311] found injury compensation to be a factor predictive of functional outcome. MacDermid et al[184] reported mean 12-month PRWE scores for individuals receiving compensation to be 34 points, compared to 13 points for those receiving no compensation. Walsh et al[311] showed that workers' compensation claimants demonstrated worse function (β = 16.5; 95% CI: 8.7, 24.3) as measured by the DASH at 12 months after DRF.

Education Level

II In the prospective study by MacDermid et al,[182] a lower baseline level of education was significantly associated with poorer PRWE scores (r = 0.25, *P*<.006) at 6 months after injury. In the study by Grewal et al, multivariable analysis revealed that not having a high school diploma accounted for approximately 5% of the total variance in PRWE scores (*P* = .002) after 12 months.[97]

III In a study of 227 individuals (mean age, 55 years; 66% female), Paksima et al[230] evaluated education as an indicator of socioeconomic status by categorizing it into 1 of 5 levels, from not completing high school to having completed at least some postgraduate college education. Over a follow-up period from 3 to 12 months, DASH scores improved slightly more than twice as much for individuals at the highest education level compared to those at the lowest education level (β = −2.16, *P* = .001).[230] Using the MHQ, Shauver et al[269] found no significant association between education level and functional outcome at 12 months (*P* = .08).

Grip Strength

I Roh et al[247] showed that low hand grip strength of the unaffected hand at baseline (<26 kg for men and <18 kg for women) was an independent predictor of lower scores on the MHQ at 12 months after volar locking plate fixation (β = 1.01; 95% CI: 0.65, 1.31), after adjusting for low appendicular lean mass and age.

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III Grip strength, expressed as a ratio of sides and adjusted for hand dominance, was shown to be significantly associated with PRWE score (β = −1.09; 95% CI: −1.76, −0.42; *P*<.01) measured prospectively at 6 weeks after injury among a group of 35 individuals (mean age, 46 years; 61% female) managed nonoperatively.[137] In 207 individuals (mean age, 50 years; 67% female) followed prospectively after volar plate fixation, Shauver et al[269] found that the difference in grip strength (adjusted for hand dominance) between injured and uninjured sides was the only variable associated with MHQ score (β = −0.69; 95% CI: −1.06, −0.33; *P*<.001) at 3 months after surgery.

Dominant Side Injury

I II III The side of injury was not a significant predictor of functional outcome among any of the studies reviewed, regardless of the measure used to assess these outcomes or the level of evidence.[17,41,97,208,247]

Osteoporosis/Osteopenia

III Among 90 postmenopausal women (mean age, 64 years; range, 50-88) studied retrospectively after DRF operatively managed with volar plating, neither DASH (r = −0.03, *P* = .79) nor MMWS (r = −0.02, *P* = .82) was found to be associated with the presence of osteoporosis (T-score ≤ −2.5) at baseline.[41] Egund et al[72] defined outcome as good (DASH score < 15) or poor (DASH score≥15) in 133 men (mean age, 54 ± 18) followed prospectively for 1 year after DRF. Osteoporosis was diagnosed in 18% of the sample and was not a significant predictor of poor outcome (OR = 2.39; 95% CI: 0.86, 6.64; *P* = .556) based on logistic regression analysis.

Diabetes

III Alsubheen et al[8] found in a prospective sample of 479 individuals (mean age, 55 years; 75% female) that after adjusting for age, sex, education level, and other health problems, diabetes was associated with slower recovery and poorer overall health status at 12 months follow-up after DRF. A larger improvement in DASH scores was evident in individuals without diabetes (mean change of 56 points) versus those who had diabetes (mean change of 44 points). Similarly, Lee et al[167] reported that after controlling for age, diabetes was a significant predictor of poor DASH scores (β = 7.191; *P* = .025).

Other Medical Comorbidities

II III Conflicting conclusions regarding the relationship between functional outcome and other medical comorbidities in individuals with DRF were reported in 3 prospective studies using the DASH.[95,96,321] In 1 study, the number of comorbidities was associated with DASH scores at 6 months after injury (N = 129, β = 0.3, *P*<.001), although the method used to record comorbidities was not specified.[95] Conversely, a second study found no relationship between Katz Comorbidity Index scores and functional limitations captured using DASH scores at 1 year (N = 228; β = 0.18; *P* = .53).[321] Having more than 3 other comorbidities contributed only 2.8% of the total variance in PRWE scores in 222 nonoperatively managed individuals at 12 months.[97]

OUTCOME PREDICTORS FOR CHRONIC PAIN/CRPS-1

Female Sex

I Using multivariable regression analysis, 2 prospective studies[123,246] found that female sex was a significant predictor for the development of CRPS-1 after DRF. Jellad et al[123] followed 90 individuals (mean age, 52 years; 62% female) and managed nonoperatively. By the final follow-up at 9 months, 29 individuals (32.2%) had been diagnosed with CRPS-1. Being female was significantly associated with the occurrence of CRPS-1 (OR = 5.774; 95% CI: 1.391, 23.966; *P* = .016).[123] Among 477 individuals (mean age, 54 years; 55% female) treated operatively and followed for 6 months, Roh et al[246] reported that female sex was one of the factors most predictive of developing CRPS-1 (OR = 2.172; 95% CI: 1.492, 6.034).

III Neither female sex nor age was found to be associated with an outcome of CRPS-1 in a large prospective (n = 1549; mean age, 43 years; 51% female) study by Moseley et al.[211]

Baseline Pain or Function

I In the prospective cohort study by Luk et al,[177] numerical pain ratings measured at the time of cast removal (mean duration = 38.7 days) accounted for 28.6% (*P*<.001) of the variance in pain scores at 24 weeks post injury.

II In a systematic review, Rolls et al[249] included 3 studies that identified baseline pain as a prognostic factor for persistent pain or CRPS-1 after DRF. The authors reviewed 1 prospective study with a low risk of bias in which pain intensity within 1 week of injury was found to be a strong predictor (OR = 3.3; 95% CI: 2.5, 4.3) of developing CRPS-1 by the 4-month follow-up.[211] Another study included in the review was a retrospective analysis of 386 individuals showing that pain intensity within 2 weeks of injury, measured using the PRWE pain subscale, predicted 22% of the variance in pain scores 12 months after DRF.[198] A baseline PRWE pain score of 35 or greater out of 50 points was 85% sensitive and 79% specific for the development of chronic pain.

II Using a visual analog scale (VAS), Farzad et al[80] measured pain levels in 57 individuals (mean age, 50 years; 53% female) within 2 weeks after fracture reduction.

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By the 12-month follow-up, 10 individuals (17%) were diagnosed with CRPS-1. Baseline pain was significantly correlated with development of CRPS-1 (r = 0.47, *P*<.01). Logistic regression revealed that the odds of developing CRPS-1 increased 1.5 times for every 1-point increase in baseline pain on VAS (*P*<.01).

III In the retrospective analysis by Farzad et al,[81] PAR and MEP assessed at 2 months after injury was predictive of chronic pain at 6 months. A score of ≥3/10 for PAR was 75% sensitive and 88% specific (AUC = 0.90) for severe pain (PRWE pain subscale score≥35/50), while a score of ≥6/10 for MEP was 67% sensitive and 79% specific (AUC = 0.78) for moderate to severe pain (defined as a pain subscale score of ≥12.5/50).

Psychosocial Factors

I Kinesiophobia (β = 0.2; *P* = .042) and posttraumatic stress (β = 0.3; *P* = .008) measured within 3 weeks of injury were significantly associated with higher pain levels at 6 months based on NRS.[95]

II Baseline depression scores of ≥16 on the CES-D scale were significantly associated with symptoms of CRPS-1 in a prospective sample of individuals at 3 months after injury (*P* = .0017).[321]

OUTCOME PREDICTORS FOR WRIST/HAND-RELATED BODY STRUCTURE AND FUNCTION IMPAIRMENTS

Age and Female Sex

I In a prospective cohort of 240 individuals (mean age, 60 years; 81% female), Bobos et al[30] found that increasing age was associated with slower hand dexterity scores for large (β = 0.32, *P*<.001), medium (β = 0.43, *P*<.001), and small (β = 0.46, *P*<.001) object manipulation tasks at 12 months. Female sex (β = 0.11, *P* = .017) was also a predictor of slower hand dexterity scores at 12 months, but only for large object manipulation tasks. Multivariable regression analysis indicated that age and female sex together explained approximately 14% of the variance in scores on the NK hand dexterity test. In a similar study involving 319 individuals (mean age, 59 years; 78% female), age was a predictor of dexterity scores at 6 months for large (β = 0.26; *P*<.001) and small (β = 0.26; *P*<.001) object manipulation, while female sex was associated only with small object manipulation (β = −0.21; *P*<.001). Age, wrist range of motion, and grip strength together explained 34% of the variability in large-object dexterity scores.[29]

III Retrospective analysis identified age as the only factor influencing wrist range of motion (*P* = .012) and grip strength (*P* = .024) at 12 months after DRF in a study by Lee et al.[167] Other retrospective studies have also found significant associations between age and grip strength[54,165] (*P*<.001), as well as hand stiffness[71] (OR = 1.03; *P* = .04) between 6 and 16 months after injury. Weaker grip strength has also been reported as a significant predictor (*P*<.001) for hand dexterity at a 2-year follow-up.[215]

Education Level

III Lower level of education was associated with worse wrist ROM (*P*<.002) and grip strength (*P* = .026) in a prospective series of individuals with DRF over 12 months.[230] The authors suggested that poorer outcomes related to the level of education were likely a reflection of lower socioeconomic status and less access to health care resources.

Psychosocial Factors

I Pain catastrophizing was reported to be inversely associated with decreased finger motion in 96 individuals at 6 weeks after surgery, as measured goniometrically (β = −5.9; 95% CI: −11, −1.3; *P* = .012) and by the distance from the fingertips to the most distal palmar crease (β = 0.40; 95% CI: 0.22, 0.59; *P*<.001).[290]

OUTCOME PREDICTORS FOR GENERAL HEALTH/QUALITY OF LIFE

II Moderate- to very low–quality evidence was summarized in a systematic review by Babatunde et al[17] indicating that age greater than 65 years, female sex, and presence of comorbidities may be factors that influence the quality-of-life outcomes after wrist fracture.

III Using the EuroQoL questionnaire, Abimanyi-Ochom et al[1] estimated the quality-adjusted life year loss in 263 individuals (mean age, 66.5 years; 85% female) after DRF. Prefracture EuroQoL score was the only variable found to be predictive of quality of life at 12 months (β = 0.410; 95% CI: 0.314, 0.508). Four other studies[78,112,210,248] used components of the 36-item Short Form (SF-36) or the 12-item Short Form (SF-12) survey to examine the influence of DRF on general health and quality of life. Included among the significant predictors of lower QoL were low patient expectations for recovery,[78] lower prefracture physical activity level,[112] age, and level of education.[210,248]

OUTCOME PREDICTORS FOR RETURN TO WORK

III Individuals who had higher baseline DASH scores within the first week after injury (r = 0.36; *P*<.01) and greater occupational demand (r = 0.33; *P*<.001) were found to be at greater risk of prolonged work loss.[185] Together, occupational demand and DASH scores explained 27% of the variation in time to return to work over a 1-year period in 227 individuals. A more recent study by Egund et al[72] reported similar findings in a sample of 88 men (mean age, 45 years) after DRF. In that study, scores for pain, disability (DASH), and

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physical health (SF-36 PCS subscale) at 6 to 8 weeks after injury were the strongest predictors for the duration of sick leave, explaining 37% of the variance after accounting for age, comorbidities, work demand, and type of treatment.

EVIDENCE SYNTHESIS

Predicting individual outcomes after DRF remains challenging due to the heterogeneous nature of wrist fractures and the variety of operative and nonoperative management strategies used, the inconsistency of measurement methods and analytical techniques, and the limited number of high-quality studies available. Based primarily on level II evidence, the variables most consistently found to be associated with lower wrist/hand function within 6 to 18 months after DRF include increasing age (greater than 65 years), third-party compensation, and the presence of comorbid psychosocial factors. Level III evidence found high baseline scores on the PRWE or DASH obtained within 1 week to 2 months of injury were also identified as potentially useful predictors of outcome at 6 to 12 months. Level III evidence was also found for diabetes as a factor associated with slower recovery in these individuals. Conflicting evidence was found regarding the importance of other medical comorbidities, education level, and female sex as predictors of wrist/hand function. No studies identified osteoporosis or side of injury (dominant vs nondominant) as factors that influence outcome.

Higher baseline pain intensity (assessed within 1 week to 2 months of injury) was associated with chronic pain, including CRPS-1, in both prospective (level I and II) and retrospective (level III) studies. However, the tools and methods used to obtain baseline measures of pain and the optimal cutoff values that define increased risk have yet to be validated. While it is unclear which aspects of emotional and mental health are most important, psychological factors were often associated with poorer outcomes across all outcome categories, including chronic pain. No conclusion can be made regarding the following factors because evidence of their relationship to persistent pain is limited and/or conflicting: older age, female sex, diabetes, and other medical comorbidities.

Evidence from a single level I study suggests that increasing age may delay recovery of some impairments, such as dexterity, range of motion, and grip strength. Whether female sex, education level, or psychosocial factors play a role in impairment-related outcomes after DRF remains in question. The overall strength of evidence regarding factors related to quality of life and return to work was found to be low based on the risk of bias assessment and imprecision of the results.

GAPS IN KNOWLEDGE

At present, the proportion of the variability for outcomes that can be explained by any single or combination of potential predictor variables is low and imprecise. Improving the accuracy and individualization of outcome prediction after DRF will require future development and validation of robust prognostic models that enable clinicians to identify those individuals at high risk of poor outcomes. In addition, further investigation on the optimal timing, duration, and content of rehabilitation protocols to enhance functional recovery would facilitate the delivery of more tailored and effective care for these individuals.

RECOMMENDATIONS

C Clinicians may use older age (>65 years), high baseline levels of disability, third-party compensation, and comorbid psychosocial factors (particularly depression) as predictors of poor outcomes related to functional disability.

C Clinicians may use female sex, high baseline levels of pain, and comorbid psychosocial factors (particularly depression) as predictors of poor outcomes related to the development of persistent pain symptoms, including CRPS-1.

Examination

OUTCOME – ACTIVITY LIMITATIONS; SELF-REPORT MEASURES

Overview

Patient-reported outcome measures (PROMs) that capture activity limitations in individuals with DRF have been widely assessed for their utility in individuals with DRF. The PROMs with the most prevalent usage in clinical practice and research studies in individuals with DRF[315] include the PRWE, DASH or its shorter version (QuickDASH), and MHQ. There is also sufficient evidence concerning the measurement properties of assessments of pain such as the numeric pain-rating scale (NPRS) in individuals with wrist/hand impairments.[175] A synthesis of measurement properties for these measures in individuals with DRF is shown in **TABLES 5** to **8**.

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TABLE 5 Patient-Rated Wrist/Hand Evaluation (PRWE)

ICF Category	Activity Limitations and Participation Restrictions
Description	The PRWE was primarily developed to capture pain and functional disability in individuals with DRF.[187] The PRWE consists of 15 questions, five of which examine pain experience and 10 examine functional impairment (six assessing impairments in usual activities and four assessing impairments in specific activity) in activities requiring the use of wrist/hand. Each item is rated on a numeric scale of 0-10, with 0 indicating no pain/disability and 10 indicating the worst pain/disability. The administrative burden of completing the PRWE is reported to be between 3 and 4 minutes.[200]
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using intraclass correlation coefficient [ICC])	Pain scale: ICC ranging between 0.76 and 0.93 for 2 assessments[110,202,145,149,250] Function scale: ICC ranging between 0.85 and 0.94 for 2 assessments[110,202,145,149,250]
Short retest interval (2-7 days)	Total score: ICC ranging between 0.81 and 0.99 for 2 assessments[109,110,148,174,202,251,259,261,263]
Longer retest interval (>7 days)	Pain scale: ICC of 0.96 with a retest interval of up to 3 months[143] Function scale: ICC of 0.95 with a retest interval of up to 3 months[143] Total score: ICC of 0.46-0.98 with retest interval of up to 205 days[6,145,148,174,93]
Absolute reliability (assessed using standard error of measurement [SEM])	Pain scale: SEM of 3.3[201] Function scale: SEM of 4.3[201] Total score: SEM of 5.4[201]
Internal consistency (assessed using Cronbach's alpha [CA])	Pain scale: CA between 0.81 and 0.93[202,145,110,250] Function scale: CA between 0.85 and 0.98[202,145,110,250] Total score: CA between 0.89 and 0.98[6,202,110,145,148,251,316]
Construct validity (relationships with other measures assessed using Pearson correlation coefficient [r])	Pain scale: DASH: r = 0.62[143] and 0.50[295] QuickDASH: r = 0.67[258] and r = 0.59[295] Pain measures (NPRS, VAS): r values between 0.59 and 0.74[145,202,108] Grip strength: r = 0.35[201] Function scale: DASH: r = 0.76[143] and r = 0.64[295] QuickDASH: r = 0.74[258] and r = 0.62[295] Pain measures (NPRS, VAS): r values between 0.53 and 0.68[145,201] Grip strength: r = 0.64[143] and r = 0.64[201] Total score: DASH: r values between 0.59 and 0.86[110,145,296,316] QuickDASH: r values between 0.65 and 0.75[6,259,295] Pain measures (NPRS, VAS): r values between 0.69 and 0.74[145,201] Grip strength: r = 0.56[143] and r = 0.60[201]
Structural validity (using Rasch analysis of factor structure)	Pain scale: showed good fit with Rasch model after (a) deleting pain item "when it is at its worst," (b) and collapsing response categories from 11 categories (0-10 scale) to 8 categories (0-10 scale)[73] Function scale: showed good fit with Rasch model after (a) eliminating items 4 and 6 (showed differential item functioning) and items 9 and 10 (disordered threshold) in 382 individuals[73] Total score: factor analysis resulted in the extraction of 1 factor that explained 66.26% of the total variance[147]
Responsiveness (assessed using effect size [ES] or standardized response means [SRM])	Pain scale: ES = 1.87[183] and ES = 2[201] SRM = 1.52[183] and SRM = 2.07[201]
Retest interval 0-3 months after the injury	Function scale: ES = 1.95[183] and ES = 1.85[201] SRM = 1.6[183] and SRM = 2.38[201] Total score: ES ranging between 0.62 and 3.16[184,201,264,79] SRM ranging between 0.90 and 2.66[80,184,201]
Retest interval from 3 months up to 6 months after the injury	Pain scale: ES = 0.86 and SRM = 0.93[143] Function scale: ES = 0.73 and SRM = 0.77[143] Total score: ES ranging between 0.43 and 1.3[145,259,316] SRM ranging between 0.54 and 2.19 [145,259,317,295]
Minimal detectable change (MDC)	Pain scale: ranging between 2.7 and 6.5 points change[145,202,251,309]
At 90% confidence level (MDC_{90})	Function scale: ranging between 2.4 and 9.9 points change[145,202,251,309] Total score: ranging between 4.4 and 12.5 points change[145,202,251,309]

Table continues on next page.

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TABLE 5 Patient-Rated Wrist/Hand Evaluation (PRWE) (continued)

ICF Category	Activity Limitations and Participation Restrictions
At 95% confidence level (MDC_{95})	Pain scale: 8.4 points[250] and 9 points[201] change Function scale: 7.79 points[250] and 12 points[201] change Total score: 13.74 points,[250] 20.47 points,[147] or 15 points[201] change
Minimal Clinically Important Difference (MCID)	Pain scale: 1.5 points between 2 assessments conducted with 0-40 weeks retest interval[309] Function scale: 10 points between 2 assessments conducted with 0-40 weeks retest interval[309] Total scale: 11.5 points between 2 assessments conducted with 0-40 weeks retest interval[309] and 8.5 points with a 6-month retest interval[37]
Translated versions:	The following translations are available: Arabic,[106] Brazilian Portuguese,[92] Brazilian,[58] Chinese,[307] Czech,[92] Danish,[103,263] French,[92] German,[108] Hindi,[201] Hungarian,[92] Italian,[76,92] Korean,[143] Persian,[80,107] Russian,[92] Spanish,[6,250] Swedish,[316] Thai,[15] Turkish,[229] Ukrainian[92]
Variations/alternate names	The PRWE has also been referred to as the Patient-Rated Wrist/Hand Evaluation (PRWHE). This is due to an emerging volume of research providing evidence concerning measurement properties of the PRWE in individuals with hand injuries. The PRWHE also includes a question on satisfaction with the appearance of the hand. However, this additional question is not integrated into scoring. Therefore, the scoring is based on the original 15 questions included in the PRWE.

Abbreviations: CA, Cronbach's alpha; DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; NPRS, numeric pain-rating scale; PRWE, Patient-Rated Wrist Evaluation; SEM, standard error of measurement; SRM, standardized response means; VAS, visual analog scale.

TABLE 6A Disabilities of Arm, Shoulder, and Hand (DASH)

ICF Category	Activity Limitations and Participation Restrictions
Description	The 30-item DASH was developed to examine impairments in activities and participation resulting from MSK injury affecting the upper extremities.[113] The DASH also consists of modules to assess participation restrictions in work or art, as well as sports performance; however, these modules are optional and are not part of scoring. Responses to each of the 30 questions on the DASH are rated on a Likert scale of 1-5, where 1 indicates no difficulty and 5 indicates an inability to perform the task. There has been sufficient research to validate the use of the DASH in assessing MSK impairments following DRF.
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using ICC) Short retest interval (2-7 days)	ICC = 0.89;[264] ICC = 0.83[173]
Longer retest interval (>7 days)	ICC = 0.91[147]
Absolute reliability (SEM)	SEM = 5.3 (calculated from the ICC values of 0.91)[147]
Internal consistency (assessed using CA)	CA = 0.96;[264] CA = 0.97[147]
Construct validity (relationships with other measures assessed using Pearson correlation coefficient [r])	Physical mobility domain of Nottingham Health Profile: r = 0.60[264] SF-36: r = −0.56[37] Data for the relationships of the DASH with PRWE and impairment measures such as grip and wrist ROM, if available, are shown in respective tables for those measures.
Responsiveness (assessed using ES or SRM) Retest interval 0-3 months after the injury	ES = 1.86 and SRM = 2.01[183]
Retest interval >3 months after the injury	ES = 2.32 and SRM = 2.52[183] SRM = 2.13[295]
Minimal Clinically Important Difference (MCID)	6.8 points with a 6-month retest interval[37]

Abbreviations: CA, Cronbach's alpha; DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; MCID, minimal clinically important difference; MSK, musculoskeletal; PRWE, Patient-Rated Wrist Evaluation; ROM, range of motion; SEM, standard error of measurement; SRM, standardized response means.

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TABLE 6B A Shortened Version of the Disabilities of Arm, Shoulder, and Hand (QuickDASH)

ICF Category	Activity Limitations and Participation Restrictions
Description	The 11-item QuickDASH was developed to reduce item redundancy in full-length DASH, brevity, and ease of administration in a clinic.[23] This shortened version of the DASH has a similar scope of assessing impairments in activities and participation resulting from MSK injury affecting the upper extremities. Since the 11 items in QuickDASH were retained in the original DASH, the responses to these 11 questions are similar to the DASH. The research concerning the measurement properties of the QuickDASH in DRF is emerging and not comprehensive.
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using ICC) Longer retest interval (>7 days)	ICC = 0.94[262]
Construct validity (relationships with other measures assessed using Pearson correlation coefficient [r])	Data for the relationships of the DASH with PRWE and impairment measures such as grip and wrist ROM, if available, are shown in respective tables for those measures.
Responsiveness (assessed using ES or SRM) Retest interval 0-3 months after the injury	ES = 0.81 and SRM = 1.27[258]
Retest interval >3 months after the injury	SRM = 2.17[295]
Minimal detectable change (MDC) At 90% confidence level (MDC_{90})	25.3 points[278]
Minimal Clinically Important Difference (MCID)	25.8 points after 12 visits for rehabilitation[278]
Translated versions:	The DASH and QuickDASH have been translated into multiple languages and cultural contexts. A detailed list of these translations is available (DASH webpage 2020)

Abbreviations: DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; MCID, minimal clinically important difference; MDC, minimal detectable change; MSK, musculoskeletal; PRWE, Patient-Rated Wrist Evaluation; ROM, range of motion; SRM, standardized response means.

OUTCOME – ACTIVITY LIMITATIONS; PERFORMANCE MEASURES

Overview

Measures assessing performance in completing functional tasks involving the wrist/hand in individuals with MSK conditions are limited. The Jebsen-Taylor Hand Function Test (JTHFT)[122] is one such test that examines competition of 7 common activities of daily living (ADLs) tasks that involve the use of wrist/hand. These tasks include writing, turning over a page, picking up small objects, simulated feeding, stacking checkers, picking up large light objects, and picking up large heavy objects.[75]

Evidence Synthesis

There is sufficient research evidence from high-quality clinical measurement studies to suggest that PROMs assessing activity limitations such as the PRWE, DASH, and MHQ have sufficient evidence to suggest excellent test-retest reliability, construct validity, and high responsiveness in assessing change in wrist/hand functions, specifically in the context of DRF. The values reflecting minimal detectable change (MDC) or MCID values have been reported for PRWE (11.5 points) and DASH (7 points) in individuals with DRF, which can significantly contribute to developing short-term goals and monitoring the recovery in respective constructs. In addition, measures for assessing pain experience such as the NPRS or VAS have sufficient evidence concerning their measurement properties in MSK conditions affecting the UE. The Patient-Specific Functional Scale (PSFS) has been recommended in the previous CPG for lateral elbow pain for assessing limitations in higher-level functional tasks such as work or athletic performance.[175] The measurement properties of the PSFS have not been assessed specifically in the context of DRF; therefore, it is not prudent to recommend it for assessing impairments in the DRF population. In individuals who demonstrate ceiling effects for the PRWE or the DASH, the optional work/sports module of the DASH can be used, especially for individuals who may be engaged in occupations requiring the use of wrist/hand for specific high-level tasks.

Measures that examine the performance of the wrist/hand in completing functional tasks are limited. The test-retest and interrater/intrarater reliability and construct validity of the JTHFT have been well established in MSK conditions affecting the wrist/hand. While the measurement properties of the JTHFT have not been specifically examined in the DRF population, it can be argued that individuals with DRF experience similar functional deficits that are experienced by the individuals with MSK conditions of the wrist/hand in whom the JTHFT has been validated. Therefore, the JTHFT can be

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TABLE 7 Michigan Hand Questionnaire (MHQ)

ICF Category	Activity Limitations and Participation Restrictions
Description	The MHQ consists of 62 questions, of which 25 are repeated for both right/left hands (37 original questions), across 6 scales. These 6 scales assess hand function, ADL, work, pain, aesthetics, and satisfaction.[45] Scores for each scale are calculated separately by converting the raw score for each scale on a scale of 0-100, where higher scores indicate better status with the exception of the pain scale where higher scores indicate worse pain. The total scores for MHQ can also be obtained by reversing scaling for pain score, adding scores for all scales, and then obtaining the average.[45] Due to the high burden of administration for 62-question, a shortened version (Brief MHQ) consisting of 12 items from the original MHQ was conceived.[310] The existing evidence concerning the measurement properties of the original MHQ in the context of DRF is summarized below.
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using ICC) Short retest interval (2-7 days)	ICC = 0.92[28] for Swedish version of MHQ
Absolute reliability (SEM)	SEM = 4.7 (calculated from the ICC = 0.92) for the Swedish version of MHQ[28]
Internal consistency (assessed using CA)	CA for 6 scales of the Swedish version of MHQ ranged from 0.81 (hand function) to 0.96 (work performance)[28] CA for 4 scales (Function, ADL, Work, Satisfaction) was >0.90, and CA for Pain and Aesthesis were 0.89 and 0.75, respectively[121] PRWE: r = −0.66, −0.72, and 0.75, respectively, with a pain scale, functional, and total score of the PRWE[28] VAS-pain: −0.55[28]
Construct validity (relationships with other measures assessed using Spearman's correlation coefficient [r])	Relationships of the MHQ and impairment measures such as grip and wrist ROM, if established, are shown in respective tables for those measures.
Structural validity (using Rasch analysis of factor structure)	With the exception of Function and Work scales, all other scales had several items that showed disordered thresholds (21 of 37 original items in MHQ) requiring several adjustments to response thresholds for these items[121] Single factor structure for each scale was verified with the exception of the Aesthetics scale[121]
Responsiveness (assessed using ES or SRM) Retest interval >3 months after the injury	SRM = 0.8 for Work scale and total score, 0.7 for hand function and pain scale, and <0.5 for ADL, Aesthetics, and Satisfaction[152] SRM = 0.73 for total score[310]

Abbreviations: CA, Cronbach's alpha; ADL, activity of daily living; DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; PRWE, Patient-Rated Wrist Evaluation; ROM, range of motion; SEM, standard error of measurement; SRM, standardized response means; VAS, visual analog scale.

used as a performance measure to assess activity limitations after DRF.

Patient-reported outcome measures serve to capture the severity of impairments, provide a basis to prognosticate the recovery trajectory, and facilitate the assessment of recovery in individuals presenting for rehabilitation. They can be used during the initial assessment and at a clinically relevant time point (for example, 3-4 weeks after the initial assessment) to determine response to interventions, and again toward the end of care to ascertain appropriateness for discharge.

Gaps in Knowledge

The literature concerning the test-retest reliability and construct validity is deficient for the QuickDASH. Future studies should focus on developing comprehensive evidence concerning the measurement properties of the QuickDASH in the context of DRF. In addition, there is a lack of evidence for the MCID for the MHQ when assessing changes in wrist/hand function in individuals with DRF, which can be examined in future studies. The PSFS can serve as an excellent tool considering its unique ability to capture impairments that are relevant to individuals, necessitating the efforts to develop an evidence pool for the measurement properties of the PSFS in the DRF population. Lastly, the JTHFT has shown promise in assessing performance in completing ADLs that require wrist/hand use in MSK conditions affecting the wrist/hand. However, test-retest reliability, construct validity, responsiveness, and MCID for the JTHFT in the context of DRF should be examined. This will enable clinicians to put patient-rated function deficits of the wrist/hand in the context of their actual performance.

RECOMMENDATIONS

A Clinicians should administer joint-specific measure of the PRWE to assess pain experience and functional disability of the wrist or administer either the DASH or MHQ to assess region-specific disability of the upper extremity at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

C Clinicians may use the JTHFT to assess the performance in completing ADL tasks that require wrist/hand use at the initial assessment and 2

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TABLE 8 Jebsen-Taylor Hand Function Test

ICF Category	Activity Limitations and Participation Restrictions
Description	The JTHFT was conceived to examine impairments in completing ADLs that require the use of hand. The JTHFT consists of 7 tasks, six of which are performed using both hands, and 1 (writing a sentence) is completed only using the dominant hand. The time taken to complete the tasks is calculated for each task and the total score for completing all tasks is calculated for the dominant and nondominant side. A lower score (ie, lesser time to complete all tasks) indicates better function. It takes between 15 and 20 minutes to complete the JTHFT.[274] Below table provides existing evidence concerning measurement properties of the JTHFT in DRF as well as other MSK conditions affecting wrist/hand such as RA, trauma, or other injuries.
Evidence Concerning Measurement Properties	
Test-retest, Intrarater, and Interrater reliability (assessed using ICC) Short retest interval (2-7 days)	Test retest ICC = 0.88 and 0.99, respectively, for dominant and nondominant hands in females with RA[172] Interrater ICC = 0.90 and 0.87, respectively, for dominant and nondominant hands in females with RA[172] ICC = 0.82 and 0.82, respectively, for dominant and nondominant hands in individuals with MSK conditions affecting upper extremity (UEMSK)[219] ICC ranged from 0.42 (pick up small common object) to 0.99 (stacking checkers) for nondominant hand, and from 0.42 (pick up small common object) to 0.96 (stacking checkers) for dominant hand in individuals with RA[259] Intrarater ICC of 0.81 and 0.98, respectively, for dominant and nondominant hands in individuals with UEMSK conditions[219] ICC ranged from 0.35 (writing 24-letter) to 0.93 (stacking checkers) for the nondominant hand, and from 0.63 (writing 24-letter) to 0.97 (moving 1-lb cans) for the dominant hand in individuals with RA[259]
Construct validity (relationships with other measures assessed using Spearman's correlation coefficient [r])	Grip: r = −0.50 and −0.45, respectively, for dominant and nondominant hand in females with RA[172] r between −0.14 and −0.50 for nondominant hand and −0.23 to −0.59 for the dominant hand for JTHFT tasks in individuals with RA[259] r between −0.10 and −0.39 for the tasks of the JTHFT using the injured hand and r between −0.01 and −0.17 for the tasks of the JTHFT using the uninjured hand in individuals with hand injuries[274] With MHQ r = −0.38 for the total score of JTHFT in individuals with DRF

Abbreviations: ADLs, activities of daily living; DRF, distal radius fracture; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; JTHFT, Jebsen-Taylor Hand Function Test; MHQ, Michigan Hand Questionnaire; MSK, musculoskeletal; RA, rheumatoid arthritis; UEMSK, upper extremity musculoskeletal conditions.

other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

MEASURES ASSESSING IMPAIRMENT IN BODY FUNCTION

Summary

Individuals with DRF receiving rehabilitation after DRF commonly exhibit impairments in movements of the wrist/distal forearm, painful limitation in gripping larger or smaller objects with the affected hand, or the proprioceptive ability of the affected wrist joint. Impairments in these domains have been examined using standardized tests and measures that are commonly utilized not just in individuals with DRF, but also in individuals with other MSK conditions affecting the wrist and hand area. These measures include the grip strength (**TABLE 9**), pinch strength (**TABLE 10**), joint ROM for the wrist and forearm (**TABLE 11**), and wrist joint position sense (JPS) (**TABLE 12**). The evidence of measurement properties for these measures in conditions other than DRF has been comprehensively summarized in previously published CPG by an AOPT/AHUEPT group aimed at managing lateral elbow pain.[175] In providing recommendations for these measures during the examination of individuals with DRF, we considered the totality of evidence for these measures in MSK conditions affecting the wrist and hand.

Evidence Synthesis

There is sufficient evidence for the wrist/forearm ROM, grip strength, and pinch strength concerning test-retest reliability and intrarater or interrater reliability in individuals with DRF or those with MSK conditions affecting the wrist/hand. In addition, the wrist/forearm ROM, grip strength, and wrist JPS have demonstrated expected concurrent relationships with other self-reported or performance measures in wrist/hand conditions, validating their use to assess constructs of movement, strength, and proprioception impairments in the

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TABLE 9 Grip Strength (GS)

ICF Category	Measurement of Impairment of Body Function: Power of Muscle Groups
Description	Grip strength is commonly assessed in individuals who are treated for rehabilitation of DRF. Grip strength assesses force produced while gripping a testing device such as a handheld dynamometer (HHD). The American Society of Hand Therapists has provided a clear protocol for assessing GS.[181] This table provides existing evidence concerning the measurement properties of GS in DRF.
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using ICC) Short retest interval (2-7 days)	ICC = 0.85[201] ICC = 0.98 between manual and electronic dynamometers[235] ICC = 0.99[157]
Absolute reliability (SEM)	SEM = 1.75 kg[201]
Construct validity (relationships with other measures assessed using Spearman's rank coefficient (rs))	PRWE: r = −0.35, −0.64, and −0.60, respectively, with a pain scale, functional, and total score of the PRWE[201] DASH: r = 0.17 with grip assessed as a percentage of the unaffected side (Forward et al, 2007); r = −0.53 when assessed with items 22-30 of DASH[26] Patient's rating of change in grip strength: r = 0.51[144] Gross and fine motor tasks of hand: r = −0.72 with putting a stocking over hand; r = −0.03 with picking up coins and putting them in a purse[24]
Responsiveness (assessed using ES or SRM) Retest interval <3 months after the injury	ES = 1.67 and SRM = 1.34[201] ES = 0.94 and SRM = 1.52[183] SRM = 1[152] SRM = 0.05[10]
Minimal detectable change (MDC) At 90% confidence level (MDC_{90})	MDC = 4.1 kg (Mehta, 2012); MDC = 6.5 kg[144]
Minimal Clinically Important Difference (MCID)	6.5 kg change at 1-year follow-up[144]

Abbreviations: DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; DRF, distal radius fracture; ES, effect size; HHD, handheld dynamometer; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; MCID, minimal clinically important difference; MDC, minimal detectable change; PRWE, Patient-Rated Wrist Evaluation; SEM, standard error of measurement; SRM, standardized response means.

wrist, respectively. Measures used in clinical practice must show good sensitivity to capture changes in individuals' status. The wrist/forearm ROM, grip strength, pinch strength, and wrist JPS all showed acceptable sensitivity to change in individuals with MSK conditions of the hand including DRF. Lastly, the MDC and MCID values have been reported for grip (6.5 kg) and wrist JPS (5°) in individuals with DRF, which can significantly contribute to developing short-term goals and monitoring the recovery in respective constructs. Clinicians providing rehabilitation to individuals with DRF should consider circumstances such as potential contraindications, stage of healing, or highly irritable pain level in administering these measures, since testing in such circumstances can either harm the individual or further aggravate symptoms.

Gaps in Knowledge

While pinch strength or dexterity are commonly utilized in individuals with DRF, the body of evidence concerning their measurement properties is not comprehensive with important statistics such as the MDC or MCID missing. In particular, the evidence concerning measurement properties of dexterity measures is scarce not only in individuals with DRF but even in individuals with other MSK conditions affecting the wrist/hand. Tests of dexterity have been widely used and have robust evidence for assessing hand function in individuals with neurological conditions.[94] Additionally, the evidence for performing wrist JPS in individuals with DRF is emerging and not yet conclusive. There are clear gaps that need to be addressed in future research. They include assessing the rater-dependent and test-retest reliability, validity, responsiveness, and MDC values for administering pinch strength, dexterity, and wrist JPS specifically in the context of DRF. Lastly, the evidence concerning the measurement properties of assessing the movement of finger joints in individuals with DRF is lacking. Future research should examine whether assessment of the finger ROM provides a reliable, valid, and responsive assessment of impairments in individuals with DRF.

Recommendations

A Clinicians should use wrist and forearm ROM assessments at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

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TABLE 10 Pinch Strength Test

ICF Category	Measurement of Impairment of Body Function: Power of Muscle Groups
Description	Pinch strength examines precision and strength in handling a small object in 3 different positions using a pinch gauge. They include 2-point pinch (pinching the gauge using the tip of the thumb and tip of the index finger), 3-point pinch (pinching the gauge using the pulp of the thumb and pulp of the index and middle fingers), and lateral pinch (pinching the gauge using the radial side of the index finger and thumb).[146] While the literature on measurement properties of pinch strength testing in the DRF population is scarce, there is sufficient literature on measurement properties of pinch strength in MSK conditions affecting the wrist/hand.[304] This evidence is described below.
Evidence Concerning Measurement Properties	
Test-retest, Intrarater, and Interrater reliability (assessed using ICC)	Between 2 types of pinch gauge ICC = 0.29 and 0.53, respectively, in healthy men and women using electronic and mechanical pinch gauge[145]
Short retest interval (<7 days)	Test retest ICC between 0.71 and 0.90 and 0.87 for all 3 types of pinch forces in healthy adults[168] Intrarater ICC = 0.93 and 0.97, respectively, for tip and key pinch in individuals with hand conditions[265] Interrater ICC = 0.89 and 94, respectively, for tip and key pinch in individuals with hand conditions[265] Intrarater ICC between 0.89 and 0.93 for all 3 pinch positions in individuals with hand pain[212]
Long retest interval (>7 days)	Interrater ICC between 0.87 and 0.94 for all 3 pinch positions in individuals with hand pain[212]
Absolute reliability (SEM)	SEM = 0.43 for the electronic gauge and = 0.50 for the mechanical gauge for assessing lateral pinch[145]
Construct validity (relationships with other measures assessed using Spearman's correlation coefficient [r])	Grip: r = 0.72 for in individuals with RA[69]
Responsiveness (assessed using ES or SRM)	SRM = 0.9 in individuals with DRF[152]
Retest interval <3 months	
Retest interval >3 months	SRM = 0.5 in individuals with DRF[152] SRM = 0.88 in individuals with RA[69] ES = 0.07 for pinch strength after carpal tunnel decompression[124] SRM = 0.14 for pinch strength after carpal tunnel decompression[124]

Abbreviations: DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; MSK, musculoskeletal; RA, rheumatoid arthritis; SEM, standard error of measurement; SRM, standardized response means.

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A Clinicians should use grip strength assessment, as long as there are no contraindications for assessing it, to assess strength deficits of the wrist/hand muscles at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

C Clinicians may use pinch strength and wrist JPS in assessing precision in handling small objects and proprioceptive ability, respectively, at the initial assessment and 2 other clinically relevant follow-up time points, one of which can be discharged, in individuals presenting for rehabilitation of DRF.

OUTCOME – FALL RISK SCREENING

Overview

There is sufficient evidence to suggest that DRF, especially in older individuals (≥65 years of age), is associated with poor bone health[220,303] and is often a risk factor for subsequent hip or spinal fractures.[40,56,126] The risk for subsequent major fragility fractures after a DRF, such as those involving the spine or hip, is compounded in individuals who have an increased risk for falls due to impaired physical function, including poor balance, fear of falling (FOF), or decreased lower extremity muscle strength (LEMS).[62,86] The importance of risk screening for subsequent falls and concomitant fragility fractures is recognized but unfortunately not common in medical[251] or rehabilitation practice.[63,202] Screening the risk profile for subsequent falls after DRF, including impaired balance as well as FOF, is well within the scope of PTs and aligns well with their expertise as movement specialists.

Evidence Synthesis and Gaps in Knowledge

While the presence of physical function impairments in individuals who sustain DRF, especially in those ≥65 years of age is well understood,[62,86] the literature concerning the

TABLE 11 Wrist and Forearm Range of Motion (ROM)

ICF Category	Measurement of Impairment of Body Function: Joint Mobility
Description	Wrist joint movements such as flexion, extension, ulnar deviation, and radial deviation are commonly assessed to determine the overall mobility of the wrist joint in all planes. Assessment of distal forearm movements of pronation/supination is affected after DRF and requires assessment to determine wrist/hand functioning. The starting position for assessing wrist flexion/extension involves placing the elbow at 90° of flexion, the forearm fully pronated, and the wrist in neutral flexion/extension. The movable arm of a universal goniometer is placed along the fifth metacarpal, fulcrum at triquetrum, and fixed arm along the forearm. Alternatively for assessing wrist flexion, the movable arm of a universal goniometer is aligned with the dorsal aspect of the third metacarpal, the fulcrum is placed dorsal to the wrist joint adjacent to the capitate, and the fixed arm is placed with the dorsal midline of the forearm. Similarly, for assessing wrist extension, the movable arm of a universal goniometer is aligned with the palmar midline of the third metacarpal, the fulcrum is placed over the palmar aspect of the wrist joint adjacent to the capitate, and the fixed arm is placed with the volar midline of the forearm. For assessing ulnar deviation and radial deviation, the elbow is kept at 90° of flexion, the forearm fully pronated, the wrist in neutral flexion/extension, and all digits are kept extended and adducted. The movable arm of a universal goniometer is placed along the third metacarpal, the fulcrum along the capitate, and the fixed arm along the forearm. For assessing forearm pronation/supination, the elbow is kept at 90° of flexion, the arm is kept alongside the chest wall, and the forearm is kept in the neutral position. The fixed arm of a goniometer is kept parallel to the humerus. For assessing supination, the movable arm is kept along the ventral aspect of the wrist, whereas for assessing pronation, the movable arm is kept along the dorsal aspect of the wrist. For active movement in each direction, the individual is asked to move as much as possible. Joint movement is recorded for respective movement in degrees. A detailed overview of intrarater/interrater reliability, concurrent validity, and responsiveness of assessing wrist and forearm movements in individuals with UE pathology or asymptomatic individuals has been provided. This table includes the evidence of measurement properties of assessing wrist and forearm movements specifically in the DRF population. The totality of evidence for assessing wrist and forearm movements using a goniometer should be understood in the context of this data and summary provided in previous CPG that outlined the management of lateral elbow pain.[175]
Evidence Concerning Measurement Properties	
Test-retest reliability (assessed using ICC)	ICC of 0.95 and 0.99 for wrist flexion and extension, respectively, between electronic and manual goniometers[235]
Short retest interval (0-7 days)	ICC of 0.94 and 0.97 for pronation and supination, respectively, between electronic and manual goniometers[235]
	ICC of 0.71 and 0.87 for wrist ulnar and radial deviation, respectively, between electronic and manual goniometers[235]
Long retest interval (>7 days)	ICC ranging between 0.63 and 0.71 for wrist flexion and extension for intrarater reliability[127]
	ICC ranging between 0.68 and 0.47 for forearm supination and pronation for intrarater reliability[127]
Absolute reliability (SEM)	Calculated from ICC values shown in Plant et al (2016)
	SEM of 2.3° and 1.7, respectively, for wrist flexion and extension
	SEM of 1.4° and 1.8, respectively, for pronation and supination
	SEM of 9.1° and 3, respectively, for wrist ulnar and radial deviation
Construct validity (relationships with measures assessed using Spearman's coefficient [r])	With PRWE: r values between 0.40 and 0.70 for all ROM with pain and function scales of the PRWE[187]
Responsiveness (assessed using ES or SRM)	ES of 0.67 and SRM of 0.84 for total wrist ROM (sum of all ROM[183]
Retest interval of 3 months after the injury	SRM of 1.08 for total wrist ROM[10]
	SRM of 0.7 for total wrist ROM[152]

Abbreviations: CPG, clinical practice guideline; DRF, distal radius fracture; ES, effect size; ICC, intraclass correlation coefficient; ICF, International Classification of Functioning, Disability, and Health; PRWE, Patient-Rated Wrist Evaluation; SEM, standard error of measurement; SRM, standardized response means; UE, upper extremity.

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measurement properties of common measures for assessing these impairments in context of DRF is scarce. One study with a very small sample size (N = 21) and exclusively female participants showed preliminary evidence of reliability and validity of commonly used measures for screening balance impairments, FOF, and LEMS in DRF population.[199] Results of this study support the reliability and validity of the timed up and go test (TUG) and one-leg stand test for assessing balance deficits, Activities-Specific Balance Confidence Scale (ABC) to assess FOF, and chair stand test (CST) for assessing LEMS.[199] This preliminary evidence has not been substantiated in any subsequent study. A much larger pool of studies with larger samples are needed to understand the usefulness of these common measures in screening the risk of balance impairments, FOF, or LEMS after DRF. Our recommendations below are primarily based on the prevalent use of these measures in commu-

TABLE 12 Joint Position Sense Test

ICF Category	Measurement of Sensory Function: Proprioception
Description	The joint position sense (JPS) test examines the proprioceptive ability of the wrist in the presence of pain or sensory impairments affecting the wrist joint. For the assessment, individuals are seated facing an exam table with elbow flexed, forearm in neutral and kept vertical to the exam table, and wrist in neutral. The examiner moves the individual's wrist passively into a 20° extension using a universal goniometer and holds the position for 3-seconds to allow the individual to "memorize" this angle. The individual is then asked to move the wrist in a fully flexed position, following which is asked to assume the memorized position of the wrist (eg, 20° extension). The examiner measures the wrist extension angle using the goniometer and records any difference in this memorized angle and 20° extension. The difference, if any, is considered to be indicative of the JPS deficit. The mean of 2 trials is recorded as the JPS deficit score.[135] Below is the evidence concerning the measurement properties of the JPS in the DRF population.
Evidence Concerning Measurement Properties	
Construct validity (relationships with other measures assessed using Spearman's coefficient [r])	PRWE: r = −0.35 at 8-week follow-up;[135] r = 0.65 at initial PT assessment[134]
Responsiveness (assessed using ES or SRM) Retest interval <3 months	ES between 1.42 and 2.36 with a reassessment period 8-12 wk[135] SRM between 1.22 and 2.75 with a reassessment period 8-12 wk[135]
Minimal detectable change (MDC) At 95% confidence level (MDC_{95})	4°-5° with a reassessment period 8-12 wk[135]
Minimal Clinically Important Difference (MCID)	4°-7° with a reassessment period 8-12 wk[135]

Abbreviations: DRF, distal radius fracture; ES, effect size; ICF, International Classification of Functioning, Disability, and Health; MDC, minimal detectable change; MCID, minimal clinically important difference; PRWE, Patient-Rated Wrist Evaluation; PT, physical therapy; SRM, standardized response means.

nity-dwelling older adults for screening these impairments as contextualized evidence for their use in DRF is developed.[178,209]

Recommendations

F Clinicians may administer TUG for fall risk screening in individuals with DRF and consider TUG scores of >12 seconds as the threshold for increased fall risk.

F Clinicians may administer ABC for screening FOF in individuals with DRF and consider ABC scores of <67% as the threshold for increased fall risk.

F Clinicians may administer five-times CST for screening LEMS in individuals with DRF and consider the scores of >12 seconds as the threshold for impaired LEMS.

Interventions

As described in the clinical course section, DRF management involves an early protective phase whether treated operatively or nonoperatively. This protective phase includes either cast or orthosis immobilization to facilitate proper bone-tissue physiological healing while allowing mobility exercises in the hand and proximal joints. The length of this early protective phase may vary depending on whether a nonoperative or operative fracture treatment approach was utilized. Nonoperatively managed individuals with DRF are typically immobilized in a cast for 4 to 6 weeks before they initiate wrist mobilization exercises.[53] Following DRF surgery (ie, open reduction internal fixation, external fixation, or percutaneous pinning), the early protective immobilization period is variable (ie, a few days to several weeks) depending on fracture healing and stability, as well as surgeon's preference.[31,241] Thus, the timing for initiating wrist exercises after surgery is not universally agreed upon and typically starts when the physician verifies that a satisfactory healing level has been attained via radiographic evidence and exercise loading can be safely imposed across the fracture site. Regardless of fracture treatment type, when proper fracture healing has occurred, 3 different rehabilitation approaches have been proposed: SupT along with advice for an iHEP, an iHEP alone, or simply no therapy.[32,299] The typical recommendation for SupT is

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1 to 3 clinic weekly visits, where therapeutic interventions can be performed under the supervision of a clinician. In addition to SupT, an iHEP is important for performing daily exercises at home under the initial instruction and distant monitoring of a clinician or sometimes a physician. An alternative to SupT or iHEP may be no therapy, which may involve initial advice for only self-care and management of daily activities, and it allows individuals to self-train without the provision of specific instructions. Currently, no clearly defined guidelines exist on which subgroups of individuals with DRF would benefit from the utilization of any of these rehabilitation approaches. Selection mainly depended on the surgeon's preference or the severity of an individual's physical and functional impairment levels. Traditional DRF rehabilitation commonly entails multimodal therapeutic intervention programs using both SupT and iHEP. No gold-standard multimodal rehabilitation approach exists to date, and DRF therapy programs are usually based on a therapist's discretion. Commonly utilized rehabilitation interventions for DRF include therapeutic modalities, edema control techniques, AROM and strengthening exercises, SM and proprioceptive training, joint mobilization, and orthosis application for joint stiffness management.[101] The following section offers an analysis of the currently available research evidence for these commonly employed intervention approaches along with several evidence-based recommendations.

THERAPY INITIATION TIMING

This section will present the available evidence and the associated recommendations to guide when to initiate rehabilitation components for individuals recovering from a DRF (ie, accelerated vs delayed approach) after operative treatment, and the timing for initiating strengthening exercises regardless of the type of fracture treatment. Traditional postoperative therapy approaches delay initiation of therapy until after 4 to 5 weeks of immobilization while strengthening exercises start after 6 weeks postoperatively.[240,297] Conversely, an accelerated therapy approach has been described as initiating wrist AROM and strengthening exercises within the first 2 to 3 weeks after surgery.[31] For nonoperative DRF treatment, strengthening usually starts after the end of a 6-week cast-immobilization period.[53] This section aims to present the currently available evidence on these topics.

Accelerated vs Delayed Approach Postoperatively

I Deng et al[60] conducted a systematic review and meta-analysis to compare various accelerated and delayed therapy initiation approaches following operative intervention with volar plating. The 9 included randomized controlled trials (RCTs) compared early wrist therapy initiation at ≤3 weeks of immobilization to a traditional approach with therapy initiation at ≥4 weeks of immobilization. Early finger and elbow or shoulder exercises were implemented immediately after surgery in all studies. Watson et al[312] (N = 133; 64% female; mean age, 52 years) compared 3 different wrist therapy initiation times; 1, 3, and 6 weeks. The 1-week group had only a removable wrist orthosis while the 3- and 6-week groups were managed via cast immobilization before wrist therapy initiation. All groups completed a 6-week SupT program along with an iHEP. A small RCT by Quadlbauer et al[240] (N = 28; 86% female; mean age, 54 years) compared wrist therapy initiation within the first week to therapy initiation after 5 weeks of cast immobilization. Both groups progressed through SupT, which lasted for an average of 3 months. Lozano-Calderon et al[174] (N = 60; 65% female; mean age, 53 years) compared early therapy initiation at 8 days to traditional therapy initiation at 6 weeks following surgery. A removable thermoplastic orthosis was used for both groups prior to the initiation of wrist therapy. Brehmer et al[31] (N = 81; 73% female; mean age, 52.5 years) compared an accelerated protocol of initiating early wrist PROM and light strengthening at 2 weeks to a standard protocol that delayed these exercises until 6 weeks following surgery. In both groups, wrist AROM was initiated along with early finger exercises within 3 to 5 days postoperatively, a removable thermoplastic orthosis was used, and therapy lasted for up to 12 weeks. Clementsen et al[48] (N = 119; 90% female; mean age, 55 years) compared 2 early (3 days and 2 weeks) therapy initiation groups. Both groups utilized a removable thermoplastic orthosis and the same HEP. The "earlier group" initiated SupT at 3 days while the "later group" initiated an iHEP at 2 weeks. Sorensen et al[283] (N = 95, %; gender not reported; mean age, 67 years) also compared 2 early (1 day and 2 weeks) therapy initiation groups. Both groups performed early active finger exercises. The early group used a removable orthosis and started wrist AROM immediately postoperatively. The delayed group was treated with a plaster cast immobilization for 2 weeks before progressing to wrist AROM with a removable wrist orthosis. Both groups followed an iHEP and performed light daily activities while wearing their orthosis until 6 weeks. Dennison et al[61] (N = 33; 94% female; mean age, 54 years) compared the early therapy initiation group at 2 weeks to a delayed therapy initiation group at 5 weeks after DRF surgical repair with volar plating. Both groups utilized early digit AROM exercises during their cast immobilization periods prior to initiating the same SupT program with wrist AROM and strengthening exercises under the supervision of a hand therapist. Zeckey et al[325] (N = 50; 94% female; mean age, 81 years) compared early therapy initiation immediately after surgery to delayed therapy initiation at 4 weeks after surgery with volar plating. Both groups used an orthosis for 4 weeks. The early group was allowed to remove the splint postoperatively and perform wrist exercises. All individuals had SupT along

with a HEP. Andrade-Silva et al[12] (N = 39; 56% female; mean age, 49.3 years) compared 2 early (1 day and 2 weeks) therapy initiation groups after surgery with volar plating. A forearm thermoplastic orthosis was used by the delayed group for 2 weeks as compared to only soft postoperative dressings for the early group. Both groups followed an iHEP and performed light daily activities until they initiated SupT at 2 weeks postoperatively.

Outcome measures analyzed in this systematic review included upper-limb function (DASH), wrist function (PRWE), pain (VAS), wrist AROM, grip strength, and rates of complications. Variable short- (2-12 weeks) and long-term (≥6 months) assessment times were reported. Group differences favored early therapy initiation for function, AROM, and grip strength. Pooled effect sizes showed significant DASH score differences at 6 weeks (mean difference [MD], 10.15; 95% CI: −15.74, −4.57; $P<.01$) and 6 months (MD, 1.77; 95% CI: −3.09, −0.45; $P<.01$). Significant PRWE differences were found at 6 weeks (MD, 12.47; 95% CI: −18.10, −6.84; $P<.01$). Significant AROM differences were found at 6 weeks for wrist flexion (MD, 10.87; 95% CI: 2.30, 19.45; $P = .01$), extension (MD, 9.06; 95% CI: 3.24, 14.88; $P<.01$), pronation (MD, 3.93; 95% CI: 1.37, 6.50; $P<.01$), supination (MD, 5.63; 95% CI: 2.10, 9.16; $P<.01$) and radial deviation (MD, 1.99; 95% CI: 0.46, 3.51; $P = .01$). Significant group differences in grip strength were found at 2 (MD, 2.30; 95% CI: 1.10, 3.51; $P<.01$) and 6 weeks (MD, 3.11; 95% CI: 1.27, 4.95; $P<.01$), postoperatively. Group differences in pooled effect sizes for pain scores were not significant ($P>.05$). A trend of higher but not significant rate of fracture redisplacement complications existed for the early therapy initiation group as compared to the delayed therapy approach (relative risk [RR] = 3.00; 95% CI: 1.02, 8.83; $P = .05$). Differences in total complication rates were not statistically different (RR = 1.16; 95% CI: 0.72, 1.87; $P = .54$) between groups.

I Lee et al[166] conducted another systematic review and meta-analysis to compare the accelerated and delayed wrist therapy initiation approaches following operative intervention with volar plating. The 4 included RCTs[174,240,312] were also included in the previous systematic review.[60] All 4 studies reported outcomes on upper-limb function (DASH), wrist AROM, and grip strength. Pain (VAS) was assessed in 3 studies.[174,240,312] Wrist function (PRWE) was assessed in only 2 studies.[240,312] Variable short- (6-12 weeks) and long-term (≥6 months) assessment times were reported. Group differences favored early therapy initiation for function, AROM, and grip strength. Summary effect sizes showed significant DASH score differences at 6 weeks (MD, 12.3; 95% CI: −16.25, −8.35; $P<.001$) and 3 months (MD, 2.87; 95% CI: −5.45, −0.30; $P = .029$). Significant AROM differences were found at 6 weeks for wrist flexion (MD, 16; 95% CI: 11.14, 20.93; $P<.001$), pronation (MD, 5.8; 95% CI: 0.43, 11.17; $P = .016$), and supination (MD, 7.57; 95% CI: 1.39, 13.76; $P = .034$), and at 3 months for flexion (MD, 8.29; 95% CI: 3.38, 13.21; $P = .001$) and extension (MD, 5.61; 95% CI: 0.13, 11.10; $P = .045$). Significant group differences in grip strength were found only at 6 months (MD, 3.75; 95% CI: 0.50, 6.99; $P = .024$). Group differences in pain scores were not significant. Risk ratio of complication rates between the early therapy (N = 120, RR =14.1%) and the traditional (N = 111, RR =10.8%) groups were not significant (RR range, 0.94-0.97; $P>.05$) at all follow-up times. This systematic review did not summarize the effect size for PRWE outcomes. In the 2 studies that assessed wrist function, significant PRWE scores (MD, 13-17; $P<.05$) were found at 6 weeks, favoring the early therapy initiation approach.[240,312]

II Collis et al[49] conducted a lower-quality systematic review to compare the efficacy and safety between early and delayed initiation of light daily activities in conjunction with wrist therapy following a volar plating operative intervention. Six of the analyzed RCTs[12,48,174,240,297,312] were also included in the previous 2 systematic reviews.[60,166] Two low-level case-control retrospective studies[67,115] were also included in the analysis. Variable short- (6-12 weeks) and long-term (≥6 months) assessment times were reported for pain (VAS), function (DASH, PRWE), and wrist AROM. Effect sizes for each study were only labeled as either not reported, small, medium, or large without any statistical values on the group differences. Pooled effect size estimates for group differences were not reported. It was concluded that commencing early light activities with wrist exercises without a splint prior to 2 weeks postoperatively is safe and leads to greater wrist function and AROM at up to 8 weeks than when it is delayed for 2 or more weeks.

I Laohaprasitiporn et al[160] compared early therapy initiation immediately after surgery with volar plating (N = 24; 63% female; mean age, 54.4 years) to therapy initiation at 2 weeks (N = 24; 67% female; mean age, 56.2 years) after surgery. The early group initiated finger, shoulder, and wrist AROM exercises the day after surgery. The delayed group performed finger and shoulder exercises while the wrist was immobilized with an orthosis and initiated wrist AROM at 2 weeks when the orthosis was removed. Group differences in pain (VAS), wrist AROM, grip strength, and self-reported function (DASH and PRWE) were not significantly ($P<.05$) different when assessed at 2, 6, and 12 weeks, as well as at 1 year for the PRWE alone. Postoperative complication rates were 12% (N = 3) for each group while there was no significant group difference in

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fracture radiographic parameters at 2, 6, and 12 weeks following surgery.

I Quadlbauer et al[242] compared early therapy initiation 1 day after surgery with volar plating (N = 56; 69% female; mean age, 56 years) to a delayed therapy initiation at 5 weeks after surgery (N = 60; 75% female; mean age, 58 years). The early group was treated with a removable orthosis and started wrist AROM immediately after surgery. The delayed group received a nonremovable cast for 5 weeks. Both groups had comparable SupT programs with HEP. A significant difference in total wrist flexion/extension AROM was found at 6 weeks and up to 1 year (MD range, 10.2°-36.8°; $P<.01$). A significant difference in total supination/pronation AROM was found at 6 and 9 weeks (MD range, 13.4°-23.5°; $P<.01$). These differences favored the early therapy group, which also showed better wrist function between 6 weeks and 6 months (PRWE MD range, 6.5%-17.4%; QDASH MD range, 7.3%-18.6%; $P<.01$) and grip strength at up to 1 year (MD range, 3.8-5.8 kg; $P<.01$) following surgery. Comparable complication rates were reported for the early (13%) and delayed (15%) therapy groups.

IV Driessens et al[66] conducted a retrospective case-control study, which compared therapy initiation within the first week (mean initiation time, 4 days; N = 37; 51.4% female; mean age, 46.5 years) to therapy initiation after the first week (mean initiation time, 24 days; N = 70; 54.3% female; mean age, 50.1 years) following surgery. Both groups had similar SupT (median = 9 visits; total therapy, 11-12 weeks) programs with orthosis, edema control, scar management, AROM, progressive strengthening, and HEP education. No significant ($P>.05$) group differences in wrist AROM were found at the time of discharge (≥12 weeks). Postoperative group complication rates were not reported.

IV Valdes[297] also conducted a small retrospective case-control study to investigate whether early therapy initiation at 1 week (N = 14; 78% female; mean age, 62.8 years) may result in better wrist AROM, grip strength, function (Upper Limb Functional Index), and lower number of therapy visits/days to achieve functional AROM as compared to delayed therapy initiation at 6 weeks (N = 9; 66% female; mean age, 55.2 years) following surgery. Both groups were treated with a volar wrist orthosis and comparable SupT with iHEP programs. Therapy ended when patients completed at least 2 weeks of strengthening and achieved functional wrist AROM (flexion and extension 40°, supination and pronation 50°). At discharge (≥8 weeks), no significant differences were found in all outcomes except for the total number of visits (MD, 10; $P<.05$) and total number of days to reach functional AROM (MD, 37; $P<.05$), which favored the early therapy initiation group.

STRENGTHENING INITIATION TIMING

II Brehmer et al[31] conducted an RCT to compare an accelerated protocol of initiating early wrist strengthening (both isotonic and grip exercises) along with wrist PROM at 2 weeks (N = 36; 73% female; mean age, 49.8 years) to a standard protocol that delayed strengthening and PROM exercises until 6 weeks (N = 45; 73% female; mean age, 55.3 years) following a DRF repair with volar plating. Both groups initiated early finger exercises 3 to 5 days following surgery, performed hand therapy up to 12 weeks, and used a thermoplastic orthosis up to the time strengthening exercises began. Significant group differences in function (DASH) were noted between 2 and 12 weeks (MD range, 3% and 10%; $P<.05$) in favor of the accelerated group. These results were clinically meaningful (MCID, 10%) at 4 and 6 weeks. Both groups had comparable DASH scores at 6 months (MD, 2%; $P = .19$). The accelerated group showed significantly ($P<.05$) better AROM results for flexion (MD range, 5°-8°) between 2 and 24 weeks, extension (MD range, 5°-6°) between 3 and 8 weeks, and supination (MD range, 6°-11°) between 3 and 8 weeks. Significant group differences in grip strength existed at 6 (MD, 12 lb; $P = .02$) and 24 weeks (MD, 12 lb; $P = .02$) in favor of the accelerated group. No adverse effects to the fracture alignment were reported in either group and all fractures were healed by 3 months.

II Nguyen et al[217] investigated whether an early hand strengthening program during immobilization may result in better pain, grip strength, and functional (QDASH) outcomes as compared to a standard strengthening program among older (≥60 years) individuals following nonoperative DRF management with a 6-week cast immobilization. The early strengthening group (N = 22; 86% female; mean age, 79 years) initiated submaximal isometric finger flexion exercises, and soft rubber ball grip strengthening exercises (10 repetitions, 5×/day, every other day) between weeks 2 and 6. The standard strengthening group (N = 26; 73% female; mean age, 80 years) received only instructions for finger AROM and initiated strengthening exercises following cast removal at 6 weeks. Both groups were managed with a HEP. Significant group differences in pain were found at 2 weeks (MD, 2.0; $P = .006$) and 12 weeks (MD, 2.0; $P = .046$). Significant grip strength (ratio to uninjured side) existed at 6 weeks (MD, 15%; $P = .004$) and 12 weeks (MD, 30%; $P = .003$), which was also clinically meaningful (MCID, 19.5%). These differences favored the early strengthening group. No significant group differences were found in function, although a 15%-point MD existed at 12 weeks, which

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was clinically meaningful (MCID, 10%) in favor of the early strengthening group. No significant group difference in radiographic fracture findings were noted at 6 weeks.

V Kaji et al[131] conducted a retrospective case-control study to compare early grip strengthening initiation immediately after surgery (N = 20; 95% female; mean age, 68.8 years) to delayed grip strengthening at 6 weeks after surgery (N = 19; 89% female; mean age, 70.3 years). Therapy was initiated for both groups on the first postoperative day with AROM exercises, light isometric towels, and putty squeezes. The early strengthening group also performed hand-gripper exercises with progressing loads between 1.5 and 11 lb up to week 6. The delayed strengthening group started gripper exercises after 6 weeks. Both groups followed SupT (2-3 visits/week) and an iHEP. The early strengthening group had significantly higher grip strength (ratio to uninjured side) at 3 months (MD, 9%; $P<.05$) and 6 months (MD, 12%; $P<.01$). Wrist flexion AROM was significantly better (MD, 9°; $P<.05$) in favor of the early strengthening group at 3 months. Group differences in function (QDASH) were not significant ($P>.05$) and there were no significant group differences in radiographic fracture alignment at 6 months.

Evidence Synthesis

The optimum time to initiate rehabilitation following an operative DRF treatment is still not fully agreed upon. Shorter immobilization time with early (within 1-3 weeks) exercises consisting of AROM of the hand, wrist, elbow, and shoulder appear safe and may lead to noticeably quicker functional gains when compared to the traditional delayed approach (≥4 weeks). Two high-quality systematic reviews[60,166] and 1 low-quality systematic review[49] (including 8 level I-II, and 1 level III RCTs) indicated that early therapy initiation at ≤3 weeks leads to better short-term (6-12 weeks) function, wrist AROM, and grip strength, as well as long-term (6 months) function and grip strength outcomes as compared to delaying therapy to ≥6 weeks.

The 4 studies not included in the aforementioned systematic reviews (2 level I[160,242] and 2 level IV[66,297]) further supported that therapy initiation within the first 2 weeks postoperatively leads to superior short-term (6-week) functional, wrist AROM, and grip strength outcomes than initiating therapy ≥4 weeks after surgery. The Laohaprasitiporn et al[160] study (level I) indicated that there are no extra benefits on pain, AROM, grip strength, and functional outcomes when therapy is initiated within the first postoperative week as compared to 2 weeks after surgery. The Quadlbauer[242] study (level I) indicated that significant functional gains may persist for up to 6 months, while significant AROM and grip strength gains can last up to 1 year after surgery. Two low-quality (level IV) case-control studies[66,297] did not find any benefits on function, AROM, and grip strength for initiating therapy early in the first postoperative week as compared to ≥4 weeks. However, the Valdes[297] study showed that early therapy initiation at week 1 may lead to fewer therapy visits, and potentially help to lower health care costs as compared to starting therapy at 6 weeks. Two systematic reviews[60,166] indicated a trend for a slightly greater risk rate (RR = 3.0%-3.3%) of postoperative complications or adverse effects on fracture union when therapy is initiated earlier than when delaying wrist therapy for 4 or more weeks. However, this increased risk was found not to be significant.

The other debated issue this section addressed was the efficacy of early strengthening exercises starting, following operative treatment in individuals with DRF. One level II study[31] and 1 very low–level (level V) study[131] results indicated that initiating early strengthening within the first 2 weeks after surgery safely facilitates short-term functional gains (up to 12 weeks), as well as AROM and grip strength gains (up to 6 months) compared to following a traditional approach of waiting to start strengthening after 5 weeks after surgery. One level II study[217] also supported that early strength exercises during the second week of the cast-immobilization period following a nonoperative DRF treatment provide a significant short-term (6-12 weeks) benefit on grip strength for older (> 60 years) individuals with a DRF. Implementation of early strengthening consisted of gentle isometric grip exercises performed as a HEP, as well as progressive low-load gripping exercises with putty or exercise grippers during SupT. Based on limited evidence from only these 3 studies, early light strengthening exercises may safely facilitate early functional return to daily activities without significantly increased risk of adverse effects to the surgical repair.

While the evidence is very limited, studies suggest that starting submaximal wrist and hand strengthening exercises as soon as 2 weeks following DRF treatment, even during cast immobilization, may minimally increase the risk for surgical repair stability compromise or potentially a fracture malunion deformity in some subjects. Although the risk is minimal and not significantly different than when you initiate traditional strengthening exercises after 5 to 6 weeks, physicians and clinicians should weigh the benefits and harms for some individuals who are at greater risk for fracture site instability, due to their age, bone quality, and fracture severity. It is important to note that studies have included mostly uncomplicated DRF patients with low levels of comorbidities who may benefit from initiating strengthening earlier and safely reaching their ROM, strength, and functional goals sooner.

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Gaps in Knowledge

The majority of the included studies recruited mostly uncomplicated individuals with DRF. More studies are needed to compare the effects of early and late wrist therapy initiation times among DRF patients with significant postoperative complications and comorbidities. Further research is also needed to determine whether early strengthening initiation is a safe and effective intervention method for improving short- and long-term outcomes among these DRF subpopulations following nonoperative and operative interventions. Future studies should also compare the efficacy of different early or late exercise progression paradigms while providing more clarity on exercise parameters and attempting to discern the amount of SupT required to attain clinically important short- and long-term functional outcome gains.

Recommendations

A Clinicians should initiate early therapy that consists of hand, wrist, elbow, and shoulder AROM exercises along with light daily activity within the first 3 weeks after a surgically repaired DRF to improve short-term (up to 3 months) outcomes for pain, wrist AROM, grip strength, and functional, and long-term (≥6 months) outcomes for wrist AROM and grip strength.

B Clinicians should initiate submaximal progressive strengthening, such as towel and putty squeezing and light-load gripping exercises at 2 weeks following a surgically repaired DRF or during the second week of cast immobilization (only the uncomplicated individuals with stable DRF, satisfactory radius-ulna articular alignment, and no ulnar-sided pain) to improve short-term (up to 6 months) outcomes for pain, wrist AROM, grip strength, and functional capacity with negligible risk of compromising proper fracture healing.

THERAPY SUPERVISION AND DOSAGE

The topic of therapy supervision relates to whether rehabilitation is provided in a clinical setting under the direct supervision (SupT) of a clinician (PT or OT) or therapy is performed at home as an unsupervised iHEP under a clinician's instructions. Therapy dosage refers to the applied frequency of supervised sessions. Both therapy supervision and dosage potentially influence clinical outcomes, regardless of whether the fracture treatment is operative or nonoperative. Several studies have investigated whether the provision of SupT can produce superior outcomes as compared to performing only an iHEP.[48,53,90,100,161,222,298,299] Some other studies have compared the efficacy of SupT or iHEP to the clinical merits of not utilizing any form of therapy.[32,44,141] The dosage of SupT has not been equivalent in all studies. Based on traditional clinical practice patterns, SupT after DRF typically uses 1 to 3 weekly sessions[90,100,222,298,299] depending on the therapist's discretion and the extent of postfracture comorbidities (eg, advanced age, osteoporosis, diabetes, smoking, high fall risk, lower socioeconomic level, anxiety, and depression) and complications (eg, malunion, other concomitant fractures, hand stiffness, nerve compression, carpal ligament injury, and CRPS-1) that may influence therapy outcomes.[299,317] In several studies,[32,48,53,161,299] the applied SupT dosage had a reduced frequency (average of ≤1 session biweekly), which under-represents how SupT is typically used in clinical practice, making a valid comparison difficult between SupT and iHEP or no therapy. Optimum therapy mode (SupT, iHEP, or no therapy) and dosage levels following operative and nonoperative treatments are not fully agreed among physicians and clinicians. This may be due to the lack of a prognostic-based classification system to guide clinical decision-making. This section presents the currently available literature on the topics of therapy supervision and dosage.

Therapy Supervision

I Two systematic reviews by Handoll and Elliott[101] and Valdes et al[299] and compared the effectiveness of SupT (provided by either PTs or OTs) to an iHEP approach (directed by a therapist or surgeon) following nonoperative and operative treatments. Both systematic reviews included the same 6 RCTs.[42,153,188,284,308,314] Studies that were appraised and excluded in these systematic reviews (due to low quality) were also excluded in this CPG. Included in these reviews, Christensen et al[42] (N = 30; 90% female; mean age, 66 years) compared SupT to iHEP following nonoperative treatment. Both groups were treated by an OT and received the same iHEP instructions. Krischak et al[153] (N = 46; 65% female; mean age, 54.8 years) compared SupT to iHEP following operative treatment while Maciel et al[188] (N = 41; 75% female; mean age, 55.8 years) compared SupT to iHEP following nonoperative treatment, and groups in both studies were treated by a PT. Souer et al[284] (N = 94; % female; mean age years) compared SupT to iHEP following operative intervention and SupT was directed by an OT while the iHEP was instructed by the supervising surgeon. One iHEP individual crossed over to SupT due to a lack of progress that was attributed to persistent stiffness. Wakefield et al[308] (N = 96; 90% female; mean age, 72 years) compared SupT to iHEP following nonoperative treatment with both groups being directed by a PT. Watt et al[314] (N = 18; 94% female; mean age, 75.8 years) compared SupT to iHEP following nonoperative treatment with SupT being directed by a PT and the iHEP instructed by the supervising surgeon. All these studies showed a moderate to high risk of bias due to several methodological flaws.[101,299] Outcome measures of pain (VAS), AROM, grip strength, and self-reported functional measures (DASH and PRWE) were assessed for short- and long-term

effects (range, 3-24 weeks) for the nonoperatively (57%) and operatively (43%) treated individuals. Forest plots of effect sizes (95% CI) were reported, but effect sizes were not pooled to determine the overall weighted MD for all the studies. Reported effect sizes range for function (−0.15 to 1.18; 95% CI: −0.55, 1.80) favored the iHEP group while effect sizes for wrist motion (−1.56 to 0.58; 95% CI: −2.62, −0.66), forearm motion (−1.13 to 0.65; 95% CI: −1.13, 1.07), and grip strength (−0.81 to 0.33; 95% CI: −0.81, 0.90) favored the SupT group. The magnitudes of the reported effect sizes were not described as clinically meaningful.[299] Both the reviews by Valdes et al and by Handoll and Elliott concluded that both SupT and iHEP treatment approaches may achieve comparable outcomes. Yet, results should be interpreted with caution due to various limitations among the included studies. These limitations included a lack of reporting effect sizes or clinically significant group differences, under-reporting baseline scores, biasing the iHEP group with longer programs, and not reporting sample-size calculations.[101] Sampling selection bias may also have influenced the outcomes of these studies as exclusion criteria were directed to individuals with significant postfracture complications and comorbidities that may adversely influence recovery and require skilled SupT following DRF.[101] These reviews also pointed to the lack of consistency among studies regarding who directed SupT (OT vs PT) or iHEP (therapist vs surgeon).[101,299]

In Soares et al[279] conducted a recent systematic review and meta-analysis to compare the effects of SupT to unsupervised therapy (iHEP or no therapy) following nonoperative and operative treatment for DRF. This review included all 6 RCTs from the reviews of Valdes et al[299] and Handoll and Elliott[101] plus 7 additional studies.[32,48,53,90,100,161,298] Valdes et al[298] (N = 50; 84% female; age range, 28-92 years) compared the efficacy of SupT to iHEP following surgery. Both groups were directed by a hand therapist and the SupT group had the same home program instructions as the iHEP group. Groups had equal complication rates (56%) and 4 complicated individuals were transferred from the iHEP to SupT group due to poor progression. Bruder et al[32] (N = 33; 75% female; mean age, 54 years) compared SupT to no therapy following nonoperative treatment. SupT was directed by a PT, and the no-therapy group received only advice for self-managing daily activities. Gutiérrez-Espinoza et al[100] (N = 74; 95% female; mean age, 72.1 years) compared SupT to iHEP among older (≥60 years) individuals following nonoperative treatment. Both groups were directed by a PT, and SupT had the same home program instructions as the iHEP group. Adherence to the 6-week iHEP group was assessed via phone calls by the therapist. Clementsen et al[48] (N = 119; 91% female; mean age, 55 years) compared SupT to iHEP after operative treatment. The SupT group performed a progressive exercise program and the same home program instructions as in the iHEP group. Both groups were directed by a PT. Coughlin et al[53] (N = 116; 66% female; mean age, 49 years) compared SupT to 2 modes of iHEP advice (written leaflet vs video) following nonoperative treatment. All 3 groups were directed by a PT. The leaflet and video iHEP were instructed via 4 clinic visits and consisted of 7 key exercises used in SupT. Complications in the iHEP groups (12.9%) forced 1 video and 6 leaflet individuals to cross over to SupT due to poor progress. Lara et al[161] (N = 49; 63% female; age range, 46-67 years) compared SupT to video-directed iHEP for 12 weeks following operative treatment. SupT was directed by a hand therapist while the video-based iHEP that consisted of similar exercises to SupT did not require therapist guidance. Two iHEP individuals crossed over to SupT due to slow progress. Gamo et al[90] (N = 57; 100% female; mean age, 68 years) compared SupT to iHEP instructed following operative treatment. The SupT group performed a progressive exercise program and the same home program instructions as in the iHEP group. Both groups were directed by a hand therapist. Common outcome measures were pain, wrist AROM, grip strength, and self-reported function (PRWE). Significant trial heterogeneity limited the ability to perform meta-analysis effect size summaries to only 6 and 12 weeks with 2 age-based subgroups (≤40 or >40 years) analysis. Pain (VAS) was assessed in 8/13 RCTs. At 6 weeks, the younger subgroup showed no significant pain score differences (N = 200; MD, 0.17; 95% CI: −0.60, 0.94; P = .67), but significant pain score difference was present for the older subgroup (N = 178; MD, −1.26; 95% CI: −2.13, −0.04; P = .00) favoring SupT. At 12 weeks, no differences in pain existed (N = 263; MD, −0.01; 95% CI: −0.25, 0.24; P = .96) regardless of age level. Function (PRWE) was assessed in 7/13 RCTs. At 6 weeks, no significant differences were found for the young (N = 230; MD, 2.16; 95% CI: −8.12, 12.44; 4 trials; P = .68) or older (N = 124; MD, −11.67; 95% CI: −24.17, −0.83; 2 trials; P = .07) subgroups. Similarly, no differences in function existed at 12 weeks (N = 164; MD, 2.09; 95% CI: −2.91, 7.09; 2 trials; P = .41) regardless of age level. Wrist flexion and extension AROM was assessed in 6/13 trials. No significant AROM differences existed for flexion at 6 weeks (N = 265; MD, −0.70; 95% CI: −4.06, 2.65; P = .68) or 12 weeks (N = 219; MD, −3.37; 95% CI: −9.51, 2.76; P = .28) and for extension at 6 weeks (N = 266; MD, 1.68; 95% CI: −1.87, 5.22; P = .35) or 12 weeks (N = 137; MD, 2.61; 95% CI: −1.02, 6.24; P = .16). Grip strength was assessed in 10/13 trials. At 6 weeks, there was no significant grip strength difference (N = 265; MD, −1.01; 95% CI: −4.44, 2.43; P = .57) for the young subgroup but a significant grip strength difference (N = 94; MD, 4.62; 95% CI: −1.51, 7.73; P = .004) existed in the older subgroup favoring iHEP. At 12 weeks, no grip strength differences

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existed (N = 268; MD, −1.69; 95% CI: −4.46, 1.08; P = .23) regardless of age level. Low methodological quality of the trials and inconclusive results prevented this review from offering sufficient supporting evidence for either intervention.

I Kay et al[141] compared a 6-week structured iHEP (N = 28; 71% female; mean age, 55 years) to not performing any therapy (N = 28; 68% female; mean age, 55.8 years) among individuals with DRF who were treated via pinning and/or 6-week cast immobilization. The iHEP group received advice by a PT and consisted of edema control; hand, wrist, elbow, and shoulder AROM; wrist passive stretching; and progressive strengthening exercises initiated at 3 weeks following cast removal. All home exercises were illustrated in a provided booklet to improve compliance. The control group did not receive advice for home exercises. Groups had comparable baseline outcome scores (pain [PRWE subscale], wrist AROM [extension-flexion, ulnar-radial deviation, supination-pronation], thumb opposition, grip strength, and function [Quick DASH, PRWE]), and showed comparable improvements at 3 and 6 weeks following cast removal. Significant group differences existed only at 3 weeks for upper quadrant function (QDASH MD, 13; P = .008) and 6 weeks for PRWE pain subscale (MD, 14; P = .03) in favor of the iHEP group, which also reported significantly (P = .03) greater level of satisfaction. Complication rates in the iHEP and control groups were 46% and 50%, respectively. The most common (43%) complication was hand-wrist and shoulder stiffness.

III Öken et al[222] compared a ST program (N = 35; 80% female; mean age, 49,8 years) to iHEP (N = 20; 60% female; mean age, 51.1 years) among uncomplicated individuals with nondisplaced and stable DRF following 6 weeks cast immobilization. The 3-week ST program (6-7 sessions/week) consisted of PROM and AROM, and stretching exercises, and it was directed by a PT. The iHEP group was educated on gentle wrist and hand AROM and passive stretching exercises (hourly during the day, 3 weeks). Groups had equivalent baseline outcome scores following cast immobilization. Significant group differences (P<.05) in favor of the SupT group existed at 3 weeks in wrist AROM (flexion [MD, 10°], wrist extension [19°], supination [MD, 30°]), grip strength (MD, 12 kg), key pinch strength (MD, 3.3 kg), 3-point pinch strength (MD, 3.5 kg), and hand edema (MD, 20 ml). Outcomes in function were not reported.

III Chung et al[44] conducted a multicenter low-level RCT to determine if any therapy type (SupT, iHEP or both; N = 215; 85% female; mean age, 71 years) leads to better 12-month outcomes than having no therapy (N = 53, 81% female; mean age, 72 years) among older (≥60 years) individuals following nonoperative and operative treatments. Group allocation was not randomized and referral to therapy was based on the surgeons' discretion. In the therapy group, 70% of individuals had SupT (mean = 9 sessions over 14 weeks) combined with iHEP (mean 17 weeks) in which adherence was not assessed. Both groups were directed by either hand therapists or surgeons. Therapy (SupT or iHEP) was more frequently used following operative (68%) than nonoperative treatment (49%). The therapy group showed more complications (69%) than the no-therapy group (60%), but the difference was not significant (P = .21). No significant group differences existed for function (MHQ) and wrist AROM outcomes. A significant difference (MD, 9 lb; P = .03) was found for grip strength in favor of the no-therapy group. A subgroup analysis showed no group differences in function after adjusting for age and comorbidities. Information on group baseline equivalency was missing for all outcomes.

Therapy Dosage

As shown in previously reported systematic reviews,[101,279,299] SupT dosage following DRF is highly variable depending on the surgeon's or therapist's discretion. When SupT is compared to iHEP, 6 trials[42,90,100,153,222,298] have applied SupT in a typical clinical practice pattern (≥1 weekly sessions) while 6 trials[32,48,161,188,308,314] have used a limited SupT dosage (≤1 session biweekly) pattern. In 2 studies,[53,284] the number of SupT sessions was not reported. Of particular importance is the influence of SupT dosage level on therapy outcomes following DRF, especially when it is offered to individuals with significant complications and comorbidities who should benefit from a typical SupT dosage. No previous studies to date have investigated this concern. This section elucidates the current evidence on outcomes when comparing the typical to limited SupT dosage patterns after nonoperative and operative management.

Typical SupT Dosage Pattern

I Gutiérrez-Espinoza et al[100] (N = 74; 95% female; mean age, 72.1 years) compared SupT (mean 12 sessions over 6 weeks) at a frequency of 2 to 3 sessions/week to iHEP among older (≥60 years) individuals following nonoperative treatment. Significant differences (P = .001) existed at 6 weeks for wrist AROM (extension [MD, 20°], flexion [MD, 12°]), grip strength (MD, 21%), VAS pain levels (MD, 1.78), and function (PRWE MD, 17%), as well as at 6 months for wrist extension (MD, 19°), flexion (MD, 17°), grip strength (MD, 26%), and PRWE (MD, 17%) in favor of SupT. No complications were reported in either group in 6 months.

I Gamo et al[90] RCT (N = 57; 100% female; mean age, 68 years) compared SupT (mean 16.3 sessions over 12 weeks) at a frequency of 1 to 2 sessions/week to iHEP following operative treatment. Significant group differences (P<.05) in favor of SupT were found for pain (VAS)

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at 4 weeks (MD, 8.6 mm) and 6 weeks (MD, 7.4 mm), for function (QDASH) at 6 weeks (MD, 6.9%), and for wrist AROM (% value relative to the uninjured side) in total flexion/extension (MD, 12%) and supination/pronation (MD, 7.5%) at 6 weeks. Significant ($P<.05$) wrist AROM differences were present until 8 weeks. No patient complications were reported.

I Valdes et al[298] RCT (N = 50; 84% female; age range, 28-92 years) compared SupT (16 sessions over 8 weeks) at a frequency of 2 sessions/week to iHEP following operative treatment. Outcomes on pain, finger and wrist AROM, and grip strength were assessed at 2, 4, 8, and 12 weeks, while function (PRWE) was only assessed at 6 months. No significant group differences existed across all time points. Postfracture complications in the SupT (N = 15) and iHEP (N = 13) were comparable, including 4 iHEP individuals who were transferred to SupT group due to lack of progress. Intention-to-treat analysis was used in this study.

III Christensen et al[42] (N = 30; 90% female; mean age, 66 years) compared SupT (mean 37 sessions over 18 weeks) at a frequency of 2 sessions/week to iHEP following nonoperative treatment. There was no significant difference in function, which was measured by a nonvalidated outcome measure (modified Gartland and Werley score), at 5 and 12 weeks, and 9 months. Comparisons in fracture severity and complication rates between groups were not provided.

III Krischak et al[153] (N = 46; 65% female; mean age, 54.8 years) compared SupT directed by a PT (mean 12 sessions over 6 weeks) at a frequency of 2 sessions/week to an iHEP group following operative treatment. All outcomes were documented as a % value relative to the uninjured side. At 6 weeks, there was a significant difference in function (PRWE; MD, 50%; $P = .001$), grip strength (MD, 22%; $P = .003$), and wrist flexion/extension AROM (MD, 27%; $P = .001$) in favor of the iHEP group. There were no group differences in initial fracture severity levels and postoperative fracture alignment at 6 weeks.

III Öken et al[222] (N = 55; 72% female; mean age, 50.3 years) compared SupT at a frequency of 6 to 7 sessions/week over 3 weeks to iHEP, which was directed by a hand therapist. Significant group differences in wrist AROM flexion (MD, 10°; $P = .004$), wrist extension (MD, 19°; $P = .001$), supination (MD, 30°; $P = .002$), grip strength (MD, 12 kg; $P = .001$), key pinch strength (MD, 3.3 kg; $P = .001$), 3-point pinch strength (MD, 3.5 kg; $P = .001$), and hand edema (MD, 20 ml; $P = .012$) were found in favor of SupT at 3 weeks following nonoperative treatment. Individuals with any postimmobilization complications were excluded from the study.

Limited SupT Dosage Pattern

I Bruder et al[32] (N = 33; 75% female; mean age, 54 years) compared SupT (mean 2.9 sessions over 6 weeks) to home advice directed by a PT regarding self-care and daily activity management following nonoperative treatment. No significant group differences were found for function (PRWE and QDASH), PRWE pain subscale, wrist AROM (flexion, extension, supination), and grip strength at 7 weeks and 6 months following 6 weeks cast immobilization. No treatment complications were reported for each group.

I Clementsen et al[48] RCT (N = 119; 91% female; mean age, 55 years) compared SupT at a frequency of 1 session biweekly over 12 weeks to iHEP following operative treatment. The SupT group initiated rehabilitation 3 days after surgery, while the iHEP was immobilized for 2 weeks prior to beginning home exercises. There were no differences in function (QDASH, PRWE), Pain (VAS), wrist AROM, and grip strength at 6 and 12 weeks, as well as 1 and 2 years after surgery. Complex intra-articular DRFs were excluded, and postfracture complication rate was low (10 %) in both groups.

II Maciel et al[188] (N = 41; 75% female; mean age, 55.8 years) compared a SupT group (mean 4.4 sessions over 6 weeks) to an iHEP group following nonoperative treatment. There were no differences in function (PRWE), wrist AROM, and grip strength at 6 and 24 weeks after cast removal. There were no group differences in fracture severity levels and no complications were reported for each group.

II Wakefield and McQueen[308] (N = 96; 90% female; mean age, 72 years) compared SupT (mean 3 sessions over 12 weeks) to iHEP following nonoperative treatment. Pain (VAS), wrist AROM, and grip strength were assessed at 3 and 6 months following cast removal. Significant group difference existed only for wrist flexion/extension total AROM (MD, 12°; $P = .001$) in favor of SupT at 6 months. No group differences were found in fracture severity and displacement levels before or after the 5-week immobilization period.

III Watt et al[314] (N = 18; 94% female; mean age, 75.8 years) compared SupT (mean 5 sessions over 6 weeks) to iHEP group following nonoperative treatment. There was a significant group difference for wrist extension AROM (MD, 10.3; $P = .010$) and grip strength

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(MD, 4.7 kg; P = .026) in favor of SupT, 6 weeks following cast immobilization. There were no group differences in initial fracture severity levels. No complications were reported for either group.

III Lara et al[161] (N = 49; 63% female; age range, 46-67 years) compared SupT (mean 5 sessions over 12 weeks) to a video-based iHEP following operative treatment. Videos were created by the study's medical institution and showed their standardized institutional postoperative exercise program. Therapy was initiated 2 weeks after surgery in both groups. No significant differences were found for function (QDASH), Pain (VAS), edema (wrist girth), wrist AROM, and grip strength at 2, 6, and 12 weeks after surgery. A greater number of complex intra-articular DRF were in the SupT (N = 16) than the iHEP (N = 8) group. Two of them required reoperation. Two iHEP individuals crossed over to SupT due to inadequate progress. Intention-to-treat analysis was used in this study.

Evidence Synthesis

Based on limited evidence, this section substantiates the concept that older DRF individuals with complications and comorbidities would benefit from weekly SupT services and an iHEP directed by hand therapists (PTs or OTs), regardless of fracture treatment management, while younger and uncomplicated DRF patient cases may not need SupT services to optimize their short- and long-term functional goals. Three systematic reviews[101,279,299] included 12 RCTs that compared SupT to iHEP and a single trial compared SupT to no therapy approach. In 3 other trials, SupT was compared to iHEP[222] and therapy (SupT or iHEP) was compared to no therapy approaches.[44,141] These trials (4 level I,[48,90,100,298] 3 level II,[188,308,314] and 6 level III[42,53,153,161,222,284]) produced inconsistent results indicating that both SupT and iHEP may achieve comparable outcomes among individuals with DRF following nonoperative and operative treatment. Methodological limitations that frequently affected these studies were excluding DRF individuals with complications and comorbidities, lacking inadequate power and blinding, having heterogeneous treatment parameters, not assessing function, utilizing nonvalidated functional measures, lacking baseline equivalency, not adequately reporting treatment details, and not assessing long-term outcomes. Six studies (2 level I, 2 level II, and 2 level III) reported short (3-6 weeks) and long-term (6 months) outcomes in favor of SupT.[53,90,100,222,308,314] Two of these studies (level I and III)[53,100] recruited individuals with postfracture complications or older individuals. These studies results indicated that older individuals or individuals with more significant postfracture complications may attain better outcomes (pain, AROM, grip strength, function) from receiving a combination of SupT with iHEP rather than an iHEP alone. Five studies (2 level I, 1 level II, 2 level III) showed comparable outcomes between SupT and iHEP.[32,42,48,161,188,298] These studies did not target older individuals and they recruited mostly individuals with low or no complications. One level I study,[100] which targeted older (≥60 years) individuals with DRF, found SupT to be superior to iHEP. Four studies (2 level I and 2 level III) reported the largest rates (10%-56%) of patient complications. In these studies, a significant number (up to 30%) of iHEP group individuals needed to transfer to SupT due to poor progress indicating that individuals with postfracture comorbidities (ie, increased hand, wrist, and shoulder stiffness, CRPS-1, OA, CTS) may benefit from SupT provided by a hand therapist for optimum recovery.[53,90,100,222,308,314] In one of these studies,[53,90,100,222,308,314] regression analysis indicated that 35% of the functional deficits were predicted by these comorbidities at 6 months. Only 2 level III studies reported outcomes in favor of the iHEP approach,[153,284] but their methodological limitations weakened their potential to support recommendations. Three studies compared therapy to no therapy. Kay et al[141] (level I) strongly supported the short-term (6 weeks) superiority of iHEP as compared to no therapy following nonoperative management. Bruder et al[32] (level I) showed comparable short- (7 weeks) and long-term (6 months) effects between SupT and advice for only self-care following nonoperative management. A critical study limitation was the limited SupT frequency to only 3 sessions over 6 weeks. Chung et al[44] (level III) showed inconclusive results when 3 therapy approaches (SupT, iHEP, or both) were clustered in 1 group and compared to no therapy. The validity of this study was threatened by lack of randomization, heterogeneity of the therapy group, not monitoring adherence, poor exercise program standardization, and lack of baseline equivalency in the tested outcomes.

Regarding therapy dosage, a combination of SupT with iHEP, which is directed frequently on a weekly basis (≥1 weekly session) by hand therapists (PT or OT) may produce better outcomes (pain, AROM, strength, and function) than limited SupT (≤1 session biweekly) following nonoperative or operative treatments. Among the 6 trials that applied a typical SupT dosage pattern, 3 (2 level I and 1 level III) trials reported short- (6 weeks) and longer-term (6 months) outcomes in favor of SupT,[90,100,222] 2 (level I and III) trials showed comparable outcomes,[42,298] and only 1 (level III) showed some evidence in favor of the iHEP.[153] In contrast, among the 6 studies that applied a limited SupT dosage pattern, 4 studies (2 level I, 1 level II, 1 level III) showed comparable outcomes between SupT and iHEP[32,48,161,188] and only 2 (level II) studies favored SupT.[308,314] Collectively, these findings may imply that when SupT has a decreased frequency pattern, it tends to produce more comparable short- and long-term clinical

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outcomes (pain, function, wrist AROM, grip strength) to an iHEP alone approach following nonoperative and operative treatments for DRF. This is important because when SupT is provided to individuals with significant complications, those individuals may need more frequently supervised care by a therapist for proper progression and adequate functional recovery. Among all the 16 reviewed studies, SupT providers were either a PT (N = 8), an OT (N = 2), or a certified hand therapist (N = 6), and the iHEP was instructed by the same clinician who directed SupT (N = 13) or the supervising surgeon (N = 3). Among the 8 studies that favored SupT or iHEP outcomes, the majority (N = 7)[53,90,100,222,308] encompassed iHEP training via clinicians (3 level I, 1 level II, 3 level III) and only 1 study[314] involved a surgeon in iHEP training (level II) following nonoperative or operative treatments. This provides sufficient evidence to suggest that iHEP provision should be directed and monitored by hand therapists (OT or PT), who are considered upper extremity rehabilitation experts in the health care industry. This should be conducted in accordance with the orthopaedic team guidance to ensure that ideal multidisciplinary fracture management standards are followed.

When a decision needs to be made on whether an individual should be referred to SupT services following DRF, risk for harm may be present in terms of overutilization or underutilization of health care resources. Although an unnecessary referral to SupT may not present additional risks for physical harm to individuals who could solely benefit from using an iHEP (ie, younger and uncomplicated cases), it may lead to an increased burden on the individual's time and financial responsibility while increasing health care spending. In contrast, failure to utilize SupT services, especially when therapy is needed (ie, older individuals with comorbidities and complications), may substantially increase the risk of delaying or impairing the full or timely potential of an individual's physical and functional recovery following DRF. This may lead to prolonged rehabilitation times and additional therapy visits that will also substantially increase health care costs. Following a DRF, the orthopedic care team should consider both benefits and harms relative to each individual's injury contextual factors individually. More research is needed to better subclassify DRF patients in terms of their therapy dosage needs based on individual factors, injury complexity, and recovery prognosis.

Gaps in Knowledge

Several interdependent elements that may influence outcomes (eg, age, fracture severity, postfracture complications, and individual psychosocial factors) should be considered to answer the posed questions of whether SupT is superior to iHEP or no therapy, and what SupT dosage is optimal. The existing body of literature lacks studies that integrate these contextual factors in a classification system that categorizes individuals based on rehabilitation prognosis. Future high-quality studies are needed to provide answers to these lingering gaps in the research.

Recommendations

A Clinicians (PTs or OTs) should be the primary instructors of iHEP following operative and/or nonoperative treatment for individuals with DRF to improve short- and long-term outcomes for wrist pain, AROM, grip strength, and function.

B Clinicians should have older (≥60 years) individuals or those with complications and comorbidities following operative and/or nonoperative treatments after a DRF attend a SupT program at a frequency of ≥1 weekly session, supplemented with an iHEP, to improve short- and long-term wrist pain, AROM, grip strength, and function.

D Conflicting evidence prevents making a recommendation for or against SupT, iHEP, or no therapy for younger individuals with no complications or comorbidities following nonoperative or operative treatment for optimum short- and long-term outcomes of their DRF.

EDEMA CONTROL METHODS

Hand and wrist edema control may be important during the early phases of DRF rehabilitation following either nonoperative or operative management. Accumulation of hand and digital edema following DRF is considered a significant physical impairment that may negatively impact an individual's recovery.[204] Edema control may consist of several different approaches, such as the use of compression garments or gloves, manual lymphatic drainage (MLD) techniques, upper-limb elevation, application of intermittent pneumatic compression (IPC), and/or other modalities.[7,105,204] This section synthesizes the evidence regarding edema control interventions, other than therapeutic modalities following nonoperative and operative DRF treatments. Intermittent pneumatic compression units and other modalities will be covered in the therapeutic modalities section of this CPG.

Manual Lymphatic Drainage

II The systematic review and meta-analysis conducted by Gutiérrez-Espinoza et al[99] found evidence to support MLD in the treatment of edema after DRF managed nonoperatively or operatively (ie, external fixator). This systematic review included 2 lower-level RCTs[105,149] that compared conventional treatment plus massage for edema reduction versus conventional treatment alone. Conventional

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treatment in both studies included elevation, hand and wrist exercises, compression, functional training, and iHEP instruction (visits: 9-23). The experimental groups in both studies received treatments of MLD, which included specific massage techniques aimed at promoting the flow of lymph in the upper extremity (visits: 11-17). In the Knygsand-Roenhoej and Maribo[149] study (n = 29; 72% female; mean age, 63) the experimental group also performed exercises in the segment just massaged along with diaphragmatic breathing, application of low-stretch bandaging, and instructions to perform a one-handed massage as part of their iHEP. Knygsand-Roenhoej and Maribo[149] found no significant difference between groups for edema, AROM, or pain at 1, 3, 6, 9, or 26 weeks. There was a significant difference between groups in favor of MLD for ADLs at 3 weeks (means not reported), but no difference at 6, 9, or 26 weeks. MLD group required significantly fewer treatment sessions (14 vs 19); after 6 weeks, 21% of MLD group and 60% of the conventional treatment group required further treatment for edema. Haren et al[105] (N = 26; 77% female; mean age, 61) found a statistically significant difference in median hand volume between groups at 3 days (64 ml in control versus 39 ml in the MLD group; 95% CI: 0.6, 49.5) and 17 days (50 ml in control versus 27 ml in the MLD group; 95% CI: 2.2, 43.4). There were no significant differences between groups at 33 days (35 ml in control versus 19 ml in the MLD group; 95% CI: −0.3, 31.5) and 68 days (24 ml in control versus 12 ml in the MLD group; 95% CI: −1.0, 24.2).

II In Haren et al,[105] subjects (n = 51; 82% female; mean age, 63) were randomly assigned to receive conventional therapy plus MLD or conventional therapy alone. Treatment for both groups was initiated within 1 to 6 days after casting or external fixation and included elevation, active and resistive hand/wrist exercises, compression with an edema glove, and iHEP instruction (7-13 sessions). The MLD group received 40 minutes of MLD in addition to conventional treatment for the first 6 treatment visits. There was a median decrease of 20 ml (95% CI: −10, 45) in the control group and 30 ml (95% CI: 10, 55) in the MLD group (P = .005) after 6 sessions. The difference between groups was not significant (5 ml) at 60 days, with control having a median decrease of 35 ml (95% CI: 15, 80) in the control group and 40 ml (95% CI: 10, 90) in the MLD group.

Compression Gloves

II Miller-Shahabar et al[204] compared the effects of a custom-made compression glove (20-30 mmHg worn 10 hours/day) plus standard therapy (n = 17; 82% female; mean age, 61.5) to standard therapy only (n = 15; 13 females/2 males; mean age, 68) 2 times per week for 6 weeks. Both groups received AROM exercises for the wrist/fingers, fine motor and daily activities training, and gradual strengthening. Although group means were not provided, the authors reported significantly greater reduction in finger (P<.001), hand (P<.01), and wrist (P<.001) swelling at the 2-week follow-up in subjects who wore the compression glove. While neither group showed further significant improvement in swelling, differences between groups were maintained at the follow-up at 6 weeks. The same pattern of between-group differences over time was reported for AROM with wrist flexion (P<.01) and extension (P<.001), as well as radial (P<.001) and ulnar (P<.001) deviation. Improvements in pain and function, as measured using the PRWE, were also significantly (P<.05) greater in the glove-wearing group at both 2- and 6-week assessments.

Evidence Synthesis

A conventional approach to management of edema after DRF commonly includes elevation, active and passive exercise, and the application of compression with elastic gloves or wraps. Evidence supporting the addition of other edema control methods to a standard treatment regimen is limited. Evidence from 2 level II studies[105,149] and 1 level III study[104] suggests that the addition of specific MLD techniques may have short-term benefits for hand volume.[99] Similarly, 1 level II study[204] found that adding a custom-made compression glove improved swelling, AROM, pain and function compared to a standard 6-week protocol. No harm directly related to treatment was reported in any of the studies reviewed.

Gaps in Knowledge

Higher-level studies are needed to investigate the potential benefits of MLD. No studies have examined the cost effectiveness of treatment and specific parameters of MLD, such as frequency and duration need to be better defined. While 1 lower-level RCT found benefit to adding compression gloves to conventional treatment, further evidence is needed to determine if compression gloves are beneficial without MLD treatment as well as cost effective.

Recommendations

C Clinicians may perform a combination of edema control techniques, including MLD and other manual edema mobilization, exercises, elevation, compression gloves, low-stretch bandaging, and/or iHEP instruction, to induce short-term (2-6 weeks) benefits on hand swelling, AROM, function, and pain following nonoperative and operative DRF management.

MANUAL THERAPY TECHNIQUES

Manual therapy is generally considered part of the multimodal rehabilitation approach following DRFs. Joint mobilizations have been advocated to improve pain, joint AROM,

and function.[99] Three different approaches to mobilizations have been studied: Kaltenborn sustained translational mobilization, Maitland oscillatory mobilizations, and Mulligan's sustained mobilizations with movement (MWM). Traditionally, mobilizations before tissue resistance have been used for pain relief and edema reduction, while mobilizations within or past tissue resistance have been used to improve passive mobility. MWM is typically used to reduce pain with movement and improve proper arthrokinematics during active movements. Gutiérrez-Espinoza et al[99] conducted a systematic review with meta-analysis to examine the effects of manual therapy on functional outcomes in subjects with isolated DRF; however, only one of the included studies compared conventional treatment with manual therapy to conventional treatment alone. Therefore, this systematic review is not included in this review.

I Tomruk et al[293] studied the effects of early manual therapy on functional outcomes following DRF operative (volar plating) management. Subjects (N = 39; mean age, 51; 53% female) were randomized into a standard therapy group or the standard therapy plus MWM group with visit frequency of 2 times a week for 12 weeks for both groups. The standard therapy program started at 8 weeks postop and consisted of hand, forearm, elbow and shoulder active AROM exercises, PROM, stretching, resistance training, and instruction on home exercises. The experimental group also received wrist and forearm MWM sustained glides during AROM. Outcomes were assessed at 3, 6, and 12 weeks. Statistically significant group differences in favor of the MWM group existed with increased function on PRWE scores ($P<.05$; MD range, 14-19), decreased pain ($P<.05$; MD range, 2.7-3.2), and increased grip strength ($P<.05$; MD range, 4.5-8 kg) across all assessment times and DASH scores at 12 weeks ($P<.05$; MD, 7.4). Statistically significant group-differences ($P<.05$) also existed in favor of the MWM group for all active wrist AROM (flexion-extension, supination, radial-ulnar deviation) across all assessment times with fair to moderate effect sizes (0.22-0.56).

I Reid et al[243] conducted a multicenter RCT to investigate whether adding MWM to exercise and education improves recovery after nonoperative treatment of DRF. A total of 67 (mean age, 60; 76% female) subjects were randomized into 2 groups and attended 4 physical therapy visits over 4 weeks. The control group received standard of care with edema control, skin care, advice for self-care and progression with daily functional activities, and upper-limb AROM. The experimental group received the same standard care plus MWM to improve wrist supination and extension. Subjects were trained via instructions and videos to perform the MWM at home 2×/day. Outcomes were assessed at baseline, 4, and 12 weeks. There were statistically and clinically significant differences (based on previously published MCID values) between groups for supination at 4 weeks (MD, 12°; 95% CI: 5, 20) and 12 weeks (MD, 8°; 95% CI: 1, 15), and for wrist extension at 4 weeks (MD, 14°; 95% CI: 7, 20) and 12 weeks (MD, 14°; 95% CI: 6, 21). There was a statistically significant group-difference in function in favor of the experimental group (PRWE MD, −13; 95% CI: −23, −4; and Quick DASH MD, −11; 95% CI: −18, −3) at 4 weeks. There was no statistically significant difference between groups for grip strength at any follow-up; 97% improved with MWM at 4 weeks per global rating of change compared to 75% with the control group. No adverse effects were reported other than mild discomfort (pain levels<3/10) for less than 30 minutes after MWM (27% compared to 15% in the control group).

I Kay et al[140] investigated the effect of joint mobilizations on pain, AROM, and function in subjects with nonoperative and operative DRF management. Subjects (N = 39; mean age, 53; 69% female) were randomly assigned to a control group (standard multimodal therapy that included advice for edema control, skin care, exercises, functional activities, and iHEP instruction - mean of 3 visits) or mobilization group (same standard therapy plus additional visits of Maitland joint mobilization therapy - mean of 9 visits). Mobilizations consisted of grades I and II accessory (anterior to posterior and posterior to anterior), motions and grades III and IV, end-range passive physiologic motions at the wrist and distal radio-ulnar joints. Both groups experienced equivalent outcome improvements, and there was no statistically significant difference ($P>.05$) between groups on pain (VAS), grip strength, or function at 3 or 6 weeks. There was a statistically significant group difference in favor of the joint mobilization group at 3 weeks for wrist flexion AROM (MD, 5°; 95% CI: −13.6, 3.6; $P = .02$). When looking at CIs, this 5° MD may not be clinically important.

III Javaid et al[119] compared Maitland and Mulligan's mobilization techniques on hand function and pain after DRF. Subjects (N = 60; mean age, 45; number of females unknown) were nonrandomly assigned to 1 of 3 groups: limited care only (hot pack [HP] and PROM), limited care with Maitland oscillation mobilizations, and limited care with MWMs. Statistically significant improvements were found at 4 weeks and at follow-up for all measures in the Mulligan group (mean improvement of 3.03 points on the VAS, 79.05 on PRWE, and 21.56° of wrist extension at 4 weeks, $P<.0001$).

III In a small (n = 8 females; mean age, 64.5) single-subject experimental design study, Coyle et al[55] compared 2 mobilization techniques: grade III

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joint oscillations versus 1 sustained posterior to anterior glide. Following cast removal at 6 weeks, treatments were performed 2 times per week for 3 weeks (total 6 sessions). In general, oscillations led to much greater pain (~44% mean change) and AROM improvement, than sustained mobilizations during the first 3 visits (36% mean change in writ extension AROM compared to ~21% for the sustained group) when subjects typically experience higher pain levels. Sustained techniques generally increased pain early on, but were more effective for improving wrist extension AROM (30% mean change compared to ~22% for the oscillations) in the last 3 visits.

Evidence Synthesis

Two level I studies and 1 level III study suggest that the addition of Mulligan MWM techniques to a standard care program may be more effective than standard care alone to reduce wrist pain and improve AROM and function, at least in the short term.[119,243,293] One level I study suggests that Maitland oscillation mobilizations may lead to more short-term wrist flexion AROM gains than standard of care.[140] More evidence is needed to determine if grade III oscillations could be superior to Kaltenborn sustained mobilization early in a rehabilitation process for short-term pain control and if sustained mobilizations could be more effective after oscillations are performed to increase wrist AROM among subjects with greater amounts of stiffness.[55] While evidence is very limited, studies suggest that adverse reactions related to joint mobilization may include mild short-lasting (<30 minutes) posttreatment discomfort in some subjects. No other harms directly related to manual therapy treatment have been reported. It should be noted that all studies included manual therapy as part of a multimodal program and included other therapeutic exercises and edema control interventions within the confines of standard care.

Gaps in Knowledge

The effects of manual therapy after DRF needs to be investigated in more high-quality studies with larger samples of subjects, especially those who present with significant stiffness. The optimal parameters (grade, repetitions, frequency, and duration) for joint mobilization techniques are unknown and warrant further investigation. Further research is also needed to determine if self-performed mobilization techniques as part of an iHEP are as effective as those administered by a PT.

Recommendations

B Clinicians should use manual therapy procedures (MWM, accessory joint mobilizations, oscillations, sustained stretching) based on individual tolerance and fracture stability levels as part of multimodal management strategies for short-term improvements in wrist pain, AROM, and upper-limb function for individuals following operative and nonoperative DRF treatments.

THERAPEUTIC EXERCISES

Therapeutic exercises following DRF are typically implemented regardless of the type of fracture management. Exercises consisting of early AROM with the involved hand and other proximal joints may start during the initial wrist immobilization phase. AROM and PROM exercises with the involved wrist are initiated when proper fracture healing has been attained. Strengthening exercises encompass a variety of isometric and isotonic techniques, which may also involve the unaffected side. Additionally, functional training targeting muscle endurance, coordination, and motor control is integrated.[83,98,155,191] This functional training is a vital component of rehabilitation, often conducted by OTs who frequently collaborate with PTs throughout the DRF rehabilitation process.[83]

I Gutiérrez-Espinoza et al[98] compared the effects of standard therapy to standard therapy, plus a scapular exercise program in 102 subjects (mean age, 66; 80% female) who were treated with closed reduction and cast immobilization post DRF. The subjects in the control group (standard therapy) received 12 visits of AROM in a whirlpool, radiocarpal mobilizations, grip strengthening, and reverse dart throwing exercises. In addition to the above treatment, the scapular exercise group received low-intensity scapular positioning exercises below shoulder level. There was a statistically significant and clinically meaningful change in DASH scores between groups at 6 weeks (30.7 for scapular group versus 14 for control; 95% CI for difference between groups: 12.6, 20.9; $P = .0001$) and pain with movement (2.9 cm versus 1.2 cm in the control group; 95% CI for difference between groups: 1.2, 3.2; $P = .001$) favoring the scapular exercise group. There were no differences in PAR or PRWE scores ($P>.05$).

II Kuo et al[155] investigated whether early digit mobilization resulted in better outcomes for hand stiffness and function after external fixation among 22 subjects (mean age, 62; 68% female) with DRF. The early digit mobilization group received massage, PROM/AROM of uninvolved joints, ADLs training, isometric and concentric exercises of the digits, and tendon gliding exercises. The early digit mobilization program started 1 week after external fixation treatment and ended with external fixation removal at 6 weeks. The control group received only standard advice and basic exercises to adjacent joints excluding the hand. Both groups received 12 weeks of regular rehabilitation after removal of the external fixation. No statistically

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significant differences were found between groups for thumb/finger AROM, grip/pinch strength, and dexterity at any follow-up (1, 3, 6 weeks). A statistically significant difference was found in "maximal workspace" at 12 weeks in favor of the early digit mobilization group (81.55% vs 69.54%, P = .04, and 89.22% vs 59.97%, P = .03). Maximum workspace was defined by the authors as "maximal AROM capacity of the thumb and fingers." No adverse effects were reported for either group.

II Magnus et al[191] evaluated the effects of home-based strength training of the uninvolved upper extremity on the recovery of muscle strength, AROM, and function among 39 females (mean age, 63) subjects with unilateral nonoperatively and operatively managed DRFs. The experimental group was prescribed progressive maximum isometric strength training for finger, hand, and forearm muscles of the uninjured upper extremity, 3×/week for 26 weeks. Both the control and experimental group received a standard therapy protocol that included 6 visits of home program instruction and progression. All outcomes were assessed at 9, 12, and 26 weeks. The only statistically significant differences in favor of the experimental group existed in grip strength (P<.01; MD, 5.5 kg) and wrist flexion/extension total arc AROM (P<.01; MD, 20.3°) at 12 weeks. No statistically significant differences existed between groups in function (PRWE) at any of the follow-up points.

II Filipova et al[83] conducted an RCT to evaluate the efficacy of combined physical and occupational therapy (PT/OT) in comparison with PT alone in 62 subjects (mean age, 60; 77% female) with DRF treated conservatively. The subjects in the PT-only group received Galvanic bath, AROM exercises, joint mobilizations, and strengthening exercises. The PT/OT group receiving the same treatment as the PT group, plus 30 minutes of strengthening, and coordination and endurance training using functional movements. There was a statistically significant difference (P<.05) in relative grip strength between groups at discharge and 1 month after discharge in favor of the PT/OT intervention. There were no between-group differences in AROM or DASH at any other follow-up. It is unclear if the additional strength improvement benefits relate to the type of provider, the functional strengthening intervention, or the additional treatment time.

II Picelli et al[232] evaluated the efficacy of robot-assisted arm training on upper-limb impairment in 20 subjects (mean age, 62; 65% female) with operatively and nonoperatively treated DRF. The robotic arm training group performed 10 sessions (60 minutes each) of robot-assisted AROM and PROM exercises (unilateral, bilateral, mirror-like) 5 days/week for 2 weeks. The control group received conventional AROM, strengthening, and functional training exercises. Group outcomes in PROM, AROM, grip/pinch strength, and function (PRWE) were assessed immediately after the first session and 4 weeks later. Both groups demonstrated equivalent improvements in all outcomes over 4 weeks with no between-group differences. A critical limitation of this study was the very small sample size, which limits estimated statistical power.

III Kaufman-Cohen et al[139] evaluated the outcomes of standard rehabilitation (control group) compared to a program adding dart-throwing motion plane exercises (experimental) as part of the iHEP to a small sample of 24 subjects (mean age, 50; 42% female) treated via ORIF. The control group received edema control, mobilization, and wrist strengthening exercises with Theraband for 30 minutes × 12 visits. The subjects in the experimental group received the same as the control group but were also prescribed an iHEP moving the wrist in a dart-throwing motion plane using a modified orthosis. There was no statistically significant difference between groups in AROM, pain, function (PRWE), or grip/pinch strength after 12 sessions (6-8 weeks) although the experimental group had higher satisfaction scores.

III Naqvi et al[214] evaluated the effect of gamification in 20 subjects with DRF managed with closed reduction. The gamification group (age range, 18-65 years; 20% female) played games on an Oculus Quest head-mounted display. The control group (age range, 18-65 years; 50% female) received standardized rehabilitation. Neither intervention was well described. Both groups showed improvements in pain, AROM, strength, and function but the gamification group showed more improvement in DASH scores at 2 and 4 weeks than the control group. Power calculations not reported.

IV Mitsukane et al[206] performed a pretest and posttest cross-sectional study to evaluate the immediate effect of repetitive wrist extension contractions on grip strength among 28 operatively and nonoperatively treated subjects with DRF (mean age, 63; 68% female). The subjects in the wrist repetitive extension protocol performed 30 (3 sets of 10) maximum wrist isometric extension repetitions at end-range extension holding a lightweight (5 g) rod while the control group rested for 6 minutes. Pain (VAS) and grip strength outcomes were assessed immediately after the experiment. There was a significant postintervention to preintervention increase in grip strength (P<.01; MD, 1.4 kg) and a decrease in pain (P<.03; MD, 7.1 mm) in the experimental group, while no statistically significant improvements were seen in the control group.

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Evidence Synthesis

This section has synthesized research results based on limited evidence from 8 studies. Only a small number of therapeutic exercises that are commonly utilized following DRFs have been studied to date. Specific rehabilitation guidelines cannot be recommended, due to the paucity of experimental studies, design limitations, and the variety in therapeutic exercise approaches and subgroup of DRF subjects studied. These findings are consistent with the systematic reviews that did not meet the inclusion criteria of this CPG.[101,239] Evidence seems to support a variety of exercises that include progressive AROM, PROM, tendon gliding exercises, resistive training, motor control, and functional training.[83] One level I study demonstrated short-term improvements in arm function and pain by adding scapular strengthening to standard physical therapy.[98] When exercises are contraindicated or not well tolerated on the involved side, strengthening of the uninvolved side may offer benefits.[191] Exercises for the hand (finger AROM, finger isometric, concentric, and tendon gliding exercises) beginning 1 week after external fixation appear to be safe.[155] The limited evidence and the cost of various technologies prevent recommendations regarding dart-throwing motions using orthosis, gamification, or robot-assisted training.[139,214,232] Besides slight discomfort, postexercise soreness, and possible equipment cost toward an iHEP, no noteworthy harms have been documented from performing therapeutic exercises that are appropriately implemented regarding the timing of initiation and the dosage-levels based on individual tolerance following operative and nonoperative DRF management.

Gaps in Knowledge

While therapeutic exercises post DRF are the mainstay of physical and occupational therapy and are recommended by the CPG team members for improving pain, AROM, strength, and function, research studies that examine the efficacy of various commonly utilized therapeutic exercise strategies and progressions in the rehabilitation of DRF are scarce. High-quality studies that examine and compare various modes of therapeutic exercises and their optimal parameters are needed.

Recommendations

B Clinicians should use properly timed therapeutic exercises based on fracture treatment type and fracture stability level, including PROM, AROM, tendon gliding, motor control, functional and progressive bilateral resistance exercises that include the scapular and glenohumeral musculature to improve pain, AROM, strength, and function for individuals following a DRF.

Sensorimotor Training

A limited body of research has pointed to the presence of significant wrist SM impairment following DRF.[134,318] This impairment may be associated with a wide range of possible deficits that include decreased hand sensation (eg, 1- or 2-point touch discrimination, moving touch, stereognosis), diminished proprioception (ie, wrist JPS), decreased wrist and hand strength, and decreased function.[134] Wrist SM impairments are adversely influenced by increased pain levels and may persist for up to 12 weeks following nonoperative and operative management for DRF.[134,135] Several SM intervention methods have been proposed in the literature to address wrist pain and sensibility deficit as well as proprioception and neuromuscular decline following DRF. For early rehabilitation stages graded motor imaging (GMI), mirror therapy, sensory stimulation via vibration, wrist position replication of movement with eyes closed, and wrist isometric exercises have been proposed to help improve pain, sensibility, AROM, and JPS (ie, conscious proprioception).[133] Among these methods, GMI has been popularized for its 3 motor-cognitive exercise phases in laterality (ie, ability to discriminate left vs right body images), motor imagery (ie, ability to imagine movement of the affected arm), and mirror therapy (ie, motion of the unaffected arm in front of a mirror is perceived as motion of the hidden affected arm behind the mirror).[22,65,151,318] For late rehabilitation stages, various strengthening and perturbation exercises toward neuromuscular facilitation and instinctive muscle recruitment (ie, unconscious proprioception) can be used to restore joint stability.[133] Sensorimotor training can be provided along with other conventional exercises during SupT or could become integrated in an iHEP.

I Dilek et al[65] conducted an RCT to compare GMI combined with conventional therapy (N = 17; 70% female; mean age, 52.5 years) to conventional therapy alone (N = 19; 63% female; mean age, 47.2 years) 3 weeks after nonoperative and operative management for DRF. Individuals with complex intra-articular DRFs were excluded from this study. The conventional therapy (16 sessions, 2 sessions/week over 8 weeks) consisted of edema control techniques; AROM and PROM for the hand, wrist, elbow, and shoulder; joint mobilization; proprioception and upper extremity strengthening exercises; and an iHEP. The GMI program progressed through the 3 main elements of lateralization, motor imagery, and mirror therapy. Both treatment groups were directed by a PT. Significant ($P<.05$) differences in favor of the GMI group existed at 8 weeks for pain with activity (VAS MD, 6 cm), wrist AROM (flexion MD, 40°; extension MD, 45°; radial deviation MD, 25°; ulnar deviation MD, 26°; supination MD, 43°), and function (DASH MD, 38%, and MHQ MD, 32%). Differences in DASH scores were found to be clinically meaningful (MCID, 10.83). Groups had comparable pretreatment baselines in all measures as well as fracture severity levels.

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I Korbus and Schott[151] conducted a small RCT among older (≥60 years) females following operative treatment for DRF to compare groups that performed either mirror therapy (N = 12; mean age, 75.4 years) or motor imagery (N = 8; mean age, 73.1 years) to a control group that performed only relaxation techniques (N = 9; mean age, 72.4 years). All 3 compared interventions were performed for 6 weeks as a home-based training program (5 times/week for the first 3 weeks, 3 times/week thereafter), in addition to traditional therapy exercises and an iHEP. Groups were guided by different therapists, one for the experimental groups and one for the control group. All groups had comparable baseline characteristics. Significant group difference in function (PRWE) was shown at 12 weeks for the mirror therapy (MD, 8.9%; *P*<.001; effect size, 0.61) and the motor imagery (MD, 5.2%; *P*<.001; effect size, 0.39) as compared to the control group. Significant wrist AROM (total AROM of flexion, extension, ulnar and radial deviation) differences as compared to nonaffected side were shown at 12 weeks for the mirror therapy group (MD, 10°; *P*<.001; effect size, 0.36) and the motor imagery (MD, 12°; *P*<.001; effect size, 0.10). Both experimental groups had greater grip strength improvement rates (ratio to uninjured side) than the control group at 12 weeks, but the difference was not significant (MD, 64.5%-67.6%; *P*>.05). No adverse effects were reported, and individuals showed a high (≥96%) exercise compliance with only 2 dropouts.

III Bayon-Calatayud et al[22] conducted a small trial to compare the efficacy of mirror therapy combined with conventional therapy (N = 11; 72% female; mean age, 61 years) to conventional therapy alone (N = 11; 63% female; mean age, 55.36 years). Individuals with complex unstable DRF were excluded from this study. Both groups received equivalent time of therapy via 15 supervised sessions (5 times weekly) over a 3-week period following nonoperative and operative treatments. Conventional therapy was directed by an OT and consisted of physical agents for pain (TENS, ultrasound, HP/cold pack [CP]), AROM and PROM exercises for the hand and wrist, and strengthening methods. The mirror therapy involved wrist and finger-grasping movements in front of a mirror. No significant group differences (*P*>.05) existed in Pain (VAS; MD, 0), wrist extension AROM (MD, 4), and self-reported function (Quick DASH; MD, 5%) outcomes at 3 weeks following therapy initiation. Groups showed comparable postfracture complications of 50% (N = 11) of individuals having sensory loss and hand paresthesia, and 13% (n = 6) displaying CRPS-1 symptoms.

III Wollstein et al[318] conducted an RCT to compare occupational therapy combined with a home-based SM training program (N = 29; 85% female; mean age, 62.3 years) to only occupational therapy (N = 31; 67.7% female; mean age, 63.9 years) following operative treatment and 6 weeks immobilization. Occupational therapy (1 session/week over 6 weeks) consisted of edema control, hand and wrist AROM, and functional strengthening. The SM home program (3 times/day for 15 minutes) consisted of sensory stimulation via massage or rubbing various textures around the wrist, active hand and wrist motions (eyes open or closed), mirror therapy, motor imagery, and wrist position replications with eyes closed. No significant group differences (*P*>.05) on function (DASH), hand sensation (Semmes-Weinstein Monofilaments, 2-point discrimination, vibration), dexterity (Moberg's pick-up test), wrist proprioception, and wrist AROM existed at 6 and 12 weeks. It should be noted that there were significant methodological limitations including a 56% to 65% loss to follow-up rates.

IV Two small prospective quasi-experimental trials by Imai et al[117,118] investigated the efficacy of wrist vibration sensitization therapy to induce kinesthetic illusion of motion and improve pain (VAS), wrist AROM, and function (PRWE) following operative treatment for DRF. In both studies, vibratory stimulation was combined with standard physical therapy (N = 24; 91% female; mean age, 70.9 years) and compared to a control group of standard therapy only (N = 24; 87.5% female; mean age, 69.5 years). Both treatment groups initiated physical therapy immediately after surgery for 7 consecutive days. Standard therapy consisted of various wrist AROM exercises and CPs. Vibration therapy was applied via a battery-operated handheld massager (70-80 Hz) over the distal dorsal forearm (six 30-second cycles) prior to the start of each physical therapy session. At 7 days, significant (*P*<.05, 0.001) differences were present in favor of the vibration therapy group in resting pain (MD, 31 mm), pain with motion (MD, 23 mm), wrist flexion (MD, 10.8°), wrist extension (MD, 22.4°), supination (MD, 13.6°), pronation (MD, 10.9°) AROMs, and PRWE (MD, 25.5%). Significant differences remained at 4 weeks in resting pain (MD, 13 mm), pain with motion (22 mm), wrist flexion (MD, 10°), wrist extension (MD, 10°), supination (MD, 13.3°), pronation (MD, 12°) AROMs, and PRWE (MD, 21.2%), as well as at 8 weeks in resting pain (MD, 14 mm), pain with motion (MD, 18 mm), wrist flexion (MD, 12.8°), extension (MD, 10°), supination (MD, 12.2°), pronation (MD, 14°) AROMs, and PRWE (MD, 14.1%) in favor of the vibration therapy group. PRWE MDs were also clinically meaningful.

Evidence Synthesis

Only 6 studies investigating the efficacy of SM training interventions following nonoperative or operative DRF management are available. All analyzed studies compared conventional therapy exercises to a single or multimodal types of SM training interventions when combined with

conventional therapy. Three studies (2 level I and 1 level III) investigated SM training via either GMI with all its 3 intervention levels, or they focused on mirror therapy and motor imagery in isolation.[22,65] Another study (level III) investigated the efficacy of multimodal SM training that consists of sensory stimulation training (vibration, manual massage and texture resensitization), mirror therapy, motor imagery, and other proprioceptive exercises (wrist motion replications with eyes closed, or wrist AROM with eyes closed), and practicing functional activity with both the dominant and nondominant sides while eyes are closed.[318] Two quasi-experimental studies (level IV) investigated the efficacy of sensory stimulation via vibration as a way to improve proprioceptive sense of wrist kinesthesia.[117,118] All of these SM training interventions were provided as either in-clinic supervised activity or part of an iHEP following nonoperative or operative treatment. Based on limited evidence, combining GMI or other sensory sensitization or proprioceptive training methods with conventional therapy seems to be a superior approach than conventional therapy alone toward improving wrist and hand pain, AROM, sensation (single-point touch, 2-point discrimination, stereognosis), proprioception (JPS), and self-reported anxiety and function. Integration of these SM training interventions in clinical practice should be cost-effective as they do not require expensive instrumentation, and they do not present higher risks for adverse effects than conventional therapy. Yet, they may require increased application time and greater supervision or instruction by hand therapists with adequate experience and training. Various methodological weaknesses limited the evidence strength for some of the included studies.[22,117,118,318] These limitations consisted of excluding individuals with complications; having underpowered sample-sizes; lacking randomization, concealment, and blinding; having large loss to follow-up; assessing only short-term outcomes; and under-reporting assessment and intervention details, and exercise compliance. No harms were reported from SM training.

Gaps in Knowledge

Stronger high-quality RCTs are needed to determine both the short- and long-term efficacy of the currently proposed SM training methods in isolation or combination with conventional therapy methods after nonoperative or operative treatments for DRF. No studies were found to have investigated the efficacy of various strengthening and perturbation exercises toward neuromuscular facilitation and instinctive muscle recruitment toward wrist joint proprioceptive stability following a DRF. Future studies need to have stronger methodological designs and maximize the inclusion of complicated DRF individuals that would typically benefit from attending SupT.

Recommendations

A Clinicians should integrate GMI as part of a multimodal management strategy to improve short-term outcomes in pain, AROM, and patient-reported function during the early rehabilitation stage (6-8 weeks) for individuals following nonoperative and operative treatment for DRF.

C Clinicians may integrate a multimodal SM training approach consisting of sensory stimulation techniques (eg, vibration) and other proprioceptive exercises in conjunction with conventional therapy to improve short-term outcomes in pain, AROM, and function during the initial rehabilitation stage (6-8 weeks) for individuals following operative treatment for DRF.

ORTHOSIS MANAGEMENT FOR STIFFNESS

Wrist orthosis utilization is a complementary element in the multimodal DRF rehabilitation process.[101] It may be a clinically useful intervention type for select subgroups of complicated individuals with DRF who display a lack of proper AROM progression using only conventional exercises. Two types of orthotic devices are available following DRF. Their primary aim is to improve physiological motion via inducing permanent viscoelastic elongation of shortened or contracted soft tissues around the wrist joint. Static progressive orthoses are either commercially available or custom-made devices that can apply constant static long-duration stretch at the end-range of available wrist motions.[176] Dynamic orthoses are also commercially available or custom-made devices that can apply constant long-duration stretch at the end-range of wrist motion via spring-loading or elastic mechanisms while allowing intermittent movement.[128] The amount of force applied by static-progressive and dynamic orthoses is adjustable based on an individual's tolerance and is progressed overtime. The disadvantages of orthoses' utilization include their cost, lack of payer reimbursement, and time investment required for individuals to apply these devices on a daily basis. Construction of custom-made orthoses requires the skilled services of a specialized hand therapist.

Dynamic Orthosis

II Jongs et al[128] conducted an RCT to investigate whether a dynamic orthosis improves wrist AROM when used in conjunction with standard care. Forty subjects (mean age, 62; 70% female) with wrist flexion contractures following operative and nonoperative treatment of DRF and 3 weeks of immobilization were recruited. Both groups received a routine SupT program for 8 weeks. The experimental group also received stretching via a custom-made dynamic thermoplastic orthosis, which was used for 8 weeks (at least 6 hours a day). The splint provided constant low-load

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wrist extension stretch via an elastic band mechanism and biweekly tension adjustments were performed based on tolerance. Wrist extension PROM, wrist AROM in all directions, and function (PRWE and COPM) were assessed at 8 and 12 weeks. A statistically significant, but not clinically meaningful, group difference was present only for passive extension (MD, 6°; 95% CI: 1°, 12°) at 12 weeks. No significant or clinically meaningful group differences existed for all other outcomes.

Static Progressive Orthosis

V Lucado et al[176] retrospectively looked at the effects of static progressive orthosis (Joint Active Systems, Inc) on wrist and forearm AROM, grip strength, and function following operative treatment of DRF. Twenty-five subjects (mean age, 46; 40% female) with documented wrist stiffness after DRF and utilizing a static progressive orthosis were included. All participants received hand therapy (mean of 23 visits) in addition to wearing the orthosis 30 minutes daily, which was progressed to 3×30 minutes daily. Statistically significant ($P<.05$) pretreatment to posttreatment differences were seen in all outcomes. Wrist extension increased by 18.6°, flexion increased by 11.4°, pronation increased by 30°, supination increased by 14.5°, grip strength increased by 24.5 pounds, and DASH improved by 24%.

Evidence Synthesis

Only 2 studies that investigated the efficacy of orthosis application following operative and nonoperative DRF treatments were included in this evidence synthesis. Evidence supporting the addition of orthosis to a standard treatment regimen is limited. One level II study showed no clinically meaningful improvements in AROM or function at 8 and 12 weeks after wearing a custom-made dynamic orthosis that provided low-load stretch.[128] The patient compliance was low, loss to follow up was high (20%), and sample size was underpowered. A second level V study looked at the effects of a static progressive orthosis, but the lack of control group makes a conclusion impossible.[176] The scarcity of evidence poses challenges in formulating definitive recommendations for the utilization of static and dynamic orthoses following DRF. Therefore, guidance in this regard relies largely on expert opinion rather than conclusive empirical evidence. While the evidence is very limited, clinicians should consider both the potential benefits and harms of static-progressive and dynamic orthoses. Although these types of orthoses may result in joint mobility gains, and no specific adverse effects have been reported, the projected high cost, clinical application time demands at home, and lack of reimbursement may be viable concerns for orthoses management.

Gaps in Knowledge

Stronger RCTs are needed to determine the short- and long-term efficacy of both static progressive and dynamic orthoses in improving wrist AROM and function following nonoperative and operative DRF management. Future research should identify the preferred orthotic intervention for specific subgroups of DRF individuals, particularly those with complications or a less favorable rehabilitation prognosis, while also considering cost-effectiveness and the proper timing of orthosis initiation in the plan of care. Knowledge gaps exist regarding patient-reported satisfaction and compliance, as well as the impact of orthoses on coordination, strength, and proprioception following DRF.

Recommendations

F Clinicians may utilize dynamic and static progressive orthoses in conjunction with standard care to improve wrist PROM primarily for certain subgroups of individuals with DRF who have difficulty reaching their functional goals due to persistent wrist stiffness.

THERAPEUTIC MODALITIES

Various therapeutic modalities are available for clinicians to utilize during the DRF rehabilitation process following nonoperative or operative treatment. Therapeutic modalities are considered complementary treatment components in a multimodal rehabilitation approach after DRF, encompassing several thermal, electrical, and mechanical modalities.[101] Thermal (ie, heating and cooling), light-emitting, electrical, and mechanical agents that have been utilized in the rehabilitation of DRF include HPs, CPs, pulsed electromagnetic field (PEMF) also known as diathermy, cold laser therapy (LT), ultrasound, ultraviolet light therapy (UVLT), warm whirlpool (WWP), transcutaneous electrical nerve stimulation for pain (TENS), IPC, blood flow restriction (BFR), and continuous passive motion (CPM).[34,38,189,257,272,287,288,327] Thermal and electrical modalities are known for their biophysical effects on regulating the body's metabolism, influencing the inflammatory healing process, and modulating pain.[192,205] Mechanical intermittent compression modalities are known for their usefulness in managing edema.[7] In recent years, BFR therapy has also gained popularity as a mechanical agent with claimed benefits for muscle strengthening during resistance training.[266] CPM units are typically electrically powered devices that can passively apply gradual joint motion at preselected speeds and ranges for various joints including the wrist. Their postoperative use is generally directed toward improving joint AROM and pain.[272]

Thermal Agents (HP, CP, WWP, PEMF)

II Cheing et al[38] conducted an RCT to investigate the short-term efficacy of CP and PEMF therapy following nonoperative treatment for DRF. They compared 4 groups: group A (N = 23; 56% female; mean age, 65.5 years) had true PEMF and ice packs, group B (N = 22;

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86% female; mean age, 62 years) had sham PEMF and ice packs, group C (N = 22; 63% female; mean age, 63.8 years) had only PEMF, and group D (N = 16; 56% female; mean age, 60.3 years) had only sham PEMF. Conventional therapy combined with iHEP started 3 days after 6 weeks cast immobilization for 5 consecutive days for all groups. In each session, PEMF therapy was conducted via a U-shaped diathermy applicator (frequency, 50 Hz) for 30 minutes around the wrist and hand. Cold packs were placed over the dorsal forearm and wrist aspects. Posttreatment assessment at day 5 showed that group A was significantly better on edema (volumeter: MD range, 0.6-1.1 mm; P = .001) than all other groups. For pain at day 5, group A was better (VAS: MD range, 4.8-18.1 mm; P = .001) than groups C and D. For AROM at day 5, group A was superior in ulnar deviation (MD range, 2.6°-4.1°; P = .002) than all other groups, and in pronation (MD range, 2.1°-8.9°; P = .021) than group D. All other remaining group comparisons were not significant.

III IV Krzyzanska et al[154] and Lazovic et al[163] conducted studies to investigate the benefit of utilizing PEMF therapy during immobilization following nonoperative treatment. Krzyzanska et al[154] was a quasi-experimental study (level IV), which assessed pain, sensation, wrist AROM, grip strength, and function after a 6-week cast immobilization. The experimental group (N = 27; 81% female; mean age, 58 years) received 22 PEMF therapy sessions addressing the casted arm within a diathermy concentric coil applicator (peak intensity, 6-10 mT; frequency, 25-30 Hz) for 30 minutes. Patients were treated daily for the first 10 days, and 3 times weekly thereafter. The control group (N = 25; 92% female; mean age, 63.6 years) did not receive PEMF therapy. The Lazovic et al[163] study was a prospective RCT (level III) which assessed hand edema (figure-of-eight), pain and function (PRWE), and wrist AROM (Flexion-extension, pronation-supination, radial-ulnar deviation) among older (≥60 years) women after 4 weeks cast immobilization. The experimental group (N = 30; mean age, 67.9 years) received 10 sessions of PEMF therapy within a concentric coil (peak intensity, 6 mT; frequency, 25 Hz) for 30 minutes (5 days weekly for 2 weeks), and the control group (N = 30; mean age, 64.5 years) did not have PEMF therapy. In both studies, all groups followed an iHEP, which consisted of finger, elbow, and shoulder AROM exercises 2 to 3 times daily. Upon cast removal, Krzyzanska (2020) et al[154] found the PEMF group to be significantly better in pain (VAS: MD, 2.68 mm; P<.0001), sensibility (Monofilaments test: MD, 0.6 grams; P = .001; and 2-point discrimination test: MD, 0.6 mm; P = .001), Flexion (MD, 10°; P = .0003) and extension (MD, 11°; P = .0001) AROMs, grip strength (MD, 2.3 kg; P = .001), and function (DASH: MD, 30.1%; P = .0001). Lazovic et al[163] found significant differences for hand edema (MD, 8 mm; P = .001), and wrist flexion, extension, and supination (MDs, 8°-10°; P = .01) AROMs in favor of the PEMF group. In this study, no group-differences existed for pain, and function, and a 13% complication rate (hand stiffness and signs of CRPS-1) was reported. Individuals in both studies attained full fracture healing with no need to have surgery or extended immobilization time and no adverse effects to PEMF treatments.

II Szekeres et al and Szekeres et al[287,288] conducted 2 similar trials to investigate the immediate effects of HP and warm whirlpool (WWP) applications on edema and wrist AROM following nonoperative or operative treatments for DRF. In both studies, therapy started immediately after cast immobilization (average of 40 days) and patients completed 3 SupT visits. Each visit started with a 15-minute treatment of either a HP around the wrist or WWP (40° C) followed by 30-minutes of conventional therapy exercises. The WWP treatment entailed wrist AROM exercises in a semi-dependent position with elbow flexed at 90°. Outcomes were assessed via experienced blinded hand therapists in both studies. In the first study,[287,288] edema was assessed via a volumeter before and immediately after heat applications, as well as 30 minutes after the end of each session, and 3 weeks later. The WWP group (N = 30; 86% female; mean age, 52.7 years) was found to be superior in edema reduction to the HP group (N = 31; 74% female; mean age, 54.4 years) immediately after heat applications (P<.001; MD, 4.9 ml). The WWP treatment presented a tendency for slightly higher edema accumulation at the end of each therapy session or 3 weeks later, but differences were not significant. The second study[287,288] assessed wrist AROM (flexion/extension, pronation/supination, ulnar/radial deviation) before and after heat applications in each session as well as 3 weeks later. The WWP group (N = 30; 86% female; mean age, 52.7 years) was found significantly (P<.05) better than the HP group (N = 30; 76% female; mean age, 54.4 years) immediately after heating for wrist extension (MD, 2°) and flexion (MD, 2.2°). These AROM differences were not clinically meaningful. No AROM differences existed at 3 weeks.

Light-Emitting Agents (LT, UVLT)

II Acosta-Olivo et al[3] and Sæbø et al[257] conducted 2 similar double-blinded RCTs to compare cold LT combined with an iHEP to sham LT with the same iHEP following nonoperative and operative treatments for DRF. In the Acosta-Olivo et al[3] RCT, the LT (N = 13; 62% female; mean age, 53.2 years) and the sham LT (N = 13; 69% female; mean age, 59.2 years) groups were recruited after closed reduction/pinning and 6 weeks cast immobilization for DRF. Therapy was initiated within 7 days following cast removal and entailed 10 sessions over 3 weeks. LT (50 mW,

980 nm) was applied over 10 acupuncture points at the upper and lower extremity of the involved side. The iHEP (3 times daily) consisted of hand and wrist AROM exercises and advice on self-care with daily activities. In the Sæbø et al[257] RCT, therapy for the LT (N = 23; 82% female; mean age, 59 years) and the sham LT (N = 27; 88% female; mean age, 57 years) groups started immediately following 4-week cast immobilization. LT entailed pulsed mode wavelength (60 mW, GaAs, class 3B) delivered to both dorsal and volar aspects of the wrist with a 64 J total treatment energy over 9 sessions over 3 weeks. The iHEP (5-6 times daily) consisted of hand and wrist AROM exercises and advice on pain management and self-care with daily activities. In the Acosta-Olivo et al[3] RCT, Pain (VAS), wrist AROM, and function (PRWE) were assessed at the fifth and tenth session, and 1 week after. Significant differences in favor of the LT group existed at the fifth session for pain (MD, 1.9 mm; $P = .05$), wrist AROM (extension [MD, 13°; $P = .02$], ulnar deviation [MD, 6.9°; $P = .01$], radial deviation [MD, 6.8°; $P = .02$]), and PRWE (MD, 19.1%; $P = .010$). The LT group was significantly better at the final assessment time in pain (MD, 1.5 mm; $P = .02$), AROM (flexion [MD, 21°; $P = .01$], pronation [MD, 8.4°; $P = .005$], radial deviation [MD, 7.7°; $P = .02$]), and PRWE (MD, 15%; $P = .04$). In the Sæbø et al[257] RCT, the PRWE pain and disability subscales, and total scores were assessed at 8, 12, and 26 weeks. Statistically significant ($P<.05$) group differences in favor of the LT group existed in pain (MD range, 3.38%-3.38%) subscore throughout all times, and disability (MD range, 10.57%-11.97%) subscore at 8 and 12 weeks. The LT group was significantly ($P<.05$) better in total PRWE (MD range, 5.86%-11.71%) score throughout all times with a clinically meaningful difference at 12 weeks. In both RCTs, groups were equivalent in fracture severity characteristics and baseline measurements, and no adverse effects were reported.

II Sæbø et al[257] conducted a double-blinded RCT to compare cold LT (N = 27; 70.4% female; mean age, 52.4 years) to sham LT (N = 26; 76.9% female; mean age, 51 years) that were applied during a 4-week cast immobilization among individuals with DRF following a nonoperative treatment. LT (60 mW, 904 nm GaAs, class 3B) was initiated within 3 days following injury and entailed 9 sessions over 3 weeks with a 64 J total treatment energy. Treatments were applied through 2 cast openings over the dorsal and volar aspects of the distal radius. Both groups followed the same iHEP and advice for self-care and avoidance to perform heavy daily activities up to 8 weeks after cast removal. Function (PRWE total score), total wrist AROM (flexion, extension, ulnar and radial deviation, pronation, supination), grip strength, and wrist circumference for edema were assessed at 4 (cast removal), 8, 12, and 26 weeks. Groups had equivalent baselines across all outcomes. No significant differences existed for function and edema across all times. The LT group was significantly better in AROM (MD, 43°; $P = .000$) and grip strength (MD, 6.89 kg; $P = .011$) only at 4 weeks. Groups were equivalent in fracture severity characteristics and baseline measurements, and no adverse effects were reported.

III Ahmed et al[5] conducted a small prospective nonblinded RCT to compare a group that received LT (N = 20; 75% female; mean age, 30.8 years) to a group that received therapeutic ultrasound (N = 20; 75% female; mean age, 29.6 years) following nonoperative treatment for DRF. Both the LT (830 nm; average power, 60 mW; total dose, 9.7 J/cm; 10 minutes) and thermal ultrasound (intensity, 1.5 w/cm; 3 Mhz; continuous mode; 5 minutes) groups received 16 treatment sessions for 6 weeks immediately after cast immobilization. Information on treatment application sites or whether other traditional exercises were also utilized was not provided. At 6 weeks, the LT group was superior in the PRWE pain (MD, 6.4%; $P = .0001$), and function (MD, 5.73%; $P = .001$) subscales. Groups were not significantly ($P>.05$) different on AROM and grip strength, which were assessed via instruments with unknown psychometric properties. Baseline equivalency for all measured outcomes was also not established.

III Zlatkovic-Svenda et al[327] conducted a prospective nonblinded RCT to compare a group that received NSAIDs pain management, CPs, and traditional exercises (N = 26; mean age, 64 years) to a group that received the same protocol along with UVLT (N = 26; mean age, 62 years) among female patients following nonoperative treatment for DRF. Daily therapy was initiated immediately following cast removal. The UVLT was provided via a Bioptron device (95% polarized, low-energy radiation at 480-3400 nm, total energy 360 j/cm^2) on 5 points of the dorsal wrist for 10 minutes/day. Cold packs were applied around the wrist for 5 minutes twice daily. Hand and wrist AROM exercises, and grip exercises with a soft rubber ball were performed for 30 minutes daily. All treatments were provided by a visiting hand therapist at home. Following 15 treatments, the UVLT group was superior in pain (VAS: MD, 5.4 cm; $P = .046$), and supination AROM (MD, 8.8°; $P = .001$). At 6 months, a significantly ($P<.05$) lower incidence of CRPS-1 was noted in the UVLT group (0%) as compared to the control group (15%).

Electrotherapy Agents (TENS)

II Lee et al[164] conducted a small single-blinded prospective RCT to compare the effectiveness of TENS (N = 18) and sham TENS (N = 18) on pain control among individual with DRF (mean age, 55.5 years) who underwent operative management. Demographic information

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on patients' gender was not provided. Treatment was initiated immediately after surgery in the recovery room. Two electrodes were placed over the Waiguan (TE5) and Quchi (Li11) acupuncture points over the lateral elbow and dorsal wrist, and transmitted conventional sensory (frequency, 50 Hz) TENS once daily for 15 minutes for 5 consecutive days during hospitalization. The intensity was not turned on for sham TENS treatment. Pain (VAS) outcomes were assessed before and after each treatment. Baseline pain levels were equivalent in both groups. No significant difference in pain (VAS) improvement existed after 5 days. A significant difference (P = .002) in posttreatment pain reduction was noted after each treatment, indicating only a transient pain reduction effect. Mean differences were not reported.

Mechanical Agents (CPM, IPC, BFR)

I Shirzadi et al[272] performed a single-blinded RCT to compare the effect of CPM unit combined with conventional therapy (N = 11; 100 females; mean age, 42 years) to conventional therapy alone (N = 10; 81% female; mean age, 41 years) following operative management with 4 to 6 weeks of immobilization. The majority (72%) of individuals in either group had an external fixator. Both groups received multimodal routine SupT (3 sessions/week over 4 weeks) that consisted of thermal agents, electrical stimulation for pain, PROM and AROM, and strengthening exercises. In addition, the experimental group received CPM (2 x 15 minutes per session, 12 sessions) in the clinic for wrist flexion, extension, supination and pronation and forearm. CPM intensity was adjusted to individual tolerance using a 5°/minute PROM speed, and 5 sec end-range hold times. Both groups had significant (P = .00) improvements in pain (VAS), wrist AROM, and function (PRWE) at 4, 6, and 12 weeks. A significant (MD, 1.29 cm; P = .01) but not clinically meaningful difference in pain favored the CPM group at 4 weeks. No significant group differences existed for all other outcomes across all assessment times.

I Yamazaki et al[319] conducted a high-quality RCT to compare the efficacy of an IPC (venous perfusion assist) unit (N = 50; 76% female; mean age, 64 years) to hand elevation (N = 52; 81% female; mean age, 64 years) on hand edema, pain, AROM, grip strength, and function following operative management. After surgery, the IPC group wore the air-filled compression garment around the affected hand and forearm continuously for 1 day and thereafter 60 minutes daily (3 times for 20 minutes) for 3 weeks. The elevation group wore a sling which kept the affected hand elevated above heart-level for 3 weeks. During this time, both groups were given the same iHEP with AROM exercises and advised for light home-activity while wearing a removable orthosis. Both groups attended SupT between 6 and 12 weeks postoperatively for manual therapy and strengthening. No group differences existed for all outcome measures (edema [fingers and hand girth], pain [VAS], wrist AROM [flexion-extension, supination-pronation] grip strength, and function [DASH, PRWE]) immediately after surgery, and at 1, 3, 6, and 12 weeks postoperatively.

III Alkner et al[7] conducted an RCT to investigate the efficacy of a multimodal edema control program with (N = 56; 85% female; mean age, 63 years) or without (N = 59; 94% female; mean age, 63 years) the addition of IPC treatment among older (≥50 years) individuals following operative management and 4 weeks immobilization for DRF. Both groups were instructed by an OT in an iHEP (4 times daily over 7 weeks) which consisted of hand elevation, hand massage, edema glove, and digital and wrist AROM exercises. The experimental group received IPC supervised treatment (1 hour, 3 times weekly for 7 weeks) via an air-filled bladder unit (AV 6000 Novamedix), applied around the involved wrist with intermittent pressure (60 mmHg, 40 sec on/20 sec off intervals). No significant group differences were found for all outcome measures (pain [VAS], AROM, grip strength, edema [volumetry], and function [COPM]) at baseline, 4, 6, 11 weeks, and 1 year following surgery.

III Mader et al[190] conducted an RCT to compare a group that received CPs, and traditional therapy (N = 21; 76% female; mean age, 63 years) to a group that received IPC with traditional therapy (N = 22; 72% female; mean age, 66 years) following operative management via external fixation (74%) or other internal fixation (26%) methods. Both groups were treated for 7 days immediately after surgery. Cold packs were applied over the wrist in supine for 20 minutes (10 times/day over 7 days). IPC treatment involved high-velocity impulses (130 mmHg, 2 sec long, 3 times per minute) via the air-filled bladder strapped around the involved hand for 1 hour (5 times daily over 7 days). In addition, both groups followed the same postoperative exercise (digital joint mobilization and AROM) programs. Hand girth and finger 2 to 5 total active motion were assessed daily for 7 consecutive days. By the seventh day, significant group differences existed in favor of the IPC group on edema (MD, 3 cm; P = .01) and digital total active motion (P = .001), which was assessed via a computerized (EVAL software) program of unknown validity and group MDs were not reported.

III Two small RCTs by Cancio et al[34] and Sgromolo et al[266] with similar methodology compared BFR combined with conventional therapy to only conventional therapy during early rehabilitation following nonoperative treatment for DRF. Both groups started conventional

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therapy (2-3 times/week over 8 weeks) following 6-week cast immobilization. The experimental group received BFR at the bicep area during exercise (30 minutes at 50% occlusion rate) at each visit. The Cancio et al[34] study's BFR group (N = 6; 58% female; mean age, 51.3 years) and control (N = 7; 50% female; mean age, 41 years) groups were similar in patient-characteristics to the Sgromolo et al[266] study BFR (N = 5; 40% female; mean age, 37 years) and control (N = 4; 25% female; mean age, 43.8 years) groups. No group-differences existed at 4- and 8-week intervals across all outcomes (Pain [VAS], function [PRWE, DASH], wrist AROM, grip strength, and radiographic parameters) in both studies. Based on total change between baseline and 8 weeks, BFR groups were superior on pain with activity (MD, 1.5-1.7 cm; P = .03) and PRWE (MD, 17.6%-27.1%; P = .01) scores. However, pain (MD, 1.4-1.7) and PRWE (MD, 19%-25%) baseline differences favored the BFR group and confounded the final interpretations in both studies. No radiological or treatment complications were reported in either study.

III Fan et al[77] conducted an RCT to compare BFR combined with conventional therapy (N = 17; 58% female; mean age, 44 years) to only conventional therapy (N = 18; 44% female; mean age, 47 years) following operative treatment for DRF. Both groups started therapy 3 to 7 days after surgery. Conventional therapy followed a multimodal approach including ice packs, compression therapy, ultrasound, electrical stimulation, PROM and AROM, and submaximal (20% MVC) strengthening exercises for 4 weeks. BFR treatments (5 times/week over 4 weeks) were applied at the bicep area with 40% to 80% occlusion pressure in 20 minutes sessions during strengthening exercises. Significant differences were shown at 4 weeks for pain (VAS: MD, 1.22 mm; P = .01) and isometric wrist strength rate (strength proportion relative to healthy side) measured via a handheld dynamometer for flexion (MD, 18%; P = .01) and extension (MD, 20%; P = .01) in favor of the BFR group. At 12 weeks, significant difference in favor of the BFR group existed for function (MD, 14%; P = .01) using the modified Cooney score system, which is a nonvalidated outcome measure for DRF rehabilitation. No group differences in fracture healing were shown at 4 weeks, and no adverse effects attributable to BFR treatments were reported.

III Yang et al[320] conducted an RCT to compare BFR combined with conventional therapy (N = 13; 84% female; mean age, 64 years) to only conventional therapy (N = 12; 83% female; mean age, 64 years) among older (≥50 years) individuals following nonoperative treatment for DRF. Both groups started therapy following a 6-week cast immobilization period. Conventional therapy included wrist PROM and AROM as well as submaximal grip and pinch strengthening exercises twice a week for 6 weeks. BFR treatments (2 times/week over 6 weeks) were applied at the bicep area with 50% occlusion pressure in 8 minutes sessions. Significant differences were shown at 6 weeks for wrist AROM in ulnar deviation [P = .010, ES (η^2) = 0.25], grip strength [P = .029, ES (η^2) = 0.19] and function [P = .002, ES (η^2) = 0.34] in favor of the BFR group, but group MDs were not reported. No group differences in fracture radiographic parameters existed at 6 weeks, and no adverse effects attributable to BFR treatments were reported.

Evidence Synthesis

Despite the known biophysical effects of several types of modalities, research evidence on the efficacy of therapeutic modalities following DRF is still limited. This section synthesized clinical evidence based on 18 available RCTs that have investigated the efficacy of thermal, light-emitting, electrical, and mechanical therapeutic agents in isolation or combined with conventional therapy following nonoperative and operative DRF treatments. Among the 5 RCTs on thermal modalities (3 level II, 1 level III, 1 level IV), 2 trials[287,288] offered sufficient evidence (level II) to support the superiority of WWP over HP for improving edema and AROM immediately after application when used, along with conventional therapy following nonoperative and operative treatments for DRF. The application of WWP did not add greater risk of edema increase by the end of a treatment as compared to HP. One study[38] offered sufficient evidence (level II) to support the short-term benefit of PEMF in conjunction with conventional therapy during the first week of rehabilitation on pain, edema, and wrist AROM following nonoperative treatment. In this study, the combination of PEMF and CP was superior to using CP or PEMF in isolation. Two lower evidence (level III and IV) studies[154,163] found benefit from applying PEMF treatment during cast immobilization for short-term pain, sensibility, AROM, and functional benefits upon cast removal at 4 weeks. Among the 5 trials on light-emitting agents, 3 studies[3,256,257] offered sufficient evidence (level II) to support a beneficial short-term (3-12 weeks) effect of LT on pain, AROM, grip strength, and function following both nonoperative and operative treatment for DRF. One study[327] (level III) offered weak evidence for the use of UVLT with conventional therapy toward short-term (2 weeks) benefits on wrist pain and AROM after nonoperative treatment for DRF. This single study could not support a recommendation on UVLT. The presence of only 1 study[5] (level III) on the short-term effects of therapeutic ultrasound as compared to LT could not support any recommendation on ultrasound. There was only 1 trial[164] (level II) on electrotherapy (TENS) treatment which indicated that a 15-minute TENS treatment may result in transient postoperative pain reduction. Yet, this could not be maintained for 24 hours, and it was not significantly different than pain reduction induced

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by a placebo effect. Evidence from this study was insufficient to support a recommendation for TENS application.

Six RCTs on mechanical modalities were of low evidence (level III). Two of them[7,190] offered conflicting evidence on the efficacy of IPC therapy. One[190] pointed to IPC short-term (7 days) benefit on postoperative pain, hand AROM, and edema control, while the other[7] found that a multimodal approach of arm elevation, hand massage, AROM, and use of edema glove offers comparable benefits to IPC therapy for short- and long-term (up to 1 years) postoperative improvements on edema, pain, AROM, grip strength, and function. One level I study[319] indicated that the use of IPC therapy does not offer any additional short-term (up to 12 weeks) benefits on edema, pain, active wrist AROM, grip strength, and function, as compared to only hand elevation when combined with conventional therapy following operative management. The 4 studies on BFR therapy[3,77,266,320] also offered conflicting evidence. Two of these studies[3,266] failed to justify that BFR combined with conventional therapy was superior to conventional therapy alone toward short-term (4-8 weeks) benefits in pain, grip strength, wrist AROM, and function following nonoperative treatment. Yet, 2 other studies[77,320] pointed to the short-term (4-12 weeks) superiority of BFR treatments (2-5 times weekly), which when combined with a multimodal conventional therapy may induce significant pain, wrist AROM, grip and isometric wrist strength, and functional benefits following both nonoperative and operative treatments for DRF. All 4 studies indicated that BFR treatments can be safely applied following DRF without adverse effects. One level I study[272] refuted the clinical usefulness of CPM to improve wrist pain, AROM, and function 4 to 12 weeks following operative treatment as compared to conventional therapy. Recommendation for CPM could not be supported based on evidence from only 1 study. The preponderance of therapeutic modalities studies were affected by various methodological limitations that consisted of small or under-powered samples, significant sampling bias due to lack of concealment or assessor blinding, investigating short-term outcomes among mostly individuals with no complications or significant comorbidities, and not always assessing function. A distinct trend in patient characteristics existed in the BFR trials. Three BFR studies[3,77,266] recruited younger individuals, with near equal male-to-female ratios as compared to most other studies that recruited on average older female patients after a DRF injury. Clinicians should consider both the potential benefits and harms of all these modalities. Although no adverse effects were reported, the projected high cost, clinical application time demands, safety issues, and lack of reimbursement may be viable concerns for some of these therapeutic agents. Using physical agents that can be safely replicated in the home environment might be warranted.

Gaps in Knowledge

More studies with stronger methodological designs are needed to investigate the current or other available thermal and electrical therapeutic agents that are used in hand therapy but have yet to be researched following DRF (eg, fluidotherapy, electrical stimulation for strengthening). Future higher quality RCTs should investigate both the short- and long-term cost-effectiveness of such therapeutic agents in isolation or combination with conventional therapy among individuals with various complications and comorbidities following nonoperative and operative treatments for DRF. Further research is needed to determine if there are benefits of adding modalities to a multimodal program when subgroups of patients with specific impairments are studied.

Recommendations

B Clinicians should utilize physical agents, including LT, PEMF, WWP, HP, and CP as part of multimodal management strategies to improve short-term outcomes in pain, edema, sensation, wrist AROM, grip strength, and function in individuals following nonoperative and operative treatment for their DRF.

D Conflicting evidence prevents making a recommendation for or against mechanical agents, including CPM, IPC, and BFR, to improve pain, edema, AROM, grip strength, and functional outcomes for individuals following nonoperative or operative management of their DRF.

INTERVENTIONS CONCLUSION

In the last 20-plus years, a sizable body of literature has been published to offer evidence for the efficacy of numerous rehabilitation methods following DRFs. Several debated questions and proposed rehabilitation approaches or modalities of varying evidence levels have been investigated and reported. All the intervention recommendations in this CPG have been formulated based on the existing pool of evidence since the late 1990's. Frequent methodological weaknesses that have affected the evidence quality of many included studies consisted of limited enrollment of individuals with complications after DRF, underpowered samples, inadequate randomization and concealment, lack of blinding, large loss to follow up, heterogeneity in treatment parameters or therapy providers, lack of baseline equivalency, and use of short-term or nonvalidated outcome measures. Outcomes heterogeneity might have been largely influenced by patient selection criteria variability (eg, age, fracture severity, treatment approach, and patient comorbidities) across all studies. Lack of controlling this wide-range of contextual factors as well as limited trials availability for several interventions has made the formulation of evidence-based recommendations challenging.

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Based on currently evolving evidence, a multimodal rehabilitation approach (ie, modalities for pain and edema control; AROM exercises at the hand, wrist, and other proximal joints; joint mobilization; strengthening and proprioceptive exercises; functional retraining; advice for self-care and daily activity; and iHEP instructions) may offer the strongest merit toward optimal recovery following DRF. Regardless of fracture-treatment type, an accelerated rehabilitation approach (ie, shorter immobilization time, immediate implementation of hand AROM and edema control techniques, and wrist AROM initiation within the first 2-3 weeks after surgery) may lead to better outcomes. For the more stable fracture types, the initiation of submaximal hand grip strengthening exercises could be safely implemented around 2 to 3 weeks postoperatively or even during cast immobilization. Currently, there are no clearly defined guidelines on which subgroups of individuals would most benefit from one or more of the outlined rehabilitation interventions. More research is needed to determine the efficacy and delineate the benefit-to-harm ratio for all the included rehabilitation interventions. Although conflicting evidence exists on which individuals would be the best candidates for SupT, the utilization of SupT in a weekly basis should be the preferred approach among older individuals or those with significant complications and comorbidities following DRF. Further research is warranted to determine which subgroups of individuals would most benefit from only an iHEP or no-therapy approaches, considering the rising cost of health care. Based on best-practice standards, the provision of SupT and iHEP instructions should preferably be directed by a hand therapist for optimum clinical outcomes within the confines of a multidisciplinary team approach.

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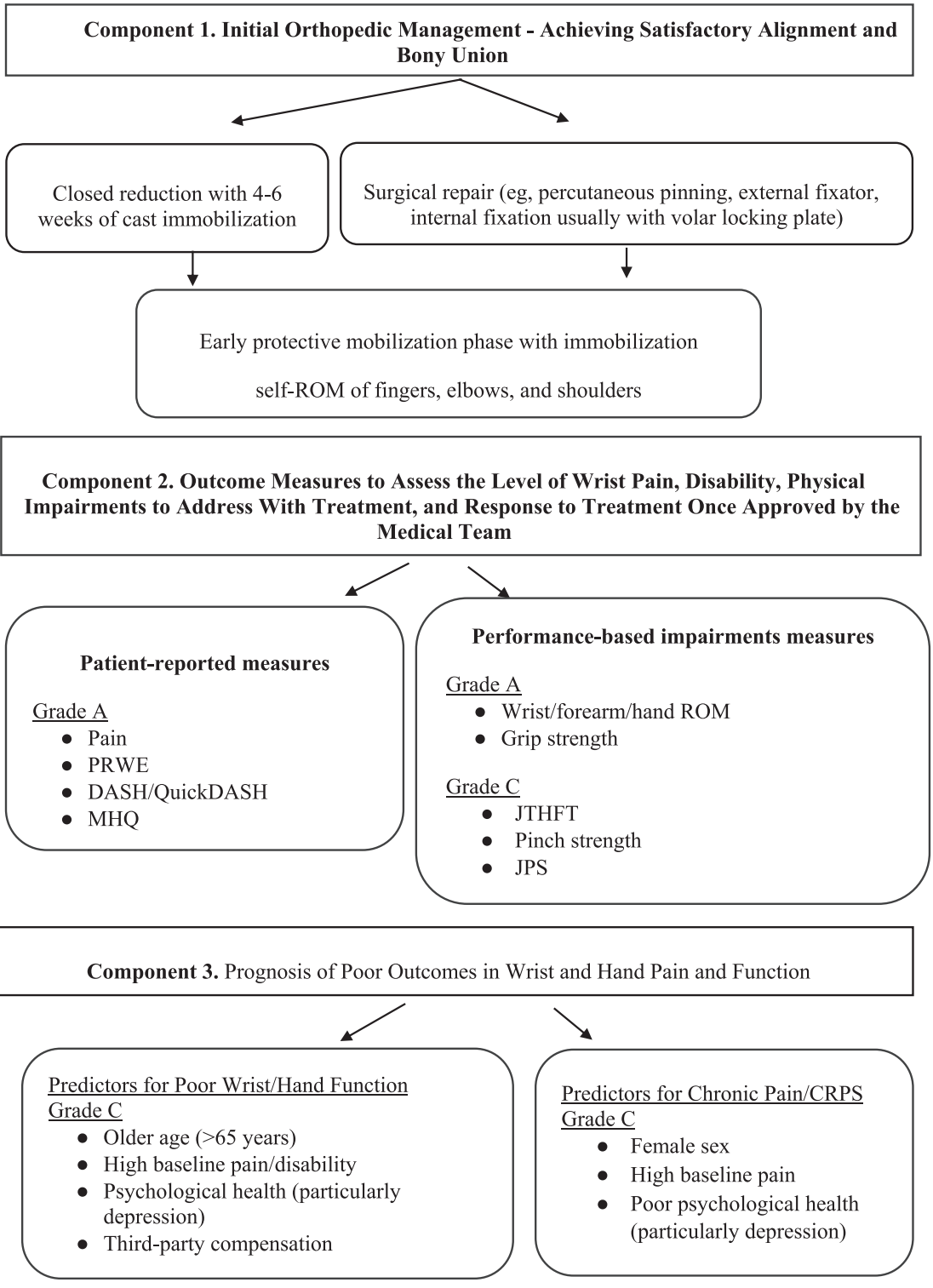
Decision Tree



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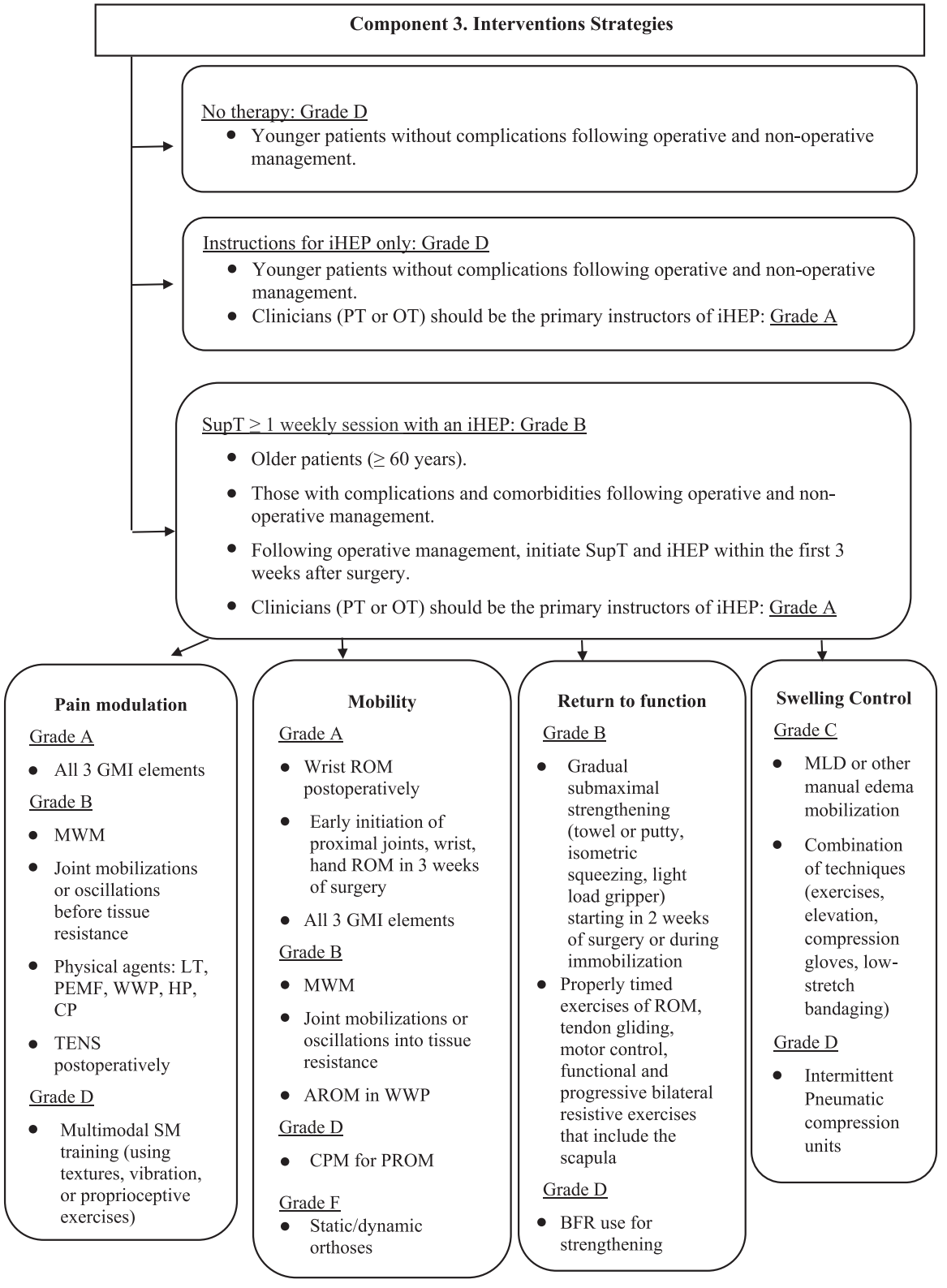

Abbreviations: CRPS, complex regional pain syndrome; DASH, Disabilities of the Arm, Shoulder, and Hand questionnaire; iHEP, independent home exercise program; JPS, joint position sense; JTHFT, Jebsen-Taylor Hand Function Test; MHQ, Michigan Hand Questionnaire; OT, occupational therapist; PRWE, Patient-Rated Wrist Evaluation; PT, physical therapists; ROM, range of motion.

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REFERENCES

1. Abimanyi-Ochom J, Watts JJ, Borgström F, et al. Changes in quality of life associated with fragility fractures: Australian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (AusICUROS). *Osteoporos Int*. 2015;26:1781-1790. https://doi.org/10.1007/s00198-015-3088-z
2. Abramo A, Kopylov P, Tagil M. Evaluation of a treatment protocol in distal radius fractures: a prospective study in 581 patients using DASH as outcome. *Acta Orthop*. 2008;79:376-385. https://doi.org/10.1080/17453670710015283
3. Acosta-Olivo C, Siller-Adame A, Tamez-Mata Y, Vilchez-Cavazos F, Pena-Martinez V, Acosta-Olivo C. Laser treatment on acupuncture points improves pain and wrist functionality in patients undergoing rehabilitation therapy after wrist bone fracture. A randomized, controlled, blinded study. *Acupunct Electrother Res*. 2017;42:11-25. https://doi.org/10.3727/036012917X14908026365007
4. Adams, DB. Effects of radial deformity on distal radioulnar joint mechanics. *J Hand Surg Am*. 1993;18:492-498. https://doi.org/10.1016/0363-5023(93)90098-N
5. Ahmed OAK, Balah OFA, Rahmy AF, Hassan H. Comparing the effect of low-level laser therapy versus therapeutic ultrasound after colles' fracture (comparison study). *Eur J Mol Clin Med*. 2021;7:4350-4358.
6. Alfie V, Gallucci G, Boretto J, et al. Patient-rated wrist evaluation: Spanish version and evaluation of its psychometric properties in patients with acute distal radius fracture. *J Wrist Surg*. 2017;6:216-219. https://doi.org/10.1055/s-0037-1599127
7. Alkner BA, Halvardsson C, Brakenhielm G, Eskilsson T, Andersson E, Fritzell P. Effect of postoperative pneumatic compression after volar plate fixation of distal radial fractures: a randomized controlled trial. *J Hand Surg Eur Vol*. 2018;43:825-831. https://doi.org/10.1177/1753193418760493
8. Alsubheen SA, MacDermid JC, Walton DM, Grewal R. The effect of diabetes on functional outcomes among individuals with distal radial fractures. *J Hand Ther*. 2019;32:476-482. https://doi.org/10.1016/j.jht.2018.02.008
9. Altman E. The ulnar side of the wrist: clinically relevant anatomy and biomechanics. *J Hand Ther*. 2016;29:111-122. https://doi.org/10.1016/j.jht.2016.03.012
10. Amadio PC, Silverstein MD, Ilstrup DM, Schleck CD, Jensen LM. Outcome after Colles fracture: the relative responsiveness of three questionnaires and physical examination measures. *J Hand Surg Am*. 1996;21:781-787. https://doi.org/10.1016/S0363-5023(96)80192-4
11. Andersen DJ, Blair WF, Steyers CM Jr, Adams BD, el-Khouri GY. Classification of distal radius fractures: an analysis of interobserver reliability and intraobserver reproducibility. *J Hand Surg Am*. 1996;21:574-582. https://doi.org/10.1016/S0363-5023(96)80006-2
12. Andrade-Silva FB, Rocha JP, Carvalho A, Kojima KE, Silva JS. Influence of postoperative immobilization on pain control of patients with distal radius fracture treated with volar locked plating: a prospective, randomized clinical trial. *Injury*. 2019;50:386-391. https://doi.org/10.1016/j.injury.2018.12.001
13. Arora R, Lutz M, Hennerbichler A, Krappinger D, Espen D, Gabl M. Complications following internal fixation of unstable distal radius fracture with a palmar locking-plate. *J Orthop Trauma*. 2007;21:316-322. https://doi.org/10.1097/BOT.0b013e318059b993
14. Asadollahi S, Keith PP. Flexor tendon injuries following plate fixation of distal radius fractures: a systematic review of the literature. *J Orthop Traumatol*. 2013;14:227-234. https://doi.org/10.1007/s10195-013-0245-z
15. Atthakomol P, Manosroi W, Mongkonkamthon A, et al. Cross-cultural adaptation, construct validity, reliability, and responsiveness of the Thai version of the Patient-Rated Wrist/Hand Evaluation (Thai PRWHE). *Qual Life Res*. 2021;30:1793-1802. https://doi.org/10.1007/s11136-021-02760-1
16. Azad A, Kang HP, Alluri RK, Vakhshori V, Kay HF, Ghiassi A. Epidemiological and treatment trends of distal radius fractures across multiple age groups. *J Wrist Surg*. 2019;8:305-311. https://doi.org/10.1055/s-0039-1685205
17. Babatunde OO, Bucknall M, Burton C, et al. Long-term clinical and socio-economic outcomes following wrist fracture: a systematic review and meta-analysis. *Osteoporos Int*. 2022;33:753-782. https://doi.org/10.1007/s00198-021-06214-9
18. Bain GI, MacLean SBM, McNaughton T, Williams R. Microstructure of the distal radius and its relevance to distal radius fractures. *J Wrist Surg*. 2017;6:307-315. https://doi.org/10.1055/s-0037-1602849
19. Bala Y, Bui QM, Wang XF, et al. Trabecular and cortical microstructure and fragility of the distal radius in women. *J Bone Miner Res*. 2015;30:621-629. https://doi.org/10.1002/jbmr.2388
20. Barai A, Lambie B, Cosgrave C, Baxter J. Management of distal radius fractures in the emergency department: a long-term functional outcome measure study with the Disabilities of Arm, Shoulder and Hand (DASH) scores. *Emerg Med Australas*. 2018;30:530-537. https://doi.org/10.1111/1742-6723.12946
21. Barton T, Chambers C, Bannister G. A comparison between subjective outcome score and moderate radial shortening following a fractured distal radius in patients of mean age 69 years. *J Hand Surg Eur Vol*. 2007;32:165-169. https://doi.org/10.1016/J.JHSB.2006.11.010
22. Bayon-Calatayud M, Benavente-Valdepenas AM, Del Prado Vazquez-Munoz M. Mirror therapy for distal radial fractures: a pilot randomized controlled study. *J Rehabil Med*. 2016;48:829-832. https://doi.org/10.2340/16501977-2130
23. Beaton DE, Wright JG, Katz JN. Development of the QuickDASH: comparison of three item-reduction approaches. *J Bone Joint Surg Am*. 2005;87:1038-1046. https://doi.org/10.2106/JBJS.D.02060
24. Bemgård M, Archenholtz B. Developing an instrument for the measurement of grip ability after distal radius fracture. *Scand J Occup Ther*. 2018;25:466-474. https://doi.org/10.1080/11038128.2017.1323950
25. Berger, AR. The anatomy and basic biomechanics of the wrist joint. *J Hand Ther*. 1996;9:84-93. https://doi.org/10.1016/S0894-1130(96)80066-4
26. Beumer A, Lindau TR. Grip strength ratio: a grip strength measurement that correlates well with DASH score in different hand/wrist conditions. *BMC Musculoskelet Disord*. 2014;15:336. https://doi.org/10.1186/1471-2474-15-336
27. Bhashyam AR, Fernandez DL, Fernandez dell'Oca A, Jupiter JB. Dorsal Barton fracture is a variation of dorsal radiocarpal dislocation: a clinical study. *J Hand Surg Eur Vol*. 2019;44:1065-1071. https://doi.org/10.1177/1753193419872639
28. Blomstrand J, Karlsson J, Fagevik Olsén M, Kjellby Wendt G. The Michigan Hand Outcomes Questionnaire (MHQ-Swe) in patients with distal radius fractures-cross-cultural adaptation to Swedish, validation and reliability. *J Orthop Surg Res*. 2021;16:442. https://doi.org/10.1186/s13018-021-02571-7
29. Bobos P, Lalone EA, Grewal R, MacDermid JC. Do impairments predict hand dexterity after distal radius fractures? A 6- month prospective cohort study. *HAND*. 2018;13:441-447. https://doi.org/10.1177/1558944717701242
30. Bobos P, Lalone EA, Grewal R, MacDermid JC. Recovery, age, and gender effects on hand dexterity after a distal radius fracture. A 1-year prospective cohort study. *J Hand Ther*. 2018;31:465-471. https://doi.org/10.1016/j.jht.2017.08.002
31. Brehmer JL, Husband JB. Accelerated rehabilitation compared with a standard protocol after distal radial fractures treated with volar open reduction and internal fixation: a prospective, randomized, controlled study. *J Bone Joint Surg Am*. 2014;96:1621-1630. https://doi.org/10.2106/JBJS.M.00860

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32. Bruder AM, Shields N, Dodd KJ, Hau R, Taylor NF. A progressive exercise and structured advice program does not improve activity more than structured advice alone following a distal radial fracture: a multi-centre, randomised trial. *J Physiother*. 2016;62:145-152. https://doi.org/10.1016/j.jphys.2016.05.011
33. Bui CNH, Rafijah GH, Lin CC, Kahn T, Peterson A, Lee TQ. Dorsal wrist extrinsic carpal ligament injury exacerbates volar radiocarpal instability after intra-articular distal radius fracture. *HAND*. 2021;16:193-200. https://doi.org/10.1177/1558944719851210
34. Cancio JM, Sgromolo NM, Rhee PC. Blood flow restriction therapy after closed treatment of distal radius fractures. *J Wrist Surg*. 2019;8:288-294. https://doi.org/10.1055/s-0039-1685455
35. Cardoso R, Szabo RM. Wrist anatomy and surgical approaches. *Orthop Clin North Am*. 2007;38:127-148. https://doi.org/10.1016/j.ocl.2007.02.010
36. Catalano LW III, Cole RJ, Gelberman RH, Evanoff BA, Gilula LA, Borrelli J Jr. Displaced intra-articular fractures of the distal aspect of the radius. Long-term results in young adults after open reduction and internal fixation. *J Bone Joint Surg Am*. 1997;79:1290-1302. https://doi.org/10.2106/00004623-199709000-00003
37. Cheema AS, O'Brien PJ, Broekhuyse HM, Lefaivre KA. Measuring outcomes over time in distal radius fractures: a comparison of generic, upper extremity-specific and wrist-specific outcome measures. *J Hand Surg Glob Online*. 2020;2:272-276. https://doi.org/10.1016/j.jhsg.2020.06.006
38. Cheing GL, Wan JW, Kai Lo S. Ice and pulsed electromagnetic field to reduce pain and swelling after distal radius fractures. *J Rehabil Med*. 2005;37:372-377. https://doi.org/10.1080/16501970510041055
39. Chen NC, Jupiter JB. Management of distal radial fractures. *J Bone Joint Surg Am*. 2007;89:2051-2062. https://doi.org/10.2106/00004623-200709000-00025
40. Choi HG, Kim DS, Lee B, Youk H, Lee JW. High risk of hip and spinal fractures after distal radius fracture: a longitudinal follow-up study using a national sample cohort. *Int J Environ Res Public Health*. 2021;18:7391. https://doi.org/10.3390/ijerph18147391
41. Choi WS, Lee HJ, Kim DY, et al. Does osteoporosis have a negative effect on the functional outcome of an osteoporotic distal radial fracture treated with a volar locking plate? *Bone Jt J*. 2015;97-Be:229-234. https://doi.org/10.1302/0301-620X.97B2.34613
42. Christensen OM, Kunov A, Hansen FF, Christiansen TC, Krasheninnikoff M. Occupational therapy and Colles' fractures. *Int Orthop*. 2001;25:43-45. https://doi.org/10.1007/s002640000183
43. Chung KC, Kotsis SV, Kim HM. Predictors of functional outcomes after surgical treatment of distal radius fractures. *J Hand Surg Am*. 2007;32:76-83. https://doi.org/10.1016/j.jhsa.2006.10.010
44. Chung KC, Malay S, Shauver MJ. The relationship between hand therapy and long-term outcomes after distal radius fracture in older adults: evidence from the randomized wrist and radius injury surgical trial. *Plast Reconstr Surg*. 2019;144:230e-237e. https://doi.org/10.1097/PRS.0000000000005829
45. Chung KC, Pillsbury MS, Walters MR, Hayward RA. Reliability and validity testing of the Michigan Hand Outcomes Questionnaire. *J Hand Surg Am*. 1998;23:575-587. https://doi.org/10.1016/S0363-5023(98)80042-7
46. Chung KC, Spilson SV. The frequency and epidemiology of hand and forearm fractures in the United States. *J Hand Surg Am*. 2001;26:908-915. https://doi.org/10.1053/jhsu.2001.26322
47. Chung KC, Watt AJ, Kotsis SV, Margaliot Z, Haase SC, Kim HM. Treatment of unstable distal radial fractures with the volar locking plating system. *J Bone Joint Surg Am*. 2006;88:2687-2694. https://doi.org/10.2106/00004623-200612000-00016
48. Clementsen SO, Hammer OL, Saltyte Benth J, Jakobsen RB, Randsborg PH. Early mobilization and physiotherapy vs. late mobilization and home exercises after ORIF of distal radial fractures: a randomized controlled trial. *JB JS Open Access*. 2019;4:e0012.1-e0012.11. https://doi.org/10.2106/JBJS.OA.19.00012
49. Collis J, Signal N, Mayland E, Clair VW-S. A systematic review of how daily activities and exercises are recommended following volar plating of distal radius fractures and the efficacy and safety of early versus late mobilisation. *Hand Ther*. 2020;25:139-151. https://doi.org/10.1177/1758998320967032
50. Cooke ME, Gu A, Wessel LE, Koo A, Osei DA, Fufa DT. Incidence of carpal tunnel syndrome after distal radius fracture. *J Hand Surg Glob Online*. 2022;4:324-327. https://doi.org/10.1016/j.jhsg.2022.08.001
51. Cooney WP 3rd, Dobyns JHL. Complications of Colles' fractures. *J Bone Joint Surg Am*. 1980;62:613-619. https://doi.org/10.2106/00004623-198062040-00016
52. Cooney Jr LM, Aversa JM, Newman JH. Insidious bilateral infrapatellar tendon rupture in a patient with systemic lupus erythematosus. *Ann Rheum Dis*. 1980;39:592-595. https://doi.org/10.1136/ard.39.6.592
53. Coughlin T, Norrish AR, Scammell BE, Matthews PA, Nightingale J, Ollivere BJ. Comparison of rehabilitation interventions in nonoperatively treated distal radius fractures: a randomized controlled trial of effectiveness. *Bone Joint J*. 2021;103-B:1033-1039. https://doi.org/10.1302/0301-620X.103B.BJJ-2020-2026.R1
54. Cowie J, Anakwe R, McQueen M. Factors associated with one-year outcome after distal radial fracture treatment. *J Orthop Surg (Hong Kong)*. 2015;23:24-28. https://doi.org/10.1177/230949901502300106
55. Coyle JA, Robertson VJ. Comparison of two passive mobilizing techniques following Colles' fracture: a multi-element design. *Man Ther*. 1998;3:34-41. https://doi.org/10.1054/math.1998.0314
56. Cuddihy MT, Gabriel SE, Crowson CS, O'Fallon WM, Melton LJ. Forearm fractures as predictors of subsequent osteoporotic fractures. *Osteoporos Int*. 1999;9:469-475. https://doi.org/10.1007/s001980050172
57. Cummings SR, Kelsey JL, Nevitt MC, O'Dowd KJ. Epidemiology of osteoporosis and osteoporotic fractures. *Epidemiol Rev*. 1985;7:178-208. https://doi.org/10.1093/oxfordjournals.epirev.a036281
58. da Silva Rodrigues EK, de Cássia Registro Fonseca M, MacDermid JC. Brazilian version of the Patient Rated Wrist Evaluation (PRWE-BR): cross-cultural adaptation, internal consistency, test-retest reliability and construct validity. *J Hand Ther*. 2015;28:69-75. https://doi.org/10.1016/j.jht.2014.09.008
59. Daruwalla ZJ, Huq SS, Wong KL, et al. Hip fractures, preceding distal radius fractures and screening for osteoporosis: should we be screening earlier? A minimum 10-year retrospective cohort study at a single centre. *Osteoporos Int*. 2016;27:361-366. https://doi.org/10.1007/s00198-015-3375-8
60. Deng ZB, Wu JP, Tang KY, et al. In adults, early mobilization may be beneficial for distal radius fractures treated with open reduction and internal fixation: a systematic review and meta-analysis. *J Orthop Surg Res*. 2021;16:691. https://doi.org/10.1186/s13018-021-02837-0
61. Dennison DG, Blanchard CL, Elhassan B, Moran SL, Shin AY. Early versus late motion following volar plating of distal radius fractures. *HAND*. 2020;15:125-130. https://doi.org/10.1177/1558944718787880
62. Dewan N, MacDermid JC, Grewal R, Beattie K. Risk factors predicting subsequent falls and osteoporotic fractures at 4 years after distal radius fracture-a prospective cohort study. *Arch Osteoporos*. 2018;13:32. https://doi.org/10.1007/s11657-018-0445-5
63. Dewan N, MacDermid JC, MacIntyre NJ, Grewal R. Therapist's practice patterns for subsequent fall/osteoporotic fracture prevention for patients with a distal radius fracture. *J Hand Ther*. 2019;32:497-506. https://doi.org/10.1016/j.jht.2018.03.001
64. Dijkstra PU, Groothoff JW, ten Duis HJ, Geertzen JH. Incidence of complex regional pain syndrome type I after fractures of the distal radius. *Eur J Pain*. 2003;7:457-462. https://doi.org/10.1016/S1090-3801(03)00015-6

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65. Dilek B, Ayhan C, Yagci G, Yakut Y. Effectiveness of the graded motor imagery to improve hand function in patients with distal radius fracture: a randomized controlled trial. *J Hand Ther*. 2018;31:2-9 e1. https://doi.org/10.1016/j.jht.2017.09.004
66. Driessens S, Diserens-Chew T, Burton C, Lassig E, Hartley C, McPhail S. A retrospective cohort investigation of active range of motion within one week of open reduction and internal fixation of distal radius fractures. *J Hand Ther*. 2013;26:225-230. https://doi.org/10.1016/j.jht.2013.05.002
67. Duprat A, Diaz JJH, Vernet P, et al. Volar locking plate fixation of distal radius fractures: splint versus immediate mobilization. *J Wrist Surg*. 2018;7:237-242. https://doi.org/10.1055/s-0037-1620271
68. Eathorne WS. The wrist: clinical anatomy and physical examination—an update. *Prim Care*. 2005;32:17-33. https://doi.org/10.1016/j.pop.2004.11.009
69. Eberhardt K, Sandqvist G, Geborek P. Hand function tests are important and sensitive tools for assessment of treatment response in patients with rheumatoid arthritis. *Scand J Rheumatol*. 2008;37:109-112. https://doi.org/10.1016/j.pop.2004.11.009
70. Edwards BJ, Song J, Dunlop DD, Fink HA, Cauley JA. Functional decline after incident wrist fractures—study of osteoporotic fractures: prospective cohort study. *BMJ*. 2010;341:c3324. https://doi.org/10.1136/bmj.c3324
71. Egol KA, Karia R, Zingman A, Lee S, Paksima N. Hand stiffness following distal radius fractures: who gets it and is it a functional problem? *Bull Hosp Jt Dis*. 2014;72:288-293.
72. Egund L, McGuigan FE, Egund N, Besjakov J, Åkesson KE. Patient-related outcome, fracture displacement and bone mineral density following distal radius fracture in young and older men. *BMC Musculoskelet Disord*. 2020;21:816. https://doi.org/10.1186/s12891-020-03843-9
73. Esakki S, MacDermid JC, Vincent JI, Packham TL, Walton D, Grewal R. Rasch analysis of the patient-rated wrist evaluation questionnaire. *Arch Physiother*. 2018;8:5. https://doi.org/10.1186/s40945-018-0046-z
74. Escorpizo R, Stucki G, Cieza A, Davis K, Stumbo T, Riddle DL. Creating an interface between the International Classification of Functioning, Disability and Health and physical therapist practice. *Phys Ther*. 2010;90:1053-1063. https://doi.org/10.2522/ptj.20090326
75. Fabbri B, Berardi A, Tofani M, et al. A systematic review of the psychometric properties of the Jebsen-Taylor Hand Function Test (JTHFT). *Hand Surg Rehabil*. 2021;40:560-567. https://doi.org/10.1016/j.hansur.2021.05.004
76. Fairplay T, Atzei A, Corradi M, Luchetti R, Cozzolino R, Schoenhuber R. Cross-cultural adaptation and validation of the Italian version of the patient-rated wrist/hand evaluation questionnaire. *J Hand Surg Eur Vol*. 2012;37:863-870. https://doi.org/10.1177/1753193412445160
77. Fan Y, Bai D, Cheng C, Tian G. The effectiveness and safety of blood flow restriction training for the post-operation treatment of distal radius fracture. *Ann Med*. 2023;55:2240329. https://doi.org/10.1080/07853890.2023.2240329
78. Fang C, Chen YJ, Fang E, et al. Patient expectations predict outcomes following distal radius fracture: a prospective cohort study using the TEFTOM questionnaire. *Injury*. 2021;52:877-882. https://doi.org/10.1016/j.injury.2020.10.091
79. Fang C, Fang E, Yee DKH, Kwan K, Leung G, Leung F. A comparison of six outcome measures across the recovery period after distal radius fixation—Which to use and when? *J Orthop Surg*. 2021;29:2309499020971866. https://doi.org/10.1177/2309499020971866
80. Farzad M, MacDermid JC, Asgary A, Shafiee E, Azizi H. The patient-rated wrist and hand evaluation was successfully translated to Persian. *J Hand Ther*. 2019;32:515-518. https://doi.org/10.1016/j.jht.2018.09.002
81. Farzad M, MacDermid JC, Mehta S, Grewal R, Shafiee E. Early post-immobilization pain at rest, movement evoked pain, and their ratio as potential predictors of pain and disability at six- and 12-months after distal radius fracture. *Arch Physiother*. 2021;11:6. https://doi.org/10.1186/s40945-021-00101-6
82. Fernandez LD. Fractures of the distal radius: operative treatment. *Instr Course Lect*. 1993;42:73-88.
83. Filipova V, Lonzaric D, Jesensek Papez B. Efficacy of combined physical and occupational therapy in patients with conservatively treated distal radius fracture: randomized controlled trial. *Wien Klin Wochenschr*. 2015;127:S282-S287. https://doi.org/10.1007/s00508-015-0812-9
84. Fok MWM, Fang CX, Lau TW, Fung YKE, Fung BKK, Leung FKL. The status of triangular fibrocartilage complex after the union of distal radius fractures with internal plate fixation. *Int Orthop*. 2018;42:1917-1922. https://doi.org/10.1007/s00264-018-3793-2
85. Fok MWM, Fernandez DL, Maniglio M. Carpal instability nondissociative following acute wrist fractures. *J Hand Surg Am*. 2020;45:662e1-662e10. https://doi.org/10.1016/j.jhsa.2019.11.018
86. Forde C, Nicolson PJ, Vye C, et al. Lower limb muscle strength and balance in older adults with a distal radius fracture: a systematic review. *BMC Musculoskelet Disord*. 2023;24:741. https://doi.org/10.1186/s12891-023-06711-4
87. Fowler PT. Intercarpal ligament injuries associated with distal radius fractures. *J Am Acad Orthop Surg*. 2019;27:e893-e901. https://doi.org/10.5435/JAAOS-D-18-00503
88. Frykman G. Fracture of the distal radius including sequelae–shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function: a clinical and experimental study. *Acta Orthop Scand*. 1967;38:1-61. https://doi.org/10.3109/ort.1967.38.suppl-108.01
89. Gabl M, Arora R, Klauser AS, Schmidle G. Characteristics of secondary arthrofibrosis after intra-articular distal radius fracture. *Arch Orthop Trauma Surg*. 2016;136:1181-1188. https://doi.org/10.1007/s00402-016-2490-0
90. Gamo K, Baba N, Kakimoto T, Kuratsu S. Efficacy of hand therapy after volar locking plate fixation of distal radius fracture in middle-aged to elderly women: a randomized controlled trial. *J Hand Surg Am*. 2022;47:62.e1-62.e7. https://doi.org/10.1016/j.jhsa.2021.08.009
91. Gartland JJ Jr, Werley CW. Evaluation of healed Colles' fractures. *J Bone Joint Surg Am*. 1951;33:895-907. https://doi.org/10.2106/00004623-195133040-00009
92. Goldhahn J, Shisha T, Macdermid JC, Goldhahn S. Multilingual cross-cultural adaptation of the patient-rated wrist evaluation (PRWE) into Czech, French, Hungarian, Italian, Portuguese (Brazil), Russian and Ukrainian. *Arch Orthop Trauma Surg*. 2013;133:589-593. https://doi.org/10.1007/s00402-013-1694-9
93. Gómez-Eslava B, Rodriguez-Ricardo MC, Serpa JC, Fajury R, García-González LA. Cross-cultural adaptation and validation of the translated patient-rated wrist evaluation score. *J Wrist Surg*. 2021;10:303-307. https://doi.org/10.1055/s-0041-1725173
94. Gopal A, Hsu WY, Allen DD, Bove R. Remote assessments of hand function in neurological disorders: systematic review. *JMIR Rehabil Assist Technol*. 2022;9:e33157. https://doi.org/10.2196/33157
95. Goudie S, Dixon D, McMillan G, Ring D, McQueen M. Is use of a psychological workbook associated with improved disabilities of the arm, shoulder and hand scores in patients with distal radius fracture? *Clin Orthop Relat Res*. 2018;476:832-845. https://doi.org/10.1007/s11999.0000000000000095
96. Goudie ST, Broll R, Warwick C, Dixon D, Ring D, McQueen M. The association between psychological factors and outcomes after distal radius fracture. *J Hand Surg Am*. 2022;47:190.E1-190.E10. https://doi.org/10.1016/j.jhsa.2021.04.012
97. Grewal R, MacDermid JC, Pope J, Chesworth BM. Baseline predictors of pain and disability one year following extra-articular distal

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radius fractures. *HAND*. 2007;2:104-111. https://doi.org/10.1007/s11552-007-9030-x

98. Gutiérrez-Espinoza H, Araya-Quintanilla F, Gutierrez-Monclus R, Cavero-Redondo I, Alvarez-Bueno C. The effectiveness of adding a scapular exercise programme to physical therapy treatment in patients with distal radius fracture treated conservatively: a randomized controlled trial. *Clin Rehabil*. 2019;33:1931-1939. https://doi.org/10.1177/0269215519866240
99. Gutiérrez-Espinoza H, Araya-Quintanilla F, Olguin-Huerta C, Valenzuela-Fuenzalida J, Gutierrez-Monclus R, Moncada-Ramirez V. Effectiveness of manual therapy in patients with distal radius fracture: a systematic review and meta-analysis. *J Man Manip Ther*. 2022;30:33-45. https://doi.org/10.1080/10669817.2021.1992090
100. Gutiérrez-Espinoza H, Rubio-Oyarzun D, Olguin-Huerta C, Gutierrez-Monclus R, Pinto-Concha S, Gana-Hervias G. Supervised physical therapy vs home exercise program for patients with distal radius fracture: a single-blind randomized clinical study. *J Hand Ther*. 2017;30:242-252. https://doi.org/10.1016/j.jht.2017.02.001
101. Handoll HH, Elliott J. Rehabilitation for distal radial fractures in adults. *Cochrane Database Syst Rev*. 2015;2015:CD003324. https://doi.org/10.1002/14651858.CD003324.pub3
102. Handoll HH, Madhok R, Howe TE. Rehabilitation for distal radial fractures in adults. *Cochrane Database Syst Rev*. 2006;CD003324. https://doi.org/10.1002/14651858.CD003324.pub2
103. Hansen AØ, Knygsand-Roenhoej K, Ardensø K. Danish version of the patient-rated wrist/hand evaluation questionnaire: translation, cross-cultural adaptation, test–retest reliability and construct validity. *Hand Ther*. 2019;24:22-30. https://doi.org/10.1177/1758998318807238
104. Haren K, Backman C, Wiberg M. Effect of manual lymph drainage as described by Vodder on oedema of the hand after fracture of the distal radius: a prospective clinical study. *Scand J Plast Reconstr Surg Hand Surg*. 2000;34:367-372. https://doi.org/10.1080/028443100750059165
105. Härén K, Wiberg M. A prospective randomized controlled trial of manual lymph drainage (MLD) for the reduction of hand oedema after distal radius fracture. *Br J Hand Ther*. 2006;11:41-47. https://doi.org/10.1177/175899830601100202
106. Hasani FN, MacDermid JC, Tang A, Kho ME. Cross-cultural adaptation and psychometric testing of the Arabic version of the Patient-Rated Wrist Hand Evaluation (PRWHE-A) in Saudi Arabia. *J Hand Ther*. 2015;28:412-419. https://doi.org/10.1016/j.jht.2015.05.003
107. Hassankhani GG, Moradi A, Vahedi E, et al. Psychometric properties of the Persian version of the patient rated wrist evaluation. *Arch Bone Jt Surg*. 2017;5:243-249.
108. Hemelaers L, Angst F, Drerup S, Simmen BR, Wood-Dauphinee S. Reliability and validity of the German version of "the Patient-rated Wrist Evaluation (PRWE)" as an outcome measure of wrist pain and disability in patients with acute distal radius fractures. *J Hand Ther*. 2008;21:366-376. https://doi.org/10.1197/j.jht.2008.03.002
109. Henry HM. Distal radius fractures: current concepts. *J Hand Surg Am*. 2008;33:1215-1227. https://doi.org/10.1016/j.jhsa.2008.07.013
110. Heo YM, Roh JY, Kim SB, et al. Evaluation of the sigmoid notch involvement in the intra-articular distal radius fractures: the efficacy of computed tomography compared with plain X-ray. *Clin Orthop Surg*. 2012;4:83-90. https://doi.org/10.4055/cios.2012.4.1.83
111. Hiraga Y, Hisano S, Mizunoe A, Nomiyama K. The mediating effect of psychological factors on the relationship between pain intensity and wrist joint function: a longitudinal study with mediation analysis. *Disabil Rehabil*. 2019;43:1814-1818. https://doi.org/10.1080/09638288.2019.1676318
112. Hooper RC, Zhou N, Wang L, Shauver MJ, Chung KC. Pre-injury activity predicts outcomes following distal radius fractures in patients age 60 and older. *PLOS ONE*. 2020;15:e0232684. https://doi.org/10.1371/journal.pone.0232684
113. Hudak PL, Amadio PC, Bombardier C. Development of an upper extremity outcome measure: the DASH (disabilities of the arm, shoulder and hand). *Am J Ind Med*. 1996;29:602-608. https://doi.org/10.1002/(SICI)1097-0274(199606)29:6<602::AID-AJIM4>3.0.CO;2-L
114. Huh SW, Jo WL, Lee JY. Rupture of flexor tendons as a complication of a distal radius fracture. *J Plast Surg Hand Surg*. 2014;48:350-352. https://doi.org/10.3109/2000656X.2013.793192
115. Iitsuka T, Iwatsuki K, Ota H, Hirata H. The optimal rehabilitation period for patients with distal radius fractures according to the MCID in DASH scores; a preliminary study. *J Hand Surg Asian Pac Vol*. 2016;21:161-166. https://doi.org/10.1142/S2424835516500144
116. Ilyas AM, Jupiter JB. Distal radius fractures—classification of treatment and indications for surgery. *Orthop Clin North Am*. 2007;38:167-173. https://doi.org/10.1016/j.ocl.2007.01.002
117. Imai R, Osumi M, Ishigaki T, Morioka S. Effect of illusory kinesthesia on hand function in patients with distal radius fractures: a quasi-randomized controlled study. *Clin Rehabil*. 2017;31:696-701. https://doi.org/10.1177/0269215516688048
118. Imai R, Osumi M, Morioka S. Influence of illusory kinesthesia by vibratory tendon stimulation on acute pain after surgery for distal radius fractures: a quasi-randomized controlled study. *Clin Rehabil*. 2016;30:594-603. https://doi.org/10.1177/0269215515593610
119. Javaid M, Anwar S, Asghar MU, et al. Comparison of Maitland Mobilization and Mulligan Mobilization with movement on pain and hand function in patients having post Colle's Fracture Stiffness. *Pak J Med Health Sci*. 2022;16:169-171. https://doi.org/10.53350/pjmhs22161169
120. Jayakumar P, Teunis T, Vranceanu AM, Lamb S, Ring D, Gwilym S. Early psychological and social factors explain the recovery trajectory after distal radial fracture. *J Bone Joint Surg Am*. 2020;102:788-795. https://doi.org/10.2106/JBJS.19.00100
121. Jayaram M, Wang BSC, Shauver MJ, Wang L, Chung KC. Using Rasch analysis to validate the Michigan Hand Outcomes Questionnaire from the wrist and radius injury surgical trial. *Plast Reconstr Surg*. 2021;148:558e-567e. https://doi.org/10.1097/PRS.0000000000008317
122. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. *Arch Phys Med Rehabil*. 1969;50:311-319.
123. Jellad A, Salah S, Ben Salah Frih Z. Complex regional pain syndrome type I: incidence and risk factors in patients with fracture of the distal radius. *Arch Phys Med Rehabil*. 2014;95:487-492. https://doi.org/10.1016/j.apmr.2013.09.012
124. Jerosch-Herold C, Shepstone L, Miller L, Chapman P. The responsiveness of sensibility and strength tests in patients undergoing carpal tunnel decompression. *BMC Musculoskelet Disord*. 2011;12:244. https://doi.org/10.1186/1471-2474-12-244
125. Johnell O, Kanis J. Epidemiology of osteoporotic fractures. *Osteoporos Int*. 2005;16:S3-S7. https://doi.org/10.1007/s00198-004-1702-6
126. Johnson NA, Stirling ER, Divall P, Thompson JR, Ullah AS, Dias JJ. Risk of hip fracture following a wrist fracture—a meta-analysis. *Injury*. 2017;48:399-405. https://doi.org/10.1016/j.injury.2016.11.002
127. Johnston GHF, Stewart SA. Intrarater reliability of range of motion measurements of the uninjured wrist in women after distal radius fracture. *J Hand Surg Am*. 2018;43:1-7. https://doi.org/10.1016/j.jhsa.2017.08.030
128. Jongs RA, Harvey LA, Gwinn T, Lucas BR. Dynamic splints do not reduce contracture following distal radial fracture: a randomised controlled trial. *J Physiother*. 2012;58:173-180. https://doi.org/10.1016/S1836-9553(12)70108-X
129. Jung JU, Yang SW, Kim JS, Park JW, Kim JP. Prognostic factors affecting clinical outcomes of arthroscopic assisted reduction and volar plating through preservation of pronator quadratus for intra-articular distal radius fracture. *J Hand Surg Asian Pac Vol*. 2020;25:345-352. https://doi.org/10.1142/S2424835520500393

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130. Jupiter BJ. Fractures of the distal end of the radius. *J Bone Joint Surg Am*. 1991;73:461-469. https://doi.org/10.2106/00004623-199173030-00019

131. Kaji Y, Yamaguchi K, Nomura Y, et al. Postoperative early and proactive grip strength training program for distal radius fractures promotes earlier recovery of grip strength: a retrospective study. *Medicine (Baltimore)*. 2022;101:e29262. https://doi.org/10.1097/MD.0000000000029262

132. Kamal RN, Shapiro LM. American Academy of Orthopaedic Surgeons/American society for surgery of the hand clinical practice guideline summary management of distal radius fractures. *J Am Acad Orthop Surg*. 2022;30:e480-e486. https://doi.org/10.5435/JAAOS-D-21-00719

133. Karagiannopoulos C, Michlovitz S. Rehabilitation strategies for wrist sensorimotor control impairment: from theory to practice. *J Hand Ther*. 2016;29:154-165. https://doi.org/10.1016/j.jht.2015.12.003

134. Karagiannopoulos C, Sitler M, Michlovitz S, Tierney R. A descriptive study on wrist and hand sensori-motor impairment and function following distal radius fracture intervention. *J Hand Ther*. 2013;26:204-214. https://doi.org/10.1016/j.jht.2013.03.004

135. Karagiannopoulos C, Sitler M, Michlovitz S, Tucker C, Tierney R. Responsiveness of the active wrist joint position sense test after distal radius fracture intervention. *J Hand Ther*. 2016;29:474-482. https://doi.org/10.1016/j.jht.2016.06.009

136. Karl JW, Olson PR, Rosenwasser MP. The epidemiology of upper extremity fractures in the United States, 2009. *J Orthop Trauma*. 2015;29:e242-e244. https://doi.org/10.1097/BOT.0000000000000312

137. Karnezis IA, Fragkiadakis EG. Association between objective clinical variables and patient-rated disability of the wrist. *J Bone Jt Surg Br Vol*. 2002;84B:967-970. https://doi.org/10.1302/0301-620X.84B7.0840967

138. Karnezis IA, Panagiotopoulos E, Tyllianakis M, Megas P, Lambiris E. Correlation between radiological parameters and patient-rated wrist dysfunction following fractures of the distal radius. *Injury*. 2005;36:1435-1439. https://doi.org/10.1016/j.injury.2005.09.005

139. Kaufman-Cohen Y, Levanon Y, Friedman J, Yaniv Y, Portnoy S. Home exercise in the dart-throwing motion plane after distal radius fractures: a pilot randomized controlled trial. *J Hand Ther*. 2021;34:531-538. https://doi.org/10.1016/j.jht.2020.03.027

140. Kay S, Haensel N, Stiller K. The effect of passive mobilisation following fractures involving the distal radius: a randomised study. *Aust J Physiother*. 2000;46:93-101. https://doi.org/10.1016/S0004-9514(14)60317-2

141. Kay S, McMahon M, Stiller K. An advice and exercise program has some benefits over natural recovery after distal radius fracture: a randomised trial. *Aust J Physiother*. 2008;54:253-259. https://doi.org/10.1016/S0004-9514(08)70004-7

142. Kelsey JL, Browner WS, Seeley DG, Nevitt MC, Cummings SR. Risk factors for fractures of the distal forearm and proximal humerus. *Am J Epidemiol*. 1992;135:477-489. https://doi.org/10.1093/oxfordjournals.aje.a116314

143. Kim JK, Kang JS. Evaluation of the Korean version of the patient-rated wrist evaluation. *J Hand Ther*. 2013;26:238-243. https://doi.org/10.1016/j.jht.2013.01.003

144. Kim JK, Park MG, Shin SJ. What is the minimum clinically important difference in grip strength? *Clin Orthop Relat Res*. 2014;472:2536-2541. https://doi.org/10.1007/s11999-014-3666-y

145. King IT II. Interinstrument reliability of the Jamar electronic dynamometer and pinch gauge compared with the Jamar hydraulic dynamometer and B&L Engineering mechanical pinch gauge. *Am J Occup Ther*. 2013;67:480-483. https://doi.org/10.5014/ajot.2013.007351

146. Klein LJ. Evaluation of the hand and upper extremity. In: Klein LJ, ed. *Fundamentals of Hand Therapy*. St. Louis, MO: Mosby; 2007:73-97.

147. Kleinlugtenbelt YV, Krol RG, Bhandari M, Goslings JC, Poolman RW, Scholtes VAB. Are the patient-rated wrist evaluation (PRWE) and the disabilities of the arm, shoulder and hand (DASH) questionnaire used in distal radial fractures truly valid and reliable? *Bone Joint Res*. 2018;7:36-45. https://doi.org/10.1302/2046-3758.71.BJR-2017-0081.R1

148. Kljajic J, Celan D, Papež BJ, Bojnec V. The patient-rated wrist and hand evaluation was successfully translated to the Slovenian language. *J Hand Ther*. 2022:730-735. https://doi.org/10.1016/j.jht.2022.06.004

149. Knygsand-Roenhoej K, Maribo T. A randomized clinical controlled study comparing the effect of modified manual edema mobilization treatment with traditional edema technique in patients with a fracture of the distal radius. *J Hand Ther*. 2011;24:184-193. https://doi.org/10.1016/j.jht.2010.10.009

150. Kooner P, Grewal R. Is therapy needed after distal radius fracture treatment, what is the evidence? *Hand Clin*. 2021;37:309-314. https://doi.org/10.1016/j.hcl.2021.02.012

151. Korbus H, Schott N. Does mental practice or mirror therapy help prevent functional loss after distal radius fracture? A randomized controlled trial. *J Hand Ther*. 2022;35:86-96. https://doi.org/10.1016/j.jht.2020.10.017

152. Kotsis SV, Lau FH, Chung KC. Responsiveness of the Michigan Hand Outcomes Questionnaire and physical measurements in outcome studies of distal radius fracture treatment. *J Hand Surg Am*. 2007;32:84-90. https://doi.org/10.1016/j.jhsa.2006.10.003

153. Krischak GD, Krasteva A, Schneider F, Gulkin D, Gebhard F, Kramer M. Physiotherapy after volar plating of wrist fractures is effective using a home exercise program. *Arch Phys Med Rehabil*. 2009;90:537-544. https://doi.org/10.1016/j.apmr.2008.09.575

154. Krzyzanska L, Straburzynska-Lupa A, Raglewska P, Romanowski L. Beneficial effects of pulsed electromagnetic field during cast immobilization in patients with distal radius fracture. *Biomed Res Int*. 2020;2020:6849352. https://doi.org/10.1155/2020/6849352

155. Kuo LC, Yang TH, Hsu YY, et al. Is progressive early digit mobilization intervention beneficial for patients with external fixation of distal radius fracture? A pilot randomized controlled trial. *Clin Rehabil*. 2013;27:983-993. https://doi.org/10.1177/0269215513487391

156. Lafontaine M, Hardy D, Delince P. Stability assessment of distal radius fractures. *Injury*. 1989;20:208-210. https://doi.org/10.1016/0020-1383(89)90113-7

157. Lagerström C, Nordgren B, Olerud C. Evaluation of grip strength measurements after Colles' fracture: a methodological study. *Scand J Rehabil Med*. 1999;31:49-54. https://doi.org/10.1080/003655099444722

158. Lalone EA, Grewal R, King GJ, MacDermid JC. A structured review addressing the use of radiographic measures of alignment and the definition of acceptability in patients with distal radius fractures. *HAND*. 2015;10:621-638. https://doi.org/10.1007/s11552-015-9772-9

159. Landgren M, Abramo A, Geijer M, Kopylov P, Tägil M. Similar 1-year subjective outcome after a distal radius fracture during the 10-year-period 2003-2012. *Acta Orthop*. 2017;88:451-456. https://doi.org/10.1080/17453674.2017.1303601

160. Laohaprasitiporn P, Boonchai K, Monteerarat Y, Limthongthang R, Vathana T. Comparative clinical and radiographic outcomes between early and delayed wrist mobilization after volar fixed-angle plate fixation of distal radius fracture. *Sci Rep*. 2022;12:9648. https://doi.org/10.1038/s41598-022-13909-4

161. Lara TR, Kagan RP, Hiratzka SL, Thompson AR, Nazir OF, Mirarchi AJ. Traditional versus digital media-based hand therapy after distal radius fracture. *J Hand Surg Am*. 2022;47:291.E1-291.E8. https://doi.org/10.1016/j.jhsa.2021.06.018

162. Laseter GF, Carter PR. Management of distal radius fractures. *J Hand Ther*. 1996;9:114-128. https://doi.org/10.1016/S0894-1130(96)80070-6

163. Lazovic M, Kocic M, Dimitrijevic L, Stankovic I, Spalevic M, Ciric T. Pulsed electromagnetic field during cast immobilization in postmenopausal women with Colles' fracture. *Srp Arh Celok Lek*. 2012;140:619-624. https://doi.org/10.2298/SARH1210619L

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164. Lee CH, Lee TY, Her JS, Liao WL, Hsieh CL. Single-blinded, randomized preliminary study evaluating the effect of transcutaneous electrical nerve stimulation on postoperative pain in patients with Colles' fracture. *J Altern Complement Med*. 2015;21:754-758. https://doi.org/10.1089/acm.2015.0119

165. Lee HJ, Gong HS, Song CH, Lee JE, Lee YH, Baek GH. Evaluation of vitamin D level and grip strength recovery in women with a distal radius fracture. *J Hand Surg Am*. 2013;38:519-525. https://doi.org/10.1016/j.jhsa.2012.12.002

166. Lee JK, Yoon BH, Kim B, et al. Is early mobilization after volar locking plate fixation in distal radius fractures really beneficial? A meta-analysis of prospective randomized studies. *J Hand Ther*. 2023;36:196-207. https://doi.org/10.1016/j.jht.2021.10.003

167. Lee S-J, Park JW, Kang BJ, Lee JI. Clinical and radiologic factors affecting functional outcomes after volar locking plate fixation of dorsal angulated distal radius fractures. *J Orthop Sci*. 2016;21:619-624. https://doi.org/10.1016/j.jos.2016.05.007

168. Li L, Li Y, Wu C, Zhang X. Test-retest reliability of tip, key, and palmar pinch force sense in healthy adults. *BMC Musculoskelet Disord*. 2020;21:189. https://doi.org/10.1186/s12891-020-3187-7

169. Lidstrom A. Fractures of the distal end of the radius. A clinical and statistical study of end results. *Acta Orthop Scand Suppl*. 1959;41:1-118. https://doi.org/10.3109/ort.1959.30.suppl-41.01

170. Lindau T, Adlercreutz C, Aspenberg P. Peripheral tears of the triangular fibrocartilage complex cause distal radioulnar joint instability after distal radial fractures. *J Hand Surg Am*. 2000;25:464-468. https://doi.org/10.1053/jhsu.2000.6467

171. Lippuner K, Johansson H, Kanis JA, Rizzoli R. Remaining lifetime and absolute 10-year probabilities of osteoporotic fracture in Swiss men and women. *Osteoporos Int*. 2009;20:1131-1140. https://doi.org/10.1007/s00198-008-0779-8

172. Li-Tsang CW, Chan SC, Chan SY, Soo AK. The Hong Kong Chinese version of the Jebsen hand function test: inter-rater and test-retest reliabilities. *Hong Kong J Occup Ther*. 2004;14:12-20. https://doi.org/10.1016/S1569-1861(09)70024-5

173. Lövgren A, Hellström K. Reliability and validity of measurement and associations between disability and behavioural factors in patients with Colles' fracture. *Physiother Theory Pract*. 2012;28:188-197. https://doi.org/10.3109/09593985.2011.583174

174. Lozano-Calderon SA, Souer S, Mudgal C, Jupiter JB, Ring D. Wrist mobilization following volar plate fixation of fractures of the distal part of the radius. *J Bone Joint Surg Am*. 2008;90:1297-1304. https://doi.org/10.2106/JBJS.G.01368

175. Lucado AM, Day JM, Vincent JI, et al. Lateral elbow pain and muscle function impairments. *J Orthop Sports Phys Ther*. 2022;52:CPG1-CPG111. https://doi.org/10.2519/jospt.2022.0302

176. Lucado AM, Li Z, Russell GB, Papadonikolakis A, Ruch DS. Changes in impairment and function after static progressive splinting for stiffness after distal radius fracture. *J Hand Ther*. 2008;21:319-325. https://doi.org/10.1197/j.jht.2008.01.002

177. Luk MLM, Chan ACM, Cho JSY, et al. Predictors of chronic pain and disability in patients treated conservatively after distal radius fracture: a prospective cohort study. *Int Orthop*. 2023;47:1535-1543. https://doi.org/10.1007/s00264-023-05785-y

178. Lusardi MM, Fritz S, Middleton A, et al. Determining risk of falls in community dwelling older adults: a systematic review and meta-analysis using posttest probability. *J Geriatr Phys Ther*. 2017;40:1-36. https://doi.org/10.1519/JPT.0000000000000099

179. Lyngcoln A, Taylor N, Pizzari T, Baskus K. The relationship between adherence to hand therapy and short-term outcome after distal radius fracture. *J Hand Ther*. 2005;18:2-8. https://doi.org/10.1197/j.jht.2004.10.008

180. Ma T, Zheng X, He XB, Guo KJ. The role of brachioradialis release during AO type C distal radius fracture fixation. *Orthop Traumatol Surg Res*. 2017;103:1099-1103. https://doi.org/10.1016/j.otsr.2017.06.015

181. MacDermid J, Solomon G, Valdes K. *Clinical Assessment Recommendations*. American Society of Hand Therapists; 2015.

182. MacDermid JC, Donner A, Richards RS, Roth JH. Patient versus injury factors as predictors of pain and disability six months after a distal radius fracture. *J Clin Epidemiol*. 2002;55:849-854. https://doi.org/10.1016/S0895-4356(02)00445-6

183. MacDermid JC, Richards RS, Donner A, Bellamy N, Roth JH. Responsiveness of the short form-36, disability of the arm, shoulder, and hand questionnaire, patient-rated wrist evaluation, and physical impairment measurements in evaluating recovery after a distal radius fracture. *J Hand Surg Am*. 2000;25:330-340. https://doi.org/10.1053/jhsu.2000.jhsu25a0330

184. MacDermid JC, Richards RS, Roth JH. Distal radius fracture: a prospective outcome study of 275 patients. *J Hand Ther*. 2001;14:154-169. https://doi.org/10.1016/S0894-1130(01)80046-6

185. MacDermid JC, Roth JH, McMurtry R. Predictors of time lost from work following a distal radius fracture. *J Occup Rehabil*. 2007;17:47-62. https://doi.org/10.1007/s10926-007-9069-0

186. MacDermid JC, Roth JH, Richards RS. Pain and disability reported in the year following a distal radius fracture: a cohort study. *BMC Musculoskelet Disord*. 2003;4:24. https://doi.org/10.1186/1471-2474-4-24

187. MacDermid JC, Turgeon T, Richards RS, Beadle M, Roth JH. Patient rating of wrist pain and disability: a reliable and valid measurement tool. *J Orthop Trauma*. 1998;12:577-586. https://doi.org/10.1097/00005131-199811000-00009

188. Maciel JS, Taylor NF, McIlveen C. A randomised clinical trial of activity-focussed physiotherapy on patients with distal radius fractures. *Arch Orthop Trauma Surg*. 2005;125:515-520. https://doi.org/10.1007/s00402-005-0037-x

189. Mader K, Kirchner S, Wolfgarten B, Pennig D. Efficacy of the A-V Impulse System versus cryotherapy in the reduction of postoperative oedema of the hand: a prospective randomised trial. *Strategies Trauma Limb Reconstr*. 2006;1:36-41. https://doi.org/10.1007/s11751-006-0004-2

190. Mader K, Kirchner S, Wolfgarten B, Pennig D. Efficacy of the AV Impulse System versus cryotherapy in the reduction of postoperative oedema of the hand: a prospective randomised trial. *Strateg Trauma Limb Reconstr*. 2006;1:36-41. https://doi.org/10.1007/s11751-006-0004-2

191. Magnus CR, Arnold CM, Johnston G, et al. Cross-education for improving strength and mobility after distal radius fractures: a randomized controlled trial. *Arch Phys Med Rehabil*. 2013;94:1247-1255. https://doi.org/10.1016/j.apmr.2013.03.005

192. Malanga GA, Yan N, Stark J. Mechanisms and efficacy of heat and cold therapies for musculoskeletal injury. *Postgrad Med*. 2015;127:57-65. https://doi.org/10.1080/00325481.2015.992719

193. Mathews AL, Chung KC. Management of complications of distal radius fractures. *Hand Clin*. 2015;31:205-215. https://doi.org/10.1016/j.hcl.2014.12.002

194. Matsuura Y, Rokkaku T, Kuniyoshi K, et al. Smith's fracture generally occurs after falling on the palm of the hand. *J Orthop Res*. 2017;35:2435-2441. https://doi.org/10.1002/jor.23556

195. Mauck BM, Swigler CW. Evidence-based review of distal radius fractures. *Orthop Clin North Am*. 2018;49:211-222. https://doi.org/10.1016/j.ocl.2017.12.001

196. McQueen M, Caspers J. Colles fracture: does the anatomical result affect the final function? *J Bone Joint Surg Br*. 1988;70:649-651. https://doi.org/10.1302/0301-620X.70B4.3403617

197. McQuillan TJ, Bernstein DN, Merchan N, et al. The association between depression and antidepressant use and outcomes after operative treatment

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of distal radius fractures at 1 year. *J Hand Surg Am*. 2022;47:1166-1171. https://doi.org/10.1016/j.jhsa.2022.08.018

198. Mehta SP, MacDermid JC, Richardson J, MacIntyre NJ, Grewal R. Baseline pain intensity is a predictor of chronic pain in individuals with distal radius fracture. *J Orthop Sports Phys Ther*. 2015;45:119-127. https://doi.org/10.2519/jospt.2015.5129

199. Mehta SP, MacDermid JC, Richardson J, MacIntyre NJ, Grewal R. Reliability and validity of selected measures associated with increased fall risk in females over the age of 45 years with distal radius fracture – a pilot study. *J Hand Ther*. 2015;28:2-9. https://doi.org/10.1016/j.jht.2014.09.009

200. Mehta SP, MacDermid JC, Richardson J, MacIntyre NJ, Grewal R. A systematic review of the measurement properties of the patient-rated wrist evaluation. *J Orthop Sports Phys Ther*. 2015;45:289-298. https://doi.org/10.2519/jospt.2015.5236

201. Mehta SP, Mhatre B, MacDermid JC, Mehta A. Cross-cultural adaptation and psychometric testing of the Hindi version of the patient-rated wrist evaluation. *J Hand Ther*. 2012;25:65-77. https://doi.org/10.1016/j.jht.2011.08.001

202. Mehta SP, Ventura LM, Boone JD, Beasley KD, Brodbeck AR, Rabinek OR. A qualitative inquiry to explore management of distal radius fracture by certified hand therapists. *J Hand Ther*. 2024. In press. https://doi.org/10.1016/j.jht.2024.02.013

203. Melone PC Jr. Articular fractures of the distal radius. *Orthop Clin North Am*. 1984;15:217-236. https://doi.org/10.1016/S0030-5898(20)31312-2

204. Miller-Shahabar I, Schreuer N, Katsevman H, et al. Efficacy of compression gloves in the rehabilitation of distal radius fractures: randomized controlled study. *Am J Phys Med Rehabil*. 2018;97:904-910. https://doi.org/10.1097/PHM.0000000000000998

205. Minor MA, Sanford MK. The role of physical therapy and physical modalities in pain management. *Rheum Dis Clin North Am*. 1999;25:233-248. https://doi.org/10.1016/S0889-857X(05)70062-4

206. Mitsukane M, Sekiya N, Himei S, Oyama K. Immediate effects of repetitive wrist extension on grip strength in patients with distal radial fracture. *Arch Phys Med Rehabil*. 2015;96:862-868. https://doi.org/10.1016/j.apmr.2014.09.024

207. Modarresi S, Suh N, Walton DM, MacDermid JC. Depression affects the recovery trajectories of patients with distal radius fractures: a latent growth curve analysis. *Musculoskelet Sci Pract*. 2019;43:96-102. https://doi.org/10.1016/j.msksp.2019.07.012

208. Moore CM, Leonardi-Bee J. The prevalence of pain and disability one year post fracture of the distal radius in a UK population: a cross sectional survey. *BMC Musculoskelet Disord*. 2008;9:129. https://doi.org/10.1186/1471-2474-9-129

209. Moore JL, Potter K, Blankshain K, Kaplan SL, O'Dwyer LC, Sullivan JE. A core set of outcome measures for adults with neurologic conditions undergoing rehabilitation: a clinical practice guideline. *J Neurol Phys Ther*. 2018;42:174-220. https://doi.org/10.1097/NPT.0000000000000229

210. Morris SN. Distal radius fracture in adults: self-reported physical functioning, role functioning, and meaning of injury. *Orthop Nurs*. 2000;19:37-48. https://doi.org/10.1097/00006416-200019040-00008

211. Moseley GL, Herbert RD, Parsons T, Lucas S, Van Hilten JJ, Marinus J. Intense pain soon after wrist fracture strongly predicts who will develop complex regional pain syndrome: prospective cohort study. *J Pain*. 2014;15:16-23. https://doi.org/10.1016/j.jpain.2013.08.009

212. Myers HL, Thomas E, Hay EM, Dziedzic KS. Hand assessment in older adults with musculoskeletal hand problems: a reliability study. *BMC Musculoskelet Disord*. 2011;12:3. https://doi.org/10.1186/1471-2474-12-3

213. Naito K, Sugiyama Y, Dilokhuttakarn T, et al. A survey of extensor pollicis longus tendon injury at the time of distal radius fractures. *Injury*. 2017;48:925-929. https://doi.org/10.1016/j.injury.2017.02.033

214. Naqvi WM, Qureshi MI, Nimbulkar G, Umate L. Gamification for distal radius fracture rehabilitation: a randomized controlled pilot study. *Cureus*. 2022;14:e29333. https://doi.org/10.7759/cureus.29333

215. Nazari G, Bobos P, MacDermid JC, Lalone EA, Grewal R. Physical impairments predict hand dexterity function after distal radius fractures: a 2-year prospective cohort study. *Hand Ther*. 2018;23:64-69. https://doi.org/10.1177/1758998317751238

216. Nellans KW, Kowalski E, Chung KC. The epidemiology of distal radius fractures. *Hand Clin*. 2012;28:113-125. https://doi.org/10.1016/j.hcl.2012.02.001

217. Nguyen A, Vather M, Bal G, et al. Does a hand strength-focused exercise program improve grip strength in older patients with wrist fractures managed nonoperatively?: A randomized controlled trial. *Am J Phys Med Rehabil*. 2020;99:285-290. https://doi.org/10.1097/PHM.0000000000001317

218. Nienstedt F. The operative treatment of intraarticular Smith fractures. *J Hand Surg Br*. 1999;24:99-103. https://doi.org/10.1016/S0266-7681(99)90049-9

219. Nobilia M, Culicchia G, Tofani M, et al. Italian version of the Jebsen–Taylor hand function test for the assessment of hand disorders: a cross-sectional study. *Am J Occup Ther*. 2019;73:7303205080p1-7303205080p6. https://doi.org/10.5014/ajot.2019.030080

220. Nordvall H, Glanberg-Persson G, Lysholm J. Are distal radius fractures due to fragility or to falls? A consecutive case-control study of bone mineral density, tendency to fall, risk factors for osteoporosis, and health-related quality of life. *Acta Orthop*. 2007;78:271-277. https://doi.org/10.1080/17453670710013799

221. Ochen Y, Peek J, van der Velde D, et al. Operative vs nonoperative treatment of distal radius fractures in adults: a systematic review and meta-analysis. *JAMA Netw Open*. 2020;3:e203497. https://doi.org/10.1001/jamanetworkopen.2020.3497

222. Öken Ö, Ceceli E, Oken F, Yorgancioglu RZ. Hospital-based versus home-based program in rehabilitation of distal radius fractures. *Turk J Phys Med Rehabil*. 2011;57:139-142. https://doi.org/10.4274/tftr.20092

223. Older TM, Stabler EV, Cassebaum WH. Colles fracture: evaluation and selection of therapy. *J Trauma*. 1965;5:469-476. https://doi.org/10.1097/00005373-196507000-00004

224. O'Neill TW, Cooper C, Finn JD, et al. Incidence of distal forearm fracture in British men and women. *Osteoporos Int*. 2001;12:555-558. https://doi.org/10.1007/s001980170076

225. Ootes D, Lambers KT, Ring DC. The epidemiology of upper extremity injuries presenting to the emergency department in the United States. *HAND*. 2012;7:18-22. https://doi.org/10.1007/s11552-011-9383-z

226. Oskam J, Kingma J, Klasen HJ. Interrater reliability for the basic categories of the AO/ASIF's system as a frame of reference for classifying distal radial fractures. *Percept Mot Skills*. 2001;92:589-594. https://doi.org/10.2466/pms.2001.92.2.589

227. Oyen J, Gjesdal CG, Brudvik C, et al. Low-energy distal radius fractures in middle-aged and elderly men and women—the burden of osteoporosis and fracture risk: a study of 1794 consecutive patients. *Osteoporos Int*. 2010;21:1257-1267. https://doi.org/10.1007/s00198-009-1068-x

228. Ozkan S, Teunis T, Ring DC, Chen NC. What is the effect of vitamin C on finger stiffness after distal radius fracture? A double-blind, placebo-controlled randomized trial. *Clin Orthop Relat Res*. 2019;477:2278-2286. https://doi.org/10.1097/CORR.0000000000000807

229. Öztürk Ö, Sari Z, Özgül B, Tasyikan L. Validity and reliability of the Turkish "Patient-Rated Wrist Evaluation" questionnaire. *Acta Orthop Traumatol Turc*. 2015;49:120-125. https://doi.org/10.3944/AOTT.2015.14.0208

230. Paksima N, Pahk B, Romo S, Egol KA. The association of education level on outcome after distal radius fracture. *HAND*. 2014;9:75-79. https://doi.org/10.1007/s11552-013-9557-y

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231. Park MJ, Cooney WP III, Hahn ME, Looi KPA. The effects of dorsally angulated distal radius fractures on carpal kinematics. *J Hand Surg Am*. 2002;27:223-232. https://doi.org/10.1053/jhsu.2002.32083

232. Picelli A, Munari D, Modenese A, et al. Robot-assisted arm training for treating adult patients with distal radius fracture: a proof-of-concept pilot study. *Eur J Phys Rehabil Med*. 2020;56:444-450. https://doi.org/10.23736/S1973-9087.20.06112-2

233. Pistoia W, van Rietbergen B, Lochmuller EM, Lill CA, Eckstein F, Ruegsegger P. Estimation of distal radius failure load with micro-finite element analysis models based on three-dimensional peripheral quantitative computed tomography images. *Bone*. 2002;30:842-848. https://doi.org/10.1016/S8756-3282(02)00736-6

234. Plant CE, Hickson C, Hedley H, Parsons NR, Costa ML. Is it time to revisit the AO classification of fractures of the distal radius? Inter- and intra-observer reliability of the AO classification. *Bone Joint J*. 2015;97-B:818-823. https://doi.org/10.1302/0301-620X.97B6.33844

235. Plant CE, Parsons NR, Edwards AT, Rice H, Denninson K, Costa ML. A comparison of electronic and manual dynamometry and goniometry in patients with fracture of the distal radius and healthy participants. *J Hand Ther*. 2016;29:73-80. https://doi.org/10.1016/j.jht.2015.11.004

236. Pogue DJ, Viegas SF, Patterson RM, et al. Effects of distal radius fracture malunion on wrist joint mechanics. *J Hand Surg Am*. 1990;15:721-727. https://doi.org/10.1016/0363-5023(90)90143-F

237. Pollock J, O'Toole RV, Nowicki SD, Eglseder WA. Articular cartilage thickness at the distal radius: a cadaveric study. *J Hand Surg Am*. 2013;38:1477-1481. https://doi.org/10.1016/j.jhsa.2013.04.037

238. Porrino JA Jr, Maloney E, Scherer K, Mulcahy H, Ha ASA. Fracture of the distal radius: epidemiology and premanagement radiographic characterization. *AJR Am J Roentgenol*. 2014;203:551-559. https://doi.org/10.2214/AJR.13.12140

239. Pradhan S, Chiu S, Burton C, et al. Overall effects and moderators of rehabilitation in patients with wrist fracture: a systematic review. *Phys Ther*. 2022;102:pzac032. https://doi.org/10.1093/ptj/pzac032

240. Quadlbauer S, Pezzei C, Jurkowitsch J, et al. Early rehabilitation of distal radius fractures stabilized by volar locking plate: a prospective randomized pilot study. *J Wrist Surg*. 2017;6:102-112. https://doi.org/10.1055/s-0036-1587317

241. Quadlbauer S, Pezzei C, Jurkowitsch J, et al. Rehabilitation after distal radius fractures: is there a need for immobilization and physiotherapy? *Arch Orthop Trauma Surg*. 2020;140:651-663. https://doi.org/10.1007/s00402-020-03367-w

242. Quadlbauer S, Pezzei C, Jurkowitsch J, et al. Immediate mobilization of distal radius fractures stabilized by volar locking plate results in a better short-term outcome than a five week immobilization: a prospective randomized trial. *Clin Rehabil*. 2022;36:69-86. https://doi.org/10.1177/02692155211036674

243. Reid SA, Andersen JM, Vicenzino B. Adding mobilisation with movement to exercise and advice hastens the improvement in range, pain and function after non-operative cast immobilisation for distal radius fracture: a multicentre, randomised trial. *J Physiother*. 2020;66:105-112. https://doi.org/10.1016/j.jphys.2020.03.010

244. Rikli DA, Regazzoni P. Fractures of the distal end of the radius treated by internal fixation and early function. A preliminary report of 20 cases. *J Bone Joint Surg Br*. 1996;78:588-592. https://doi.org/10.1302/0301-620X.78B4.0780588

245. Ring D, Jupiter JB. Treatment of osteoporotic distal radius fractures. *Osteoporos Int*. 2005;16:S80-S84. https://doi.org/10.1007/s00198-004-1808-x

246. Roh YH, Lee BK, Noh JH, et al. Factors associated with complex regional pain syndrome type I in patients with surgically treated distal radius fracture. *Arch Orthop Trauma Surg*. 2014;134:1775-1781. https://doi.org/10.1007/s00402-014-2094-5

247. Roh YH, Noh JH, Gong HS, Baek GH. Effect of low appendicular lean mass, grip strength, and gait speed on the functional outcome after surgery for distal radius fractures. *Arch Osteoporos*. 2017;12:41. https://doi.org/10.1007/s11657-017-0335-2

248. Rohde G, Haugeberg G, Mengshoel AM, Moum T, Wahl AK. No long-term impact of low-energy distal radius fracture on health-related quality of life and global quality of life: a case-control study. *BMC Musculoskelet Disord*. 2009;10:106. https://doi.org/10.1186/1471-2474-10-106

249. Rolls C, Van der Windt DA, McCabe C, Babatunde OO, Bradshaw E. Prognostic factors for persistent pain after a distal radius fracture: a systematic review. *Hand Ther*. 2022;27:123-136. https://doi.org/10.1177/17589983221124973

250. Rosales RS, García-Gutierrez R, Reboso-Morales L, Atroshi I. The Spanish version of the Patient-Rated Wrist Evaluation outcome measure: cross-cultural adaptation process, reliability, measurement error and construct validity. *Health Qual Life Outcomes*. 2017;15:169. https://doi.org/10.1186/s12955-017-0745-2

251. Ross BJ, Lee OC, Harris MB, Dowd TC, Savoie FH III, Sherman WF. Rates of osteoporosis management and secondary preventative treatment after primary fragility fractures. *JB JS Open Access*. 2021;6:e20.00142. https://doi.org/10.2106/JBJS.OA.20.00142

252. Ross PR, Chung KC. Instability in the setting of distal radius fractures: diagnosis, evaluation, and treatment. *Hand Clin*. 2020;36:417-427. https://doi.org/10.1016/j.hcl.2020.06.002

253. Rozental TD, Johannesdottir F, Kempland KC, Bouxsein ML. Characterization of trabecular bone microstructure in premenopausal women with distal radius fractures. *Osteoporos Int*. 2018;29:409-419. https://doi.org/10.1007/s00198-017-4293-8

254. Ruch DS, Yang CC, Smith BP. Results of acute arthroscopically repaired triangular fibrocartilage complex injuries associated with intra-articular distal radius fractures. *Arthroscopy*. 2003;19:511-516. https://doi.org/10.1053/jars.2003.50154

255. Rundgren J, Bojan A, Mellstrand Navarro C, Enocson A. Epidemiology, classification, treatment and mortality of distal radius fractures in adults: an observational study of 23,394 fractures from the national Swedish fracture register. *BMC Musculoskelet Disord*. 2020;21:88. https://doi.org/10.1186/s12891-020-3097-8

256. Saebo H, Naterstad IF, Bjordal JM, Stausholm MB, Joensen J. Treatment of distal radius fracture during immobilization with an orthopedic cast: a double-blinded randomized controlled trial of photobiomodulation therapy. *Photobiomodul Photomed Laser Surg*. 2021;39:280-288. https://doi.org/10.1089/photob.2020.4964

257. Sæbø H, Naterstad IF, Joensen J, Stausholm MB, Bjordal JM. Pain and disability of conservatively treated distal radius fracture: a triple-blinded randomized placebo-controlled trial of photobiomodulation therapy. *Photobiomodul Photomed Laser Surg*. 2022;40:33-41. https://doi.org/10.1089/photob.2021.0125

258. Sandelin H, Jalanko T, Huhtala H, Lassila H, Haapala J, Helkamaa T. Translation and validation of the Finnish version of the Patient-Rated Wrist Evaluation Questionnaire (PRWE) in patients with acute distal radius fracture. *Scand J Surg*. 2016;105:204-210. https://doi.org/10.1177/1457496915613649

259. Savona A, Ferralis L, Saffioti M, et al. Evaluation of intra-and inter-rater reliability and concurrent validity of the Italian version of the Jebsen–Taylor Hand Function Test in adults with rheumatoid arthritis. *Hand Ther*. 2019;24:48-54. https://doi.org/10.1177/1758998319843554

260. Schmidle G, Benedikt S, Kastenberger T, Kaiser P, Arora R, Gabl M. Arthroscopic debridement of the dorsal capsule in intraarticular distal radius fractures: does it provide superior outcomes? *Arch Orthop Trauma Surg*. 2022;142:691-699. https://doi.org/10.1007/s00402-021-04246-8

261. Schmitt JS, Di Fabio RP. Reliable change and minimum important difference (MID) proportions facilitated group responsiveness comparisons

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using individual threshold criteria. *J Clin Epidemiol*. 2004;57:1008-1018. https://doi.org/10.1016/j.jclinepi.2004.02.007

262. Schønnemann JO, Eggers J. Validation of the Danish version of the Quick-Disabilities of Arm, Shoulder and Hand Questionnaire. *Dan Med J*. 2016;63:A5306

263. Schønnemann JO, Hansen TB, Søballe K. Translation and validation of the Danish version of the Patient Rated Wrist Evaluation questionnaire. *J Plast Surg Hand Surg*. 2013;47:489-492. https://doi.org/10.3109/2000656X.2013.787934

264. Schønnemann JO, Larsen K, Hansen TB, Søballe K. Reliability and validity of the Danish version of the disabilities of arm, shoulder, and hand questionnaire in patients with fractured wrists. *J Plast Surg Hand Surg*. 2011;45:35-39. https://doi.org/10.3109/2000656X.2011.554708

265. Schreuders TA, Roebroeck ME, Goumans J, van Nieuwenhuijzen JF, Stijnen TH, Stam HJ. Measurement error in grip and pinch force measurements in patients with hand injuries. *Phys Ther*. 2003;83:806-815. https://doi.org/10.1093/ptj/83.9.806

266. Sgromolo NM, Cancio JM, Rhee PC. Safety and efficacy of blood flow restriction therapy after operative management of distal radius fractures: a randomized controlled study. *J Wrist Surg*. 2020;9:345-352. https://doi.org/10.1055/s-0040-1712504

267. Shapiro LM, Kamal RN. American Academy of Orthopaedic Surgeons appropriate use criteria: treatment of distal radius fractures. *J Am Acad Orthop Surg*. 2022;30:691-695. https://doi.org/10.5435/JAAOS-D-22-00139

268. Sharma H, Khare GN, Singh S, Ramaswamy AG, Kumaraswamy V, Singh AK. Outcomes and complications of fractures of distal radius (AO type B and C): volar plating versus nonoperative treatment. *J Orthop Sci*. 2014;19:537-544. https://doi.org/10.1007/s00776-014-0560-0

269. Shauver MJ, Chang KWC, Chung KC. Contribution of functional parameters to patient-rated outcomes after surgical treatment of distal radius fractures. *J Hand Surg*. 2014;39:436-442. https://doi.org/10.1016/j.jhsa.2013.11.015

270. Shauver MJ, Yin H, Banerjee M, Chung KC. Current and future national costs to medicare for the treatment of distal radius fracture in the elderly. *J Hand Surg Am*. 2011;36:1282-1287. https://doi.org/10.1016/j.jhsa.2011.05.017

271. Shauver MJ, Zhong L, Chung KC. Mortality after distal radial fractures in the Medicare population. *J Hand Surg Eur Vol*. 2015;40:805-811. https://doi.org/10.1177/1753193415589735

272. Shirzadi A, Farzad M, Farhoud AR, Shafiee E. Application of continuous passive motion in patients with distal radius fractures: a randomized clinical trial. *Hand Surg Rehabil*. 2020;39:522-527. https://doi.org/10.1016/j.hansur.2020.08.001

273. Short WH, Palmer AK, Werner FW, Murphy DJ. A biomechanical study of distal radial fractures. *J Hand Surg Am*. 1987;12:529-534. https://doi.org/10.1016/S0363-5023(87)80202-2

274. Sigirtmaç IC, Öksüz Ç. Investigation of reliability, validity, and cutoff value of the Jebsen-Taylor Hand Function Test. *J Hand Ther*. 2021;34:396-403. https://doi.org/10.1016/j.jht.2020.01.004

275. Simic PM, Weiland AJ. Fractures of the distal aspect of the radius: changes in treatment over the past two decades. *Instr Course Lect*. 2003;52:185-195.

276. Singer BR, McLauchlan GJ, Robinson CM, Christie J. Epidemiology of fractures in 15,000 adults: the influence of age and gender. *J Bone Joint Surg Br*. 1998;80:243-248. https://doi.org/10.1302/0301-620X.80B2.0800243

277. Smith DW, Brou KE, Henry MH. Early active rehabilitation for operatively stabilized distal radius fractures. *J Hand Ther*. 2004;17:43-49. https://doi.org/10.1197/j.jht.2003.10.006

278. Smith-Forbes EV, Howell DM, Willoughby J, Pitts DG, Uhl TL. Specificity of the minimal clinically important difference of the quick Disabilities of the Arm Shoulder and Hand (QDASH) for distal upper extremity conditions. *J Hand Ther*. 2016;29:81-88.

279. Soares F, Paranhos D, Campos F, Gasparini A, Fernandes L. Supervised exercise therapy program vs non-supervised exercise therapy program after distal radius fracture: a systematic review and meta-analysis. *J Hand Ther*. 2023;36:860-876. https://doi.org/10.1016/j.jht.2023.06.009

280. Solgaard S. Function after distal radius fracture. *Acta Orthop Scand*. 1988;59:39-42. https://doi.org/10.3109/17453678809149341

281. Solvang HW, Nordheggen RA, Clementsen S, Hammer OL, Randsborg PH. Epidemiology of distal radius fracture in Akershus, Norway, in 2010-2011. *J Orthop Surg Res*. 2018;13:199. https://doi.org/10.1186/s13018-018-0904-0

282. Soong M, van Leerdam R, Guitton TG, Got C, Katarincic J, Ring D. Fracture of the distal radius: risk factors for complications after locked volar plate fixation. *J Hand Surg Am*. 2011;36:3-9. https://doi.org/10.1016/j.jhsa.2010.09.033

283. Sorensen TJ, Ohrt-Nissen S, Ardenso KV, Laier GH, Mallet SK. Early mobilization after volar locking plate osteosynthesis of distal radial fractures in older patients—a randomized controlled trial. *J Hand Surg Am*. 2020;45:1047-1054.E1. https://doi.org/10.1016/j.jhsa.2020.05.009

284. Souer JS, Buijze G, Ring D. A prospective randomized controlled trial comparing occupational therapy with independent exercises after volar plate fixation of a fracture of the distal part of the radius. *J Bone Joint Surg Am*. 2011;93:1761-1766. https://doi.org/10.2106/JBJS.J.01452

285. Stirling ERB, Johnson NA, Dias JJ. Epidemiology of distal radius fractures in a geographically defined adult population. *J Hand Surg Eur Vol*. 2018;43:974-982. https://doi.org/10.1177/1753193418786378

286. Symonette CJ, Macdermid J, Grewal R. Social support contributes to outcomes following distal radius fractures. *Rehabil Res Pract*. 2013;2013:867250. https://doi.org/10.1155/2013/867250

287. Szekeres M, MacDermid JC, Birmingham T, Grewal R, Lalone E. The effect of therapeutic whirlpool and hot packs on hand volume during rehabilitation after distal radius fracture: a blinded randomized controlled trial. *HAND*. 2017;12:265-271. https://doi.org/10.1177/1558944716661992

288. Szekeres M, MacDermid JC, Grewal R, Birmingham T. The short-term effects of hot packs vs therapeutic whirlpool on active wrist range of motion for patients with distal radius fracture: a randomized controlled trial. *J Hand Ther*. 2018;31:276-281. https://doi.org/10.1016/j.jht.2017.08.003

289. Taleisnik J, Watson HK. Midcarpal instability caused by malunited fractures of the distal radius. *J Hand Surg Am*. 1984;9:350-357. https://doi.org/10.1016/S0363-5023(84)80222-1

290. Teunis T, Bot AGJ, Thornton ER, Ring D. Catastrophic thinking is associated with finger stiffness after distal radius fracture surgery. *J Orthop Trauma*. 2015;29:e414-e420. https://doi.org/10.1097/BOT.0000000000000342

291. Thompson GH, Grant TT. Barton's fractures-reverse Barton's fractures. Confusing eponyms. *Clin Orthop Relat Res*. 1977;210-221. https://doi.org/10.1097/00003086-197701000-00032

292. Thompson PW, Taylor J, Dawson A. The annual incidence and seasonal variation of fractures of the distal radius in men and women over 25 years in Dorset, UK. *Injury*. 2004;35:462-466. https://doi.org/10.1016/S0020-1383(03)00117-7

293. Tomruk M, Gelecek N, Basci O, Ozkan MH. Effects of early manual therapy on functional outcomes after volar plating of distal radius fractures: a randomized controlled trial. *Hand Surg Rehabil*. 2020;39:178-185. https://doi.org/10.1016/j.hansur.2019.12.002

294. Trumble TE, Schmitt SR, Vedder NB. Factors affecting functional outcome of displaced intra-articular distal radius fractures. *J Hand Surg Am*. 1994;19:325-340. https://doi.org/10.1016/0363-5023(94)90028-0

295. Tsang P, Walton D, Grewal R, MacDermid J. Validation of the QuickDASH and DASH in patients with distal radius fractures through agreement

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analysis. *Arch Phys Med Rehabil*. 2017;98:1217-1222.e1211. https://doi.org/10.1016/j.apmr.2016.11.023

296. Turner RG, Faber KJ, Athwal GS. Complications of distal radius fractures. *Orthop Clin North Am*. 2007;38:217-228. https://doi.org/10.1016/j.ocl.2007.02.002

297. Valdes K. A retrospective pilot study comparing the number of therapy visits required to regain functional wrist and forearm range of motion following volar plating of a distal radius fracture. *J Hand Ther*. 2009;22:312-318. https://doi.org/10.1016/j.jht.2009.06.003

298. Valdes K, Naughton N, Burke CJ. Therapist-supervised hand therapy versus home therapy with therapist instruction following distal radius fracture. *J Hand Surg Am*. 2015;40:1110-1116 e1111. https://doi.org/10.1016/j.jhsa.2015.01.036

299. Valdes K, Naughton N, Michlovitz S. Therapist supervised clinic-based therapy versus instruction in a home program following distal radius fracture: a systematic review. *J Hand Ther*. 2014;27:165-173. https://doi.org/10.1016/j.jht.2013.12.010

300. Van Overstraeten L, Camus EJ. The role of extrinsic ligaments in maintaining carpal stability – a prospective statistical analysis of 85 arthroscopic cases. *Hand Surg Rehabil*. 2016;35:10-15. https://doi.org/10.1016/j.hansur.2015.09.004

301. Vezeridis PS, Yoshioka H, Han R, Blazar P. Ulnar-sided wrist pain. Part I: anatomy and physical examination. *Skeletal Radiol*. 2010;39:733-745. https://doi.org/10.1007/s00256-009-0775-x

302. Villar RN, Marsh D, Rushton N, Greatorex RA. Three years after Colles' fracture. A prospective review. *J Bone Joint Surg Br*. 1987;69:635-638. https://doi.org/10.1302/0301-620X.69B4.3611172

303. Vincent JI, MacDermid JC, Bassim CW, Santaguida P. Cluster analysis to identify the profiles of individuals with compromised bone health versus unfortunate wrist fractures within the Canadian Longitudinal Study of Aging (CLSA) database. *Arch Osteoporos*. 2023;18:148. https://doi.org/10.1007/s11657-023-01350-7

304. Visser AW, Bøyesen P, Haugen IK, et al. Instruments measuring pain, physical function, or patient's global assessment in hand osteoarthritis: a systematic literature search. *J Rheumatol*. 2015;42:2118-2134. https://doi.org/10.3899/jrheum.141228

305. Vogt MT, Cauley JA, Tomaino MM, Stone K, Williams JR, Herndon JH. Distal radius fractures in older women: a 10-year follow-up study of descriptive characteristics and risk factors. The study of osteoporotic fractures. *J Am Geriatr Soc*. 2002;50:97-103. https://doi.org/10.1046/j.1532-5415.2002.50014.x

306. Waever D, Madsen ML, Rolfing JHD, et al. Distal radius fractures are difficult to classify. *Injury*. 2018;49:S29-S32. https://doi.org/10.1016/S0020-1383(18)30299-7

307. Wah JW, Wang MK, Ping CL. Construct validity of the Chinese version of the Patient-rated Wrist Evaluation Questionnaire (PRWE-Hong Kong Version). *J Hand Ther*. 2006;19:18-26. https://doi.org/10.1197/j.jht.2005.10.003

308. Wakefield AE, McQueen MM. The role of physiotherapy and clinical predictors of outcome after fracture of the distal radius. *J Bone Jt Surg Br Vol*. 2000;82B:972-976. https://doi.org/10.1302/0301-620X.82B7.0820972

309. Walenkamp MM, de Muinck Keizer RJ, Goslings JC, Vos LM, Rosenwasser MP, Schep NW. The minimum clinically important difference of the patient-rated wrist evaluation score for patients with distal radius fractures. *Clin Orthop Relat Res*. 2015;473:3235-3241. https://doi.org/10.1007/s11999-015-4376-9

310. Waljee JF, Kim HM, Burns PB, Chung KC. Development of a brief, 12-item version of the Michigan Hand Questionnaire. *Plast Reconstr Surg*. 2011;128:208-220. https://doi.org/10.1097/PRS.0b013e318218fc51

311. Walsh M, Davidovitch RI, Egol KA. Ethnic disparities in recovery following distal radial fracture. *J Bone Joint Surg Am*. 2010;92:1082-1087. https://doi.org/10.2106/JBJS.H.01329

312. Watson N, Haines T, Tran P, Keating JL. A comparison of the effect of one, three, or six weeks of immobilization on function and pain after open reduction and internal fixation of distal radial fractures in adults: a randomized controlled trial. *J Bone Joint Surg Am*. 2018;100:1118-1125. https://doi.org/10.2106/JBJS.17.00912

313. Watson NJ, Asadollahi S, Parrish F, Ridgway J, Tran P, Keating JL. Reliability of radiographic measurements for acute distal radius fractures. *BMC Med Imaging*. 2016;16:44. https://doi.org/10.1186/s12880-016-0147-7

314. Watt CF, Taylor NF, Baskus K. Do Colles' fracture patients benefit from routine referral to physiotherapy following cast removal? *Arch Orthop Trauma Surg*. 2000;120:413-415. https://doi.org/10.1007/PL00013772

315. Weinstock-Zlotnick G, Mehta SP. A structured literature synthesis of wrist outcome measures: an evidence-based approach to determine use among common wrist diagnoses. *J Hand Ther*. 2016;29:98-110. https://doi.org/10.1016/j.jht.2016.03.001

316. Wilcke MT, Abbaszadegan H, Adolphson PY. Evaluation of a Swedish version of the patient-rated wrist evaluation outcome questionnaire: good responsiveness, validity, and reliability, in 99 patients recovering from a fracture of the distal radius. *Scand J Plast Reconstr Surg Hand Surg*. 2009;43:94-101. https://doi.org/10.1080/02844310902734598

317. Wilson K, von der Heyde R, Sparks M, et al. The impact of demographic factors and comorbidities on distal radius fracture outcomes. *HAND*. 2014;9:80-86. https://doi.org/10.1007/s11552-013-9559-9

318. Wollstein R, Harel H, Lavi I, Allon R, Michael D. Postoperative treatment of distal radius fractures using sensorimotor rehabilitation. *J Wrist Surg*. 2019;8:2-9. https://doi.org/10.1055/s-0038-1672151

319. Yamazaki H, Hayashi M, Miyaoka S, et al. Venous perfusion assist system has no additional effect compared to simple elevation on post-operative edema in patients with distal radial fracture treated with volar locking plate fixation: a randomized controlled trial. *J Orthop Sci*. 2019;24:441-446. https://doi.org/10.1016/j.jos.2018.11.009

320. Yang M, Liang B, Zhao X, Wang Y, Xue M, Wang D. BFR training improves patients' reported outcomes, strength, and range of motion after casting for Colles' fracture. *Med Sci Sports Exerc*. 2023;55:1985-1994. https://doi.org/10.1249/MSS.0000000000003228

321. Yeoh JC, Pike JM, Slobogean GP, O'Brien PJ, Broekhuyse HM, Lefaivre KA. Role of depression in outcomes of low-energy distal radius fractures in patients older than 55 years. *J Orthop Trauma*. 2016;30:228-233. https://doi.org/10.1097/BOT.0000000000000514

322. Yoon A, Grewal R. Management of distal radius fractures from the North American perspective. *Hand Clin*. 2012;28:135-144. https://doi.org/10.1016/j.hcl.2012.02.002

323. Yoshida S, Yoshida K, Sakai K, Nakama K, Shiba N. Frequency of scapholunate ligament injuries associated with distal radius shearing fracture: correlation of fracture patterns and ligament tear. *Hand Surg*. 2015;20:440-446. https://doi.org/10.1142/S0218810415500379

324. Young CF, Nanu AM, Checketts RG. Seven-year outcome following Colles' type distal radial fracture. A comparison of two treatment methods. *J Hand Surg Br*. 2003;28:422-426. https://doi.org/10.1016/S0266-7681(02)00394-7

325. Zeckey C, Spath A, Kieslich S, et al. Early mobilization versus splinting after surgical management of distal radius fractures. *Dtsch Arztebl Int*. 2020;117:445-451. https://doi.org/10.3238/arztebl.2020.0445

326. Ziebart C, Macdermid JC, Suh N. Effects of gender, age, and time on wrist pain up to two years following distal radius fracture. *Crit Rev Phys Rehabil Med*. 2020;32:85-96. https://doi.org/10.1615/CritRevPhysRehabilMed.2020034189

327. Zlatkovic-Svenda MI, Leitner C, Lazovic B, Petrovic DM. Complex regional pain syndrome (Sudeck atrophy) prevention possibility and accelerated recovery in patients with distal radius at the typical site fracture using polarized, polychromatic light therapy. *Photobiomodul Photomed Laser Surg*. 2019;37:233-239. https://doi.org/10.1089/photob.2018.4544

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APPENDIX A

SEARCH STRATEGIES AND RESULTS FOR ALL DATABASES SEARCHED FOR LITERATURE ON PROGNOSIS

	PubMed	Embase	CINAHL	Cochrane	Duplicates	Original Citations
Nov 23, 2023	1783	2603	1976	1043	2541	4864

Pubmed

Search	Terms
#1 Fracture	("distal radius fracture*"[tw] OR "distal radial fracture*"[tw] OR "wrist fracture*"[tw] OR "colles fracture*"[tiab] OR "colles' fracture*"[tiab] OR "fractured distal radius"[tiab] OR "distal fractured radius"[tiab] OR "fractured wrist"[tiab] OR "fractured wrists"[tiab] OR "Colles' Fracture"[Mesh])
#2 General Prognosis	(Prognosis[Mesh] OR "Follow-up studies"[MeSH] OR "Logistic models"[MeSH] OR prognosis[tw] OR prognoses[tw] OR prognostic[tw] OR prognostication[tw] OR "risk assessment"[tw] OR "outcome probabilities"[tw] OR "outcome prediction"[tw] OR "outcome predictions"[tw] OR "outcomes prediction"[tw] OR "outcomes predictions"[tw] OR "prediction model"[tw] OR "prediction models"[tw] OR "prediction rule"[tw] OR "prediction rules"[tw] OR "risk score"[tw] OR "risk scores"[tw] OR "follow-up study"[tw] OR "follow-up studies"[tw] OR "logistic model"[tw] OR "logistic models"[tw] OR "logistic regression"[tw] OR "life table"[tw] OR "life tables"[tw] OR "Cox regression"[tw] OR "Log-rank"[tw])
#3 General Outcomes	("Treatment Outcome"[Mesh] OR "Recovery of Function"[Mesh] OR "Patient Outcome Assessment"[Mesh] OR "Outcome Assessment, Health Care"[Mesh] OR "Patient Reported Outcome Measures"[Mesh] OR "Physical Functional Performance"[Mesh:NoExp] OR outcome[tiab] OR outcomes[tiab] OR PROM[tiab] OR "recovery of function"[tw] OR "function recovery"[tw] OR "functional recovery"[tw] OR "functional performance"[tw] OR "physical performance"[tw])
#4 Specific Prognosis	("Disability Evaluation"[MeSH] OR "Physical examination"[MeSH] OR "Work Capacity Evaluation"[Mesh] OR "Activities of daily living"[MeSH] OR "activity limitation"[tw] OR "activity limitations"[tw] OR "physical activity"[tw] OR "physical activities"[tw] OR "disability scale"[tw] OR "disabilities scale"[tw] OR "disability questionnaire"[tw] OR "disabilities questionnaire"[tw] OR "daily life activity"[tw] OR "daily life activities"[tw] OR "activity of daily life"[tw] OR "activity of daily living"[tw] OR "range of motion"[tw] OR movement[tw] OR grip[tw] OR gripping[tiab] OR pinch[tw] OR pinching[tiab] OR "range of motion"[tw] OR "activity monitor*"[tw] OR function[tw] OR functionality[tw] OR "functional scale"[tw] OR "functional index"[tw] OR "activity limitation"[tw] OR "activity limitations"[tw] OR capacity[tw] OR performance[tw] OR DASH[tiab] OR QuickDASH[tiab] OR "Michigan hand outcomes"[tw] OR "Michigan hand questionnaire"[tw] OR "patient-rated wrist evaluation"[tw] OR PRWE[tiab] OR "physical activity questionnaire"[tw])
#5 Combined with Filters	#1 AND (#2 OR #3 OR #4) AND (English[Language]) AND ("1995"[Date - Publication] : "3000"[Date - Publication])) NOT ("case reports"[Publication Type] OR "case report"[ti] OR "case series"[ti] OR "case study"[ti] OR clinical series[ti] OR "editorial"[Publication Type] OR "comment"[Publication Type] OR "meta analysis"[Publication Type] OR "systematic review"[Publication Type] OR review[Publication Type] OR guideline[Publication Type] OR "practice guideline"[Publication Type] OR systematic-review[ti] OR meta-analysis[ti] OR scoping-review[ti] OR literature-review[ti])) NOT (Animals[Mesh] NOT Humans[Mesh]) NOT ("Pediatrics"[Mesh] NOT "Adult"[Mesh]) NOT ("Child"[Mesh] NOT "Adult"[Mesh]) NOT ("Radius Fractures/surgery"[MAJR] NOT "Radius Fractures/rehabilitation"[Mesh]) NOT "Cadaver"[Mesh]

Embase

Search	Terms
#1 Fracture	('distal radius fracture*':ti,ab,de,tn OR 'distal radial fracture*':ti,ab,de,tn OR 'wrist fracture*':ti,ab,de,tn OR 'colles fracture*':ti,ab OR 'fractured distal radius':ti,ab OR 'distal fractured radius':ti,ab OR 'fractured wrist':ti,ab OR 'fractured wrists':ti,ab OR 'distal radius fracture'/exp)
#2 Prognosis	('Prognosis'/exp OR 'follow up'/exp OR 'Statistical model'/exp OR prognosis:ti,ab,de,tn OR prognoses:ti,ab,de,tn OR prognostic:ti,ab,de,tn OR prognostication:ti,ab,de,tn OR 'risk assessment':ti,ab,de,tn OR 'outcome probabilities':ti,ab,de,tn OR 'outcome prediction':ti,ab,de,tn OR 'outcome predictions':ti,ab,de,tn OR 'outcomes prediction':ti,ab,de,tn OR 'outcomes predictions':ti,ab,de,tn OR 'prediction model':ti,ab,de,tn OR 'prediction models':ti,ab,de,tn OR 'prediction rule':ti,ab,de,tn OR 'prediction rules':ti,ab,de,tn OR 'risk score':ti,ab,de,tn OR 'risk scores':ti,ab,de,tn OR 'follow-up study':ti,ab,de,tn OR 'follow-up studies':ti,ab,de,tn OR 'logistic model':ti,ab,de,tn OR 'logistic models':ti,ab,de,tn OR 'logistic regression':ti,ab,de,tn OR 'life table':ti,ab,de,tn OR 'life tables':ti,ab,de,tn OR 'Cox regression':ti,ab,de,tn OR Log-rank:ti,ab,de,tn) OR ('outcomes research'/exp OR 'convalescence'/exp OR 'Outcome Assessment'/exp OR 'Patient-Reported Outcome'/exp OR 'Physical Performance'/exp OR outcome:ti,ab OR outcomes:ti,ab OR PROM:ti,ab OR 'recovery of function':ti,ab,de,tn OR 'function recovery':ti,ab,de,tn OR 'functional recovery':ti,ab,de,tn OR 'functional performance':ti,ab,de,tn OR 'physical performance':ti,ab,de,tn) OR ('Disability'/exp OR 'Physical examination'/exp OR 'Work Capacity'/exp OR 'daily life activity'/exp OR 'activity limitation':ti,ab,de,tn OR 'activity limitations':ti,ab,de,tn OR 'physical activity':ti,ab,de,tn OR 'physical activities':ti,ab,de,tn OR 'disability scale':ti,ab,de,tn OR 'disabilities scale':ti,ab,de,tn OR 'disability questionnaire':ti,ab,de,tn OR 'disabilities questionnaire':ti,ab,de,tn OR 'daily life activity':ti,ab,de,tn OR 'daily life activities':ti,ab,de,tn OR 'activity of daily life':ti,ab,de,tn OR 'activity of daily living':ti,ab,de,tn OR 'range of motion':ti,ab,de,tn OR movement:ti,ab,de,tn OR grip:ti,ab,de,tn OR gripping:ti,ab OR pinch:ti,ab,de,tn OR pinching:ti,ab OR 'range of motion':ti,ab,de,tn OR 'activity monitor*':ti,ab,de,tn OR function:ti,ab,de,tn OR functionality:ti,ab,de,tn OR 'functional scale':ti,ab,de,tn OR 'functional index':ti,ab,de,tn OR 'activity limitation':ti,ab,de,tn OR 'activity limitations':ti,ab,de,tn OR capacity:ti,ab,de,tn OR performance:ti,ab,de,tn OR DASH:ti,ab OR QuickDASH:ti,ab OR 'Michigan hand outcomes':ti,ab,de,tn OR 'Michigan hand questionnaire':ti,ab,de,tn OR 'patient-rated wrist evaluation':ti,ab,de,tn OR PRWE:ti,ab OR 'physical activity questionnaire':ti,ab,de,tn)

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APPENDIX A (CONTINUED)

Search	Terms
#3 Filters	((#1 AND #2 AND [english]/lim AND [embase]/lim AND [1995-2024]/py)) NOT ('case report':ti OR 'case series':ti OR 'case study':ti OR 'clinical series':ti OR 'meta analysis'/exp OR 'systematic review'/exp OR 'practice guideline'/exp OR 'review'/exp OR 'review'/it OR 'conference abstract'/it OR systematic-review:ti OR meta-analysis:ti OR scoping-review:ti OR literature-review:ti OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT ('animals'/exp/mj NOT 'humans'/exp/mj) NOT ('Pediatrics'/exp NOT 'Adult'/exp) NOT ('Child'/exp NOT 'Adult'/exp) NOT 'Cadaver'/exp NOT 'fracture fixation'/exp/mj

CINAHL Plus

Search	Terms
#1 Fracture	("distal radius fracture*" OR "distal radial fracture*" OR "wrist fracture*" OR (TI "colles fracture*" OR AB "colles fracture*") OR (TI "colles' fracture*" OR AB "colles' fracture*") OR (TI "fractured distal radius" OR AB "fractured distal radius") OR (TI "distal fractured radius" OR AB "distal fractured radius") OR (TI "fractured wrist" OR AB "fractured wrist") OR (TI "fractured wrists" OR AB "fractured wrists") OR (MM "Radius Fractures"))
#2 Prognosis	((MH "Prognosis+") OR prognosis OR prognoses OR prognostic OR prognostication OR "risk assessment" OR "outcome probabilities" OR "outcome prediction" OR "outcome predictions" OR "outcomes prediction" OR "outcomes predictions" OR "prediction model" OR "prediction models" OR "prediction rule" OR "prediction rules" OR "risk score" OR "risk scores" OR "follow-up study" OR "follow-up studies" OR "logistic model" OR "logistic models" OR "logistic regression" OR "life table" OR "life tables" OR "Cox regression" OR Log-rank) OR ((MH "Treatment Outcomes+") OR (MH "Outcome Assessment+") OR (MH "Patient Reported Outcomes+") OR (MH "Physical Functional Performance") OR (TI outcome OR AB outcome) OR (TI outcomes OR AB outcomes) OR (TI PROM OR AB PROM) OR "recovery of function" OR "function recovery" OR "functional recovery" OR "functional performance" OR "physical performance") OR ((MH "Disability Evaluation+") OR (MH "Physical examination+") OR (MH "Work Capacity Evaluation+") OR (MH "Activities of daily living+") OR "activity limitation" OR "activity limitations" OR "physical activity" OR "physical activities" OR "disability scale" OR "disabilities scale" OR "disability questionnaire" OR "disabilities questionnaire" OR "daily life activity" OR "daily life activities" OR "activity of daily life" OR "activity of daily living" OR "range of motion" OR movement OR grip OR (TI gripping OR AB gripping) OR pinch OR (TI pinching OR AB pinching) OR "range of motion" OR "activity monitor*" OR function OR functionality OR "functional scale" OR "functional index" OR "activity limitation" OR "activity limitations" OR capacity OR performance OR (TI DASH OR AB DASH) OR (TI QuickDASH OR AB QuickDASH) OR "Michigan hand outcomes" OR "Michigan hand questionnaire" OR "patient-rated wrist evaluation" OR (TI PRWE OR AB PRWE) OR "physical activity questionnaire")

Cochrane CENTRAL

Search	Terms
#1 Fracture	("distal radius fracture":ti,ab,kw OR "distal radius fractures":ti,ab,kw OR "distal radial fracture":ti,ab,kw OR "distal radial fractures":ti,ab,kw OR "wrist fracture":ti,ab,kw OR "wrist fractures":ti,ab,kw OR "colles fracture":ti,ab OR "colles fractures":ti,ab OR "colles' fracture":ti,ab OR "colles' fractures":ti,ab OR "fractured distal radius":ti,ab OR "distal fractured radius":ti,ab OR "fractured wrist":ti,ab OR "fractured wrists":ti,ab OR [mh "Colles' Fracture"])
#2 Prognosis	([mh Prognosis] OR [mh "Follow-up studies"] OR [mh "Logistic models"] OR prognosis:ti,ab,kw OR prognoses:ti,ab,kw OR prognostic:ti,ab,kw OR prognostication:ti,ab,kw OR "risk assessment":ti,ab,kw OR "outcome probabilities":ti,ab,kw OR "outcome prediction":ti,ab,kw OR "outcome predictions":ti,ab,kw OR "outcomes prediction":ti,ab,kw OR "outcomes predictions":ti,ab,kw OR "prediction model":ti,ab,kw OR "prediction models":ti,ab,kw OR "prediction rule":ti,ab,kw OR "prediction rules":ti,ab,kw OR "risk score":ti,ab,kw OR "risk scores":ti,ab,kw OR "follow-up study":ti,ab,kw OR "follow-up studies":ti,ab,kw OR "logistic model":ti,ab,kw OR "logistic models":ti,ab,kw OR "logistic regression":ti,ab,kw OR "life table":ti,ab,kw OR "life tables":ti,ab,kw OR "Cox regression":ti,ab,kw OR Log-rank:ti,ab,kw) OR ([mh "Treatment Outcome"] OR [mh "Recovery of Function"] OR [mh "Patient Outcome Assessment"] OR [mh "Outcome Assessment, Health Care"] OR [mh "Patient Reported Outcome Measures"] OR [mh "Physical Functional Performance"] OR outcome:ti,ab OR outcomes:ti,ab OR PROM:ti,ab OR "recovery of function":ti,ab,kw OR "function recovery":ti,ab,kw OR "functional recovery":ti,ab,kw OR "functional performance":ti,ab,kw OR "physical performance":ti,ab,kw) OR ([mh "Disability Evaluation"] OR [mh "Physical examination"] OR [mh "Work Capacity Evaluation"] OR [mh "Activities of daily living"] OR "activity limitation":ti,ab,kw OR "activity limitations":ti,ab,kw OR "physical activity":ti,ab,kw OR "physical activities":ti,ab,kw OR "disability scale":ti,ab,kw OR "disabilities scale":ti,ab,kw OR "disability questionnaire":ti,ab,kw OR "disabilities questionnaire":ti,ab,kw OR "daily life activity":ti,ab,kw OR "daily life activities":ti,ab,kw OR "activity of daily life":ti,ab,kw OR "activity of daily living":ti,ab,kw OR "range of motion":ti,ab,kw OR movement:ti,ab,kw OR grip:ti,ab,kw OR gripping:ti,ab OR pinch:ti,ab,kw OR pinching:ti,ab OR "range of motion":ti,ab,kw OR "activity monitor":ti,ab,kw OR "activity monitors":ti,ab,kw OR function:ti,ab,kw OR functionality:ti,ab,kw OR "functional scale":ti,ab,kw OR "functional index":ti,ab,kw OR "activity limitation":ti,ab,kw OR "activity limitations":ti,ab,kw OR capacity:ti,ab,kw OR performance:ti,ab,kw OR DASH:ti,ab OR QuickDASH:ti,ab OR "Michigan hand outcomes":ti,ab,kw OR "Michigan hand questionnaire":ti,ab,kw OR "patient-rated wrist evaluation":ti,ab,kw OR PRWE:ti,ab OR "physical activity questionnaire":ti,ab,kw)

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APPENDIX A (CONTINUED)

SEARCH STRATEGIES AND RESULTS FOR ALL DATABASES SEARCHED FOR LITERATURE ON EXAMINATION

	PubMed	Embase	CINAHL	Cochrane	Duplicates	Original Citations
Nov 30, 2023	806	278	286	230	616	987

Pubmed

Search	Terms
#1 Distal radius fracture	("distal radius fracture*"[tw] OR "distal radial fracture*"[tw] OR "wrist fracture*"[tw] OR "colles fracture*"[tiab] OR "colles' fracture*"[tiab] OR "fractured distal radius"[tiab] OR "distal fractured radius"[tiab] OR "fractured wrist"[tiab] OR "fractured wrists"[tiab] OR "Colles' Fracture"[Mesh])
#2 Measurement properties	("Sensitivity and Specificity"[Mesh] OR "Validation Studies as Topic"[Mesh] OR "Reproducibility of Results"[Mesh] OR "Matched-Pair Analysis"[mesh] OR "Psychometrics"[Mesh] OR "Predictive Value of Tests"[Mesh] OR "Prognosis"[Mesh] OR sensitivity[tw] OR specificity[tw] OR reproducibility[tw] OR reproducible[tw] OR validity[tw] OR validate[tw] OR validation[tw] OR reliability[tw] OR reliable[tw] OR responsiveness[tw] OR consistency[tw] OR consistencies[tw] OR consistent[tw] OR "log-likelihood ratio"[tw] OR "likelihood-ratio"[tw] OR "likelihood ratio"[tw] OR "LR test"[tw] OR "exploratory research"[tw] OR "comparative study"[tw] OR "cross-sectional study"[tw] OR "matched controls"[tw] OR "pain-free control*"[tw] OR "asymptomatic control*"[tw] OR "disease-free control*"[tw] OR psychometrics[tw] OR "predictive value of test*"[tw] OR "predictive value of results"[tw] OR "negative predictive value*"[tw] OR "positive predictive value*"[tw] OR "diagnostic accuracy"[tw] OR "diagnosis accuracy"[tw] OR "diagnostic utility"[tw] OR prognosis[tw] OR "prognostic factor*"[tw] OR "internal consistency"[tw] OR "coefficient of variation"[tw] OR "minimal detectable change*"[tw] OR "cross-cultural translation"[tw] OR "Rasch analysis"[tw] OR "factor analysis"[tw] OR "cognitive interview*"[tw] OR calibration[tw] OR calibrate[tw] OR "effect size"[tw])
#3 Measures	("Patient Reported Outcome Measures"[MeSH] OR "Patient-Reported Outcomes Measure*"[tw] OR "Patient-Reported Outcome Measure*"[tw] OR PROMIS[tiab] OR "visual analogue scale"[tw] OR "visual analog scale"[tw] OR "numerical rating scale"[tw] OR "numeric rating scale"[tw] OR "patient-reported outcome measure*"[tw] OR "self-reported outcome*"[tw] OR "Jebsen-Taylor Hand Function Test"[tw] OR "Disabilities of the Arm"[tiab] OR DASH[tiab] OR QuickDASH[tiab] OR Quick-DASH[tiab] OR "Michigan hand outcomes"[tw] OR "Michigan hand questionnaire"[tw] OR "patient-rated wrist evaluation"[tw] OR PRWE[tiab] OR "European quality of life 5 dimensions"[tw] OR "European quality of life five dimensions"[tw] OR EuroQol*[tiab] OR EQ-5D[tiab] OR EQ5D*[tiab] OR "short form health survey"[tw] OR "short-form health survey"[tw] OR SF36[tiab] OR SF-36[tiab] OR "36 item short form"[tiab] OR "36-item short form"[tiab] OR "ABILHAND Questionnaire"[tw] OR "Baltimore Therapeutic Equipment"[tw] OR "Canadian Occupational Performance Measure"[tw] OR "Global Assessment Scale"[tw] OR "Grip Strength"[tw] OR "Werley Score"[tw] OR "Manual Ability Measure"[tw] OR "MAM-36"[tiab] OR "Moberg's Pick-up Test"[tw] OR "Moberg Pick-up Test"[tw] OR "Mayo Wrist Score"[tw] OR NYOHWR[tiab] OR "New York Orthopedic Hospital Wrist Rating"[tw] OR "Patient Evaluation Measure"[tw] OR "Purdue Pegboard Test"[tw] OR "Patient Satisfaction"[tw] OR "Wrist Range of Motion"[tw] OR "Semmes-Weinstein Monofilament Test"[tw] OR "Subjective Wrist Value"[tw] OR "Vibration Test"[tw] OR "Working Ability" OR 2PDT[tiab] OR "2-point discrimination test"[tw] OR "two-point discrimination test"[tw] OR "position sense"[tw] OR sensibility[tw] OR sensation*[tw] OR "touch threshold"[tw] OR "grip power"[tw] OR "grip test"[tw] OR pinch[tw] OR dexterity[tw] OR "fine motor skills"[tw] OR "objective measure*"[tw] OR "performance measure*"[tw])
#4 All combined	#1 AND #2 AND #3
#5 With filters	#4 AND (English[Language]) AND ("1995"[Date - Publication] : "3000"[Date - Publication]) NOT ("case reports"[Publication Type] OR "case report"[ti] OR "editorial"[Publication Type] OR "comment"[Publication Type]) NOT (Animals[Mesh] NOT Humans[Mesh]) NOT ("Pediatrics"[Mesh] NOT "Adult"[Mesh]) NOT ("Child"[Mesh] NOT "Adult"[Mesh])

Embase

Concept	Terms
#1 Distal radius fracture	('distal radius fracture*':ti,ab,kw OR 'distal radial fracture*':ti,ab,kw OR 'wrist fracture*':ti,ab,kw OR 'colles fracture*':ti,ab OR 'fractured distal radius':ti,ab OR 'distal fractured radius':ti,ab OR 'fractured wrist':ti,ab,kw OR 'fractured wrists':ti,ab,kw OR 'distal radius fracture'/exp)
#2 Measurement properties	('Sensitivity and Specificity'/exp OR 'Validation Study'/exp OR 'Reproducibility'/exp OR 'Psychometry'/exp OR 'Predictive Value'/exp OR 'Prognosis'/exp OR sensitivity:ti,ab,kw OR specificity:ti,ab,kw OR reproducibility:ti,ab,kw OR reproducible:ti,ab,kw OR validity:ti,ab,kw OR validate:ti,ab,kw OR validation:ti,ab,kw OR reliability:ti,ab,kw OR reliable:ti,ab,kw OR responsiveness:ti,ab,kw OR consistency:ti,ab,kw OR consistencies:ti,ab,kw OR consistent:ti,ab,kw OR 'log-likelihood ratio':ti,ab,kw OR likelihood-ratio:ti,ab,kw OR 'likelihood ratio':ti,ab,kw OR 'LR test':ti,ab,kw OR 'exploratory research':ti,ab,kw OR 'comparative study':ti,ab,kw OR 'cross-sectional study':ti,ab,kw OR 'matched controls':ti,ab,kw OR 'pain-free control*':ti,ab,kw OR 'asymptomatic control*':ti,ab,kw OR 'disease-free control*':ti,ab,kw OR psychometrics:ti,ab,kw OR 'predictive value of test*':ti,ab,kw OR 'predictive value of results':ti,ab,kw OR 'negative predictive value*':ti,ab,kw OR 'positive predictive value*':ti,ab,kw OR 'diagnostic accuracy':ti,ab,kw OR 'diagnosis accuracy':ti,ab,kw OR 'diagnostic utility':ti,ab,kw OR prognosis:ti,ab,kw OR 'prognostic factor*':ti,ab,kw OR 'internal consistency':ti,ab,kw OR 'coefficient of variation':ti,ab,kw OR 'minimal detectable change*':ti,ab,kw OR 'cross-cultural translation':ti,ab,kw OR 'Rasch analysis':ti,ab,kw OR 'factor analysis':ti,ab,kw OR 'cognitive interview*':ti,ab,kw OR calibration:ti,ab,kw OR calibrate:ti,ab,kw OR 'effect size':ti,ab,kw)

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APPENDIX A (CONTINUED)

Concept	Terms
#3 Measures	('Patient-Reported Outcome'/exp OR 'Patient-Reported Outcomes Measure*':ti,ab,kw OR 'Patient-Reported Outcome Measure*':ti,ab,kw OR PROMIS:ti,ab OR 'visual analogue scale':ti,ab,kw OR 'visual analog scale':ti,ab,kw OR 'numerical rating scale':ti,ab,kw OR 'numeric rating scale':ti,ab,kw OR 'patient-reported outcome measure*':ti,ab,kw OR 'self-reported outcome*':ti,ab,kw OR 'Jebsen-Taylor Hand Function Test':ti,ab,kw OR 'Disabilities of the Arm':ti,ab:ti,ab,kw OR DASH:ti,ab OR QuickDASH:ti,ab OR Quick-DASH:ti,ab OR 'Michigan hand outcomes':ti,ab,kw OR 'Michigan hand questionnaire':ti,ab,kw OR 'patient-rated wrist evaluation':ti,ab,kw OR PRWE:ti,ab OR 'European quality of life 5 dimensions':ti,ab,kw OR 'European quality of life five dimensions':ti,ab,kw OR EuroQol*:ti,ab OR EQ-5D:ti,ab OR EQ5D*:ti,ab OR 'short form health survey':ti,ab,kw OR 'short-form health survey':ti,ab,kw OR SF36:ti,ab OR SF-36:ti,ab OR '36 item short form':ti,ab OR '36-item short form':ti,ab OR 'ABILHAND Questionnaire':ti,ab,kw OR 'Baltimore Therapeutic Equipment':ti,ab,kw OR 'Canadian Occupational Performance Measure':ti,ab,kw OR 'Global Assessment Scale':ti,ab,kw OR 'Grip Strength':ti,ab,kw OR 'Werley Score':ti,ab,kw OR 'Manual Ability Measure':ti,ab,kw OR MAM-36:ti,ab OR 'Moberg Pick-up Test':ti,ab,kw OR 'Mayo Wrist Score':ti,ab,kw OR NYOHWR:ti,ab OR 'New York Orthopedic Hospital Wrist Rating':ti,ab,kw OR 'Patient Evaluation Measure':ti,ab,kw OR 'Purdue Pegboard Test':ti,ab,kw OR 'Patient Satisfaction':ti,ab,kw OR 'Wrist Range of Motion':ti,ab,kw OR 'Semmes-Weinstein Monofilament Test':ti,ab,kw OR 'Subjective Wrist Value':ti,ab,kw OR 'Vibration Test':ti,ab,kw OR 'Working Ability':ti,ab,kw OR 2PDT:ti,ab OR '2-point discrimination test':ti,ab,kw OR 'two-point discrimination test':ti,ab,kw OR 'position sense':ti,ab,kw OR sensibility:ti,ab,kw OR sensation*:ti,ab,kw OR 'touch threshold':ti,ab,kw OR 'grip power':ti,ab,kw OR 'grip test':ti,ab,kw OR pinch:ti,ab,kw OR dexterity:ti,ab,kw OR 'fine motor skills':ti,ab,kw OR 'objective measure*':ti,ab,kw OR 'performance measure*':ti,ab,kw)
#4 All combined	#1 AND #2 AND #3
#5 With filters	#4 AND [english]/lim AND [1995-2024]/py NOT ('case report':ti OR 'conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it) NOT ('animals'/exp/mj NOT 'humans'/exp/mj) NOT ('Pediatrics'/exp NOT 'Adult'/exp) NOT ('Child'/exp NOT 'Adult'/exp)

CINAHL Plus

Search	Terms
#1 Distal radius fracture	("distal radius fracture*" OR "distal radial fracture*" OR "wrist fracture*" OR (TI "colles fracture*" OR AB "colles fracture*") OR (TI "colles' fracture*" OR AB "colles' fracture*") OR (TI "fractured distal radius" OR AB "fractured distal radius") OR (TI "distal fractured radius" OR AB "distal fractured radius") OR (TI "fractured wrist" OR AB "fractured wrist") OR (TI "fractured wrists" OR AB "fractured wrists") OR (MM "Radius Fractures, Distal"))
#2 Measurement properties	((MH "Sensitivity and Specificity+") OR (MH "Validation Studies+") OR (MH "Reproducibility of Results+") OR (MH "Matched-Pair Analysis+") OR (MH Psychometrics+) OR (MH "Measurement Issues and Assessments+") OR (MH "Predictive Value of Tests+") OR (MH Prognosis+) OR sensitivity OR specificity OR reproducibility OR reproducible OR validity OR validate OR validation OR reliability OR reliable OR responsiveness OR consistency OR consistencies OR consistent OR "log-likelihood ratio" OR likelihood-ratio OR "likelihood ratio" OR "LR test" OR "exploratory research" OR "comparative study" OR "cross-sectional study" OR "matched controls" OR "pain-free control*" OR "asymptomatic control*" OR "disease-free control*" OR psychometrics OR "predictive value of test*" OR "predictive value of results" OR "negative predictive value*" OR "positive predictive value*" OR "diagnostic accuracy" OR "diagnosis accuracy" OR "diagnostic utility" OR prognosis OR "prognostic factor*" OR "internal consistency" OR "coefficient of variation" OR "minimal detectable change*" OR "cross-cultural translation" OR "Rasch analysis" OR "factor analysis" OR "cognitive interview*" OR calibration OR calibrate OR "effect size")
#3 Measures	((MH "Patient-Reported Outcomes+") OR "Patient-Reported Outcomes Measure*" OR "Patient-Reported Outcome Measure*" OR (TI PROMIS OR AB PROMIS) OR "visual analogue scale" OR "visual analog scale" OR "numerical rating scale" OR "numeric rating scale" OR "patient-reported outcome measure*" OR "self-reported outcome*" OR "Jebsen-Taylor Hand Function Test" OR (TI "Disabilities of the Arm" OR AB "Disabilities of the Arm") OR (TI DASH OR AB DASH) OR (TI QuickDASH OR AB QuickDASH) OR (TI Quick-DASH OR AB Quick-DASH) OR "Michigan hand outcomes" OR "Michigan hand questionnaire" OR "patient-rated wrist evaluation" OR (TI PRWE OR AB PRWE) OR "European quality of life 5 dimensions" OR "European quality of life five dimensions" OR (TI EuroQol* OR AB EuroQol*) OR (TI EQ-5D OR AB EQ-5D) OR (TI EQ5D* OR AB EQ5D*) OR "short form health survey" OR "short-form health survey" OR (TI SF36 OR AB SF36) OR (TI SF-36 OR AB SF-36) OR (TI "36 item short form" OR AB "36 item short form") OR (TI "36-item short form" OR AB "36-item short form") OR "ABILHAND Questionnaire" OR "Baltimore Therapeutic Equipment" OR "Canadian Occupational Performance Measure" OR "Global Assessment Scale" OR "Grip Strength" OR "Werley Score" OR "Manual Ability Measure" OR (TI MAM-36 OR AB MAM-36) OR "Moberg's Pick-up Test" OR "Moberg Pick-up Test" OR "Mayo Wrist Score" OR (TI NYOHWR OR AB NYOHWR) OR "New York Orthopedic Hospital Wrist Rating" OR "Patient Evaluation Measure" OR "Purdue Pegboard Test" OR "Patient Satisfaction" OR "Wrist Range of Motion" OR "Semmes-Weinstein Monofilament Test" OR "Subjective Wrist Value" OR "Vibration Test" OR "Working Ability" OR (TI 2PDT OR AB 2PDT) OR "2-point discrimination test" OR "two-point discrimination test" OR "position sense" OR sensibility OR sensation* OR "touch threshold" OR "grip power" OR "grip test" OR pinch OR dexterity OR "fine motor skills" OR "objective measure*" OR "performance measure*")
#4 All combined	S1 AND S2 AND S3
#5 With filters	S4 AND (Filter-Language:English AND Filter- Published Date: 19950101-20231231 AND Filter-Source Type:Academic Journals AND (Filter-Age:All Adult)

Cochrane Library

Concept	Terms
#1 Distal radius fracture	("distal radius fracture*":ti,ab,kw OR "distal radial fracture*":ti,ab,kw OR "wrist fracture*":ti,ab,kw OR "colles fracture*":ti,ab OR "colles' fracture*":ti,ab OR "fractured distal radius":ti,ab OR "distal fractured radius":ti,ab OR "fractured wrist":ti,ab OR "fractured wrists":ti,ab OR [mh "Colles' Fracture"])

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APPENDIX A (CONTINUED)

Concept	Terms
#2 Measurement properties	([mh "Sensitivity and Specificity"] OR [mh "Validation Studies as Topic"] OR [mh "Reproducibility of Results"] OR [mh "Matched-Pair Analysis"] OR [mh Psychometrics] OR [mh "Predictive Value of Tests"] OR [mh Prognosis] OR sensitivity:ti,ab,kw OR specificity:ti,ab,kw OR reproducibility:ti,ab,kw OR reproducible:ti,ab,kw OR validity:ti,ab,kw OR validate:ti,ab,kw OR validation:ti,ab,kw OR reliability:ti,ab,kw OR reliable:ti,ab,kw OR responsiveness:ti,ab,kw OR consistency:ti,ab,kw OR consistencies:ti,ab,kw OR consistent:ti,ab,kw OR "log-likelihood ratio":ti,ab,kw OR likelihood-ratio:ti,ab,kw OR "likelihood ratio":ti,ab,kw OR "LR test":ti,ab,kw OR "exploratory research":ti,ab,kw OR "comparative study":ti,ab,kw OR "cross-sectional study":ti,ab,kw OR "matched controls":ti,ab,kw OR "pain-free control":ti,ab,kw OR "pain-free controls":ti,ab,kw OR "asymptomatic control":ti,ab,kw OR "asymptomatic controls":ti,ab,kw OR "disease-free control":ti,ab,kw OR "disease-free controls":ti,ab,kw OR psychometrics:ti,ab,kw OR "predictive value of test":ti,ab,kw OR "predictive value of tests":ti,ab,kw OR "predictive value of results":ti,ab,kw OR "negative predictive value":ti,ab,kw OR "negative predictive values":ti,ab,kw OR "positive predictive value":ti,ab,kw OR "positive predictive values":ti,ab,kw OR "diagnostic accuracy":ti,ab,kw OR "diagnosis accuracy":ti,ab,kw OR "diagnostic utility":ti,ab,kw OR prognosis:ti,ab,kw OR "prognostic factor":ti,ab,kw OR "prognostic factors":ti,ab,kw OR "internal consistency":ti,ab,kw OR "coefficient of variation":ti,ab,kw OR "minimal detectable change":ti,ab,kw OR "minimal detectable changes":ti,ab,kw OR "cross-cultural translation":ti,ab,kw OR "Rasch analysis":ti,ab,kw OR "factor analysis":ti,ab,kw OR "cognitive interview":ti,ab,kw OR "cognitive interviews":ti,ab,kw OR calibration:ti,ab,kw OR calibrate:ti,ab,kw OR "effect size":ti,ab,kw)
#3 Measures	([mh "Patient Reported Outcome Measures"] OR "Patient-Reported Outcomes Measure":ti,ab,kw OR "Patient-Reported Outcomes Measures":ti,ab,kw OR "Patient-Reported Outcome Measure":ti,ab,kw OR "Patient-Reported Outcome Measures":ti,ab,kw OR PROMIS:ti,ab OR "visual analogue scale":ti,ab,kw OR "visual analog scale":ti,ab,kw OR "numerical rating scale":ti,ab,kw OR "numeric rating scale":ti,ab,kw OR "self-reported outcome":ti,ab,kw OR "self-reported outcomes":ti,ab,kw OR "Jebsen-Taylor Hand Function Test":ti,ab,kw OR "Disabilities of the Arm":ti,ab OR DASH:ti,ab OR QuickDASH:ti,ab OR Quick-DASH:ti,ab OR "Michigan hand outcomes":ti,ab,kw OR "Michigan hand questionnaire":ti,ab,kw OR "patient-rated wrist evaluation":ti,ab,kw OR PRWE:ti,ab OR "European quality of life 5 dimensions":ti,ab,kw OR "European quality of life five dimensions":ti,ab,kw OR EuroQol*:ti,ab OR EQ-5D:ti,ab OR EQ5D*:ti,ab OR "short form health survey":ti,ab,kw OR "short-form health survey":ti,ab,kw OR SF36:ti,ab OR SF-36:ti,ab OR "36 item short form":ti,ab OR "36-item short form":ti,ab OR "ABILHAND Questionnaire":ti,ab,kw OR "Baltimore Therapeutic Equipment":ti,ab,kw OR "Canadian Occupational Performance Measure":ti,ab,kw OR "Global Assessment Scale":ti,ab,kw OR "Grip Strength":ti,ab,kw OR "Werley Score":ti,ab,kw OR "Manual Ability Measure":ti,ab,kw OR MAM-36:ti,ab OR "Moberg's Pick-up Test":ti,ab,kw OR "Moberg Pick-up Test":ti,ab,kw OR "Mayo Wrist Score":ti,ab,kw OR NYOHWR:ti,ab OR "New York Orthopedic Hospital Wrist Rating":ti,ab,kw OR "Patient Evaluation Measure":ti,ab,kw OR "Purdue Pegboard Test":ti,ab,kw OR "Patient Satisfaction":ti,ab,kw OR "Wrist Range of Motion":ti,ab,kw OR "Semmes-Weinstein Monofilament Test":ti,ab,kw OR "Subjective Wrist Value":ti,ab,kw OR "Vibration Test":ti,ab,kw OR "Working Ability":ti,ab,kw OR 2PDT:ti,ab OR "2-point discrimination test":ti,ab,kw OR "two-point discrimination test":ti,ab,kw OR "position sense":ti,ab,kw OR sensibility:ti,ab,kw OR sensation*:ti,ab,kw OR "touch threshold":ti,ab,kw OR "grip power":ti,ab,kw OR "grip test":ti,ab,kw OR pinch:ti,ab,kw OR dexterity:ti,ab,kw OR "fine motor skills":ti,ab,kw OR "objective measure":ti,ab,kw OR "objective measures":ti,ab,kw OR "performance measure":ti,ab,kw OR "performance measures":ti,ab,kw)
#4 All combined	#1 AND #2 AND #3 AND Publication Year:1995 – 2024

SEARCH STRATEGIES AND RESULTS FOR ALL DATABASES SEARCHED FOR LITERATURE ON INTERVENTION

	PubMed	Embase	CINAHL	Cochrane	Hand Search	Duplicates	Original Citations
Nov 30, 2023	548	657	291	516	9	1104	1370

PubMed

Search	Terms
#1 Fracture	("distal radius fracture*"[tw] OR "distal radial fracture*"[tw] OR "wrist fracture*"[tw] OR "colles fracture*"[tiab] OR "colles' fracture*"[tiab] OR "fractured distal radius"[tiab] OR "distal fractured radius"[tiab] OR "fractured wrist"[tiab] OR "fractured wrists"[tiab] OR "Colles' Fracture"[Mesh])
#2 Rehabilitation timing	(rehabilitation[tiab] OR "activities of daily living"[tiab] OR exercise[tiab] OR exercises[tiab] OR therapy[tiab] OR therapies[tiab] OR mobilization[tiab] OR mobilisation[tiab] OR "Rehabilitation"[Mesh] OR "Exercise Therapy"[Mesh]) AND (time[tiab] OR timeframe[tiab] OR timing[tiab] OR early[tiab] OR "enhanced recovery"[tiab] OR accelerated[tiab] OR traditional[tiab] OR conservative[tiab] OR delay*[tiab] OR weeks[tiab])
#3 Edema management	("edema management"[tw] OR "edema control"[tw] OR "manual edema mobilization"[tw] OR compression[tw] OR "edema glove"[tw] OR massage[tiab] OR elevate*[tiab] OR elevati*[tiab] OR "hand exercises"[tw] OR "hand movements"[tw] OR "home exercise"[tiab] OR "Compression Bandages"[Mesh:NoExp] OR "Edema/prevention and control"[Mesh])
#4 Therapeutic modalities	("physical therapy"[tiab] OR "physical therapies"[tiab] OR physiotherapy[tiab] OR physiotherapies[tiab] OR "rehabilitation"[tiab] OR "Rehabilitation"[Mesh] OR "Physical Therapy Modalities"[Mesh]) OR (cryotherapy[tw] OR cryotherapies[tw] OR "cold therapy"[tw] OR "cold therapies"[tw] OR ice[tiab] OR icing[tiab] OR "heat therapy"[tw] OR "heat therapies"[tw] OR heating[tiab] OR thermotherapy[tw] OR "local hyperthermia"[tiab] OR "induced hyperthermia"[tiab] OR "ultrasound therapy"[tw] OR "ultrasound therapies"[tw] OR "ultrasonic therapy"[tw] OR "ultrasonic therapies"[tw] OR "electric stimulation"[tw] OR "electrical stimulation"[tw] OR "nerve stimulation"[tw] OR "stimulation therapies"[tw] OR "neuromuscular re-education"[tw] OR "electromagnetic therapy"[tw] OR "electromagnetic therapies"[tw] OR "magnetic field therapy"[tw] OR "PEMF therapy"[tiab] OR "Cryotherapy"[Mesh] OR "Ultrasonic Therapy"[Mesh] OR "Hyperthermia, Induced"[Mesh:NoExp] OR "Electric Stimulation"[Mesh] OR "Electric Stimulation Therapy"[Mesh] OR "Transcutaneous Electric Nerve Stimulation"[Mesh])

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APPENDIX A (CONTINUED)

Search	Terms
#5 Therapeutic exercises	("therapeutic modality"[tiab] OR "therapeutic modalities"[tiab] OR "exercise therapy"[tiab] OR "exercise therapies"[tiab] OR "therapeutic exercise"[tiab] OR "therapeutic exercises"[tiab] OR stretching[tiab] OR "exercise movement"[tiab] OR "exercise movements"[tiab] OR strengthen[tiab] OR strengthening[tiab] OR "resistance training"[tiab] OR "strength training"[tiab] OR weight-lifting[tiab] OR "range of motion exercise*"[tiab] OR "range of motion therapy"[tiab] OR "range of motion therapies"[tiab] OR "joint flexibility exercise*"[tiab] OR "joint flexibility therapy"[tiab] OR "joint flexibility therapies"[tiab] OR "active mobilization"[tiab] OR "active mobilizations"[tiab] OR "active mobilisation"[tiab] OR "active mobilisations"[tiab] OR proprioception[tiab] OR "sensorimotor training"[tiab] OR "sensorimotor feedback"[tiab] OR "Exercise Therapy"[Mesh] OR "Resistance Training"[Mesh])
#6 Joint/passive mobilization	("musculoskeletal manipulation*"[tw] OR "wrist manipulation*"[tw] OR "manual therapies"[tw] OR "manual therapy"[tw] OR "manipulation therapy"[tw] OR "manipulation therapies"[tw] OR "manipulative therapies"[tw] OR "manipulative therapy"[tw] OR "joint manipulation*"[tw] OR "joint mobilization*"[tw] OR "joint mobilisation*"[tw] OR "passive mobilization*"[tw] OR "passive movement*"[tw] OR "passive motion"[tw] OR "passive mobilisation*"[tw] OR "Musculoskeletal Manipulations"[Mesh:NoExp])
#7 Orthoses management	("orthotic device"[tw] OR "orthotic devices"[tw] OR "orthotic management"[tw] OR orthoses[tw] OR "dynamic orthosis"[tw] OR "static progressive"[tw] OR splint[tiab] OR splints[tiab] OR splinting[tiab] OR "Orthotic Devices"[Mesh:NoExp])
#8 Management types	("home exercise*"[tw] OR "home-exercise*"[tw] OR "home-based"[tw] OR self-training[tw] OR "self training"[tw] OR self-rehabilitation[tw] OR "self rehabilitation"[tw] OR "supervised exercise*"[tw] OR "supervised therapy"[tw] OR "supervised therapies"[tw] OR "supervised physical therapy"[tw] OR "supervised physical therapies"[tw] OR "supervised rehabilitation"[tw] OR "supervised program"[tw] OR "therapist-supervised"[tw] OR "therapist instruction"[tw])
#9 Combined	#1 AND (#2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)
#10 Filters	#9 AND (English[Language]) AND ("1995/01/01"[Date - Entry] : "2023/11/30"[Date - Entry]) NOT ("case reports"[Publication Type] OR "case report"[ti] OR "case series"[ti] OR "case study"[ti] OR clinical series[ti] OR "editorial"[Publication Type] OR "comment"[Publication Type] OR "meta analysis"[Publication Type] OR "systematic review"[Publication Type] OR review[Publication Type] OR guideline[Publication Type] OR "practice guideline"[Publication Type] OR systematic-review[ti] OR meta-analysis[ti] OR scoping-review[ti] OR literature-review[ti])) NOT (Animals[Mesh] NOT Humans[Mesh]) NOT ("Pediatrics"[Mesh] NOT "Adult"[Mesh]) NOT ("Child"[Mesh] NOT "Adult"[Mesh]) NOT ("Radius Fractures/surgery"[MAJR] NOT "Radius Fractures/rehabilitation"[Mesh]) NOT "Cadaver"[Mesh]

Embase

Search	Terms
#1 Fracture	('distal radius fracture*':ti,ab,kw OR 'distal radial fracture*':ti,ab,kw OR 'wrist fracture*':ti,ab,kw OR 'colles fracture*':ti,ab OR 'fractured distal radius':ti,ab OR 'distal fractured radius':ti,ab OR 'fractured wrist':ti,ab,kw OR 'fractured wrists':ti,ab,kw OR 'distal radius fracture'/exp)
#2 Rehabilitation timing	(rehabilitation:ti,ab OR 'activities of daily living':ti,ab OR exercise:ti,ab OR exercises:ti,ab OR therapy:ti,ab OR therapies:ti,ab OR mobilization:ti,ab OR mobilisation:ti,ab OR 'kinesiotherapy'/exp) AND (time:ti,ab OR timeframe:ti,ab OR timing:ti,ab OR early:ti,ab OR 'enhanced recovery':ti,ab OR accelerated:ti,ab OR traditional:ti,ab OR conservative:ti,ab OR delay*:ti,ab OR weeks:ti,ab)
#3 Edema management	('edema management' OR 'edema control' OR 'manual edema mobilization' OR compression OR 'edema glove' OR massage:ti,ab OR elevate*:ti,ab OR elevati*:ti,ab OR 'hand exercises' OR 'hand movements' OR 'home exercise':ti,ab OR 'Compression Bandage'/de)
#4 Therapeutic modalities	('physical therapy':ti,ab OR 'physical therapies':ti,ab OR physiotherapy:ti,ab OR physiotherapies:ti,ab OR rehabilitation:ti,ab OR Rehabilitation/de OR 'Physiotherapy'/exp) OR (cryotherapy:ti,ab,kw OR cryotherapies:ti,ab,kw OR 'cold therapy':ti,ab,kw OR 'cold therapies':ti,ab,kw OR ice:ti,ab OR icing:ti,ab OR 'heat therapy':ti,ab,kw OR 'heat therapies':ti,ab,kw OR heating:ti,ab OR thermotherapy:ti,ab,kw OR 'local hyperthermia':ti,ab OR 'induced hyperthermia':ti,ab OR 'ultrasound therapy':ti,ab,kw OR 'ultrasound therapies':ti,ab,kw OR 'ultrasonic therapy':ti,ab,kw OR 'ultrasonic therapies':ti,ab,kw OR 'electric stimulation':ti,ab,kw OR 'electrical stimulation':ti,ab,kw OR 'nerve stimulation':ti,ab,kw OR 'stimulation therapies':ti,ab,kw OR 'neuromuscular re-education':ti,ab,kw OR 'electromagnetic therapy':ti,ab,kw OR 'electromagnetic therapies':ti,ab,kw OR 'magnetic field therapy':ti,ab,kw OR 'PEMF therapy':ti,ab OR Cryotherapy/exp OR 'Ultrasound Therapy'/exp OR 'Thermotherapy'/de OR 'Electric Stimulation'/exp OR 'Electrotherapy'/exp OR 'Transcutaneous Electrical Nerve Stimulation'/exp)
#5 Therapeutic exercises	('therapeutic modality':ti,ab OR 'therapeutic modalities':ti,ab OR 'exercise therapy':ti,ab OR 'exercise therapies':ti,ab OR 'therapeutic exercise':ti,ab OR 'therapeutic exercises':ti,ab OR stretching:ti,ab OR 'exercise movement':ti,ab OR 'exercise movements':ti,ab OR strengthen:ti,ab OR strengthening:ti,ab OR 'resistance training':ti,ab OR 'strength training':ti,ab OR weight-lifting:ti,ab OR 'range of motion exercise*':ti,ab OR 'range of motion therapy':ti,ab OR 'range of motion therapies':ti,ab OR 'joint flexibility exercise*':ti,ab OR 'joint flexibility therapy':ti,ab OR 'joint flexibility therapies':ti,ab OR 'active mobilization':ti,ab OR 'active mobilizations':ti,ab OR 'active mobilisation':ti,ab OR 'active mobilisations':ti,ab OR proprioception:ti,ab OR 'sensorimotor training':ti,ab OR 'sensorimotor feedback':ti,ab OR 'kinesiotherapy'/exp OR 'Resistance Training'/exp)
#6 Joint/passive mobilization	('musculoskeletal manipulation*':ti,ab,kw OR 'wrist manipulation*':ti,ab,kw OR 'manual therapies':ti,ab,kw OR 'manual therapy':ti,ab,kw OR 'manipulation therapy':ti,ab,kw OR 'manipulation therapies':ti,ab,kw OR 'manipulative therapies':ti,ab,kw OR 'manipulative therapy':ti,ab,kw OR 'joint manipulation*':ti,ab,kw OR 'joint mobilization*':ti,ab,kw OR 'joint mobilisation*':ti,ab,kw OR 'passive mobilization*':ti,ab,kw OR 'passive movement*':ti,ab,kw OR 'passive motion':ti,ab,kw OR 'passive mobilisation*':ti,ab,kw OR 'Musculoskeletal Manipulation'/de)
#7 Orthoses management	('orthotic device':ti,ab,kw OR 'orthotic devices':ti,ab,kw OR 'orthotic management':ti,ab,kw OR orthoses:ti,ab,kw OR 'dynamic orthosis':ti,ab,kw OR 'static progressive':ti,ab,kw OR splint:ti,ab OR splints:ti,ab OR splinting:ti,ab OR 'Orthosis'/de)

Table continues on next page.

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APPENDIX A (CONTINUED)

Search	Terms
#8 Management types	('home exercise*':ti,ab,kw OR home-exercise*:ti,ab,kw OR home-based:ti,ab,kw OR self-training:ti,ab,kw OR 'self training':ti,ab,kw OR self-rehabilitation:ti,ab,kw OR 'self rehabilitation':ti,ab,kw OR 'supervised exercise*':ti,ab,kw OR 'supervised therapy':ti,ab,kw OR 'supervised therapies':ti,ab,kw OR 'supervised physical therapy':ti,ab,kw OR 'supervised physical therapies':ti,ab,kw OR 'supervised rehabilitation':ti,ab,kw OR 'supervised program':ti,ab,kw OR therapist-supervised:ti,ab,kw OR 'therapist instruction':ti,ab,kw)
#9 Combined	#1 AND (#2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)
#10 Filters	#9 AND [english]/lim AND AND [01-01-1995]/sd NOT [01-12-2023]/sd NOT ('case report':ti OR 'conference abstract'/it OR 'editorial'/it OR 'letter'/it OR 'note'/it OR 'meta analysis'/exp OR 'systematic review'/exp OR 'practice guideline'/exp OR 'review'/exp OR 'review'/it OR 'systematic review':ti OR 'meta analysis':ti OR 'scoping review':ti OR 'literature review':ti) NOT ('animal'/exp/mj NOT 'human'/exp/mj) NOT ('pediatrics'/exp NOT 'adult'/exp) NOT ('child'/exp NOT 'adult'/exp) NOT ('orthopedic surgery'/exp/mj OR 'cadaver'/exp)

CINAHL Plus

Search	Terms
#1 Fracture	("distal radius fracture*" OR "distal radial fracture*" OR "wrist fracture*" OR (TI "colles fracture*" OR AB "colles fracture*") OR (TI "colles' fracture*" OR AB "colles' fracture*") OR (TI "fractured distal radius" OR AB "fractured distal radius") OR (TI "distal fractured radius" OR AB "distal fractured radius") OR (TI "fractured wrist" OR AB "fractured wrist") OR (TI "fractured wrists" OR AB "fractured wrists") OR (MM "Radius Fractures, Distal"))
#2 Rehabilitation timing	((TI rehabilitation OR AB rehabilitation) OR (TI "activities of daily living" OR AB "activities of daily living") OR (TI exercise OR AB exercise) OR (TI exercises OR AB exercises) OR (TI therapy OR AB therapy) OR (TI therapies OR AB therapies) OR (TI mobilization OR AB mobilization) OR (TI mobilisation OR AB mobilisation) OR (MH Rehabilitation+) OR (MH "Therapeutic Exercise+")) AND ((TI time OR AB time) OR (TI timeframe OR AB timeframe) OR (TI timing OR AB timing) OR (TI early OR AB early) OR (TI "enhanced recovery" OR AB "enhanced recovery") OR (TI accelerated OR AB accelerated) OR (TI traditional OR AB traditional) OR (TI conservative OR AB conservative) OR (TI delay* OR AB delay*) OR (TI weeks OR AB weeks))
#3 Edema management	("edema management" OR "edema control" OR "manual edema mobilization" OR compression OR "edema glove" OR (TI massage OR AB massage) OR (TI elevate* OR AB elevate*) OR (TI elevati* OR AB elevati*) OR "hand exercises" OR "hand movements" OR (TI "home exercise" OR AB "home exercise") OR (MH "Elastic Bandages"))
#4 Therapeutic modalities	((TI "physical therapy" OR AB "physical therapy") OR (TI "physical therapies" OR AB "physical therapies") OR (TI physiotherapy OR AB physiotherapy) OR (TI physiotherapies OR AB physiotherapies) OR (TI rehabilitation OR AB rehabilitation) OR (MH Rehabilitation+) OR (MH "Physical Therapy+")) OR (cryotherapy OR cryotherapies OR "cold therapy" OR "cold therapies" OR (TI ice OR AB ice) OR (TI icing OR AB icing) OR "heat therapy" OR "heat therapies" OR (TI heating OR AB heating) OR thermotherapy OR (TI "local hyperthermia" OR AB "local hyperthermia") OR (TI "induced hyperthermia" OR AB "induced hyperthermia") OR "ultrasound therapy" OR "ultrasound therapies" OR "ultrasonic therapy" OR "ultrasonic therapies" OR "electric stimulation" OR "electrical stimulation" OR "nerve stimulation" OR "stimulation therapies" OR "neuromuscular re-education" OR "electromagnetic therapy" OR "electromagnetic therapies" OR "magnetic field therapy" OR (TI "PEMF therapy" OR AB "PEMF therapy") OR (MH Cryotherapy+) OR (MH "Ultrasonic Therapy+") OR (MH "Hyperthermia, Induced") OR (MH "Electric Stimulation+") OR (MH "Transcutaneous Electric Nerve Stimulation+"))
#5 Therapeutic exercises	((TI "therapeutic modality" OR AB "therapeutic modality") OR (TI "therapeutic modalities" OR AB "therapeutic modalities") OR (TI "exercise therapy" OR AB "exercise therapy") OR (TI "exercise therapies" OR AB "exercise therapies") OR (TI "therapeutic exercise" OR AB "therapeutic exercise") OR (TI "therapeutic exercises" OR AB "therapeutic exercises") OR (TI stretching OR AB stretching) OR (TI "exercise movement" OR AB "exercise movement") OR (TI "exercise movements" OR AB "exercise movements") OR (TI strengthen OR AB strengthen) OR (TI strengthening OR AB strengthening) OR (TI "resistance training" OR AB "resistance training") OR (TI "strength training" OR AB "strength training") OR (TI weight-lifting OR AB weight-lifting) OR (TI "range of motion exercise*" OR AB "range of motion exercise*") OR (TI "range of motion therapy" OR AB "range of motion therapy") OR (TI "range of motion therapies" OR AB "range of motion therapies") OR (TI "joint flexibility exercise*" OR AB "joint flexibility exercise*") OR (TI "joint flexibility therapy" OR AB "joint flexibility therapy") OR (TI "joint flexibility therapies" OR AB "joint flexibility therapies") OR (TI "active mobilization" OR AB "active mobilization") OR (TI "active mobilizations" OR AB "active mobilizations") OR (TI "active mobilisation" OR AB "active mobilisation") OR (TI "active mobilisations" OR AB "active mobilisations") OR (TI proprioception OR AB proprioception) OR (TI "sensorimotor training" OR AB "sensorimotor training") OR (TI "sensorimotor feedback" OR AB "sensorimotor feedback") OR (MH "Therapeutic Exercise+") OR (MH "Resistance Training+"))
#6 Joint/passive mobilization	("musculoskeletal manipulation*" OR "wrist manipulation*" OR "manual therapies" OR "manual therapy" OR "manipulation therapy" OR "manipulation therapies" OR "manipulative therapies" OR "manipulative therapy" OR "joint manipulation*" OR "joint mobilization*" OR "joint mobilisation*" OR "passive mobilization*" OR "passive movement*" OR "passive motion" OR "passive mobilisation*" OR (MH "Manipulation, Orthopedic"))
#7 Orthoses management	("orthotic device" OR "orthotic devices" OR "orthotic management" OR orthoses OR "dynamic orthosis" OR "static progressive" OR (TI splint OR AB splint) OR (TI splints OR AB splints) OR (TI splinting OR AB splinting) OR (MH "Orthoses"))
#8 Management types	("home exercise*" OR home-exercise* OR home-based OR self-training OR "self training" OR self-rehabilitation OR "self rehabilitation" OR "supervised exercise*" OR "supervised therapy" OR "supervised therapies" OR "supervised physical therapy" OR "supervised physical therapies" OR "supervised rehabilitation" OR "supervised program" OR therapist-supervised OR "therapist instruction")
#9 Combined	S1 AND (S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8)
#10 Filters	S9 AND (Filter-Language:English AND Filter- Published Date: 19950101-20231130 AND Filter-Source Type:Academic Journals AND (Filter-Age:All Adult)

Table continues on next page.

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APPENDIX A (CONTINUED)

Cochrane Library

Search	Terms
#1 Fracture	("distal radius fracture":ti,ab,kw OR "distal radius fractures":ti,ab,kw OR "distal radial fracture":ti,ab,kw OR "distal radial fractures":ti,ab,kw OR wrist NEXT fracture*:ti,ab,kw OR colles NEXT fracture*:ti,ab OR colles' NEXT fracture*:ti,ab OR "fractured distal radius":ti,ab OR "distal fractured radius":ti,ab OR "fractured wrist":ti,ab OR "fractured wrists":ti,ab OR [mh "Colles' Fracture"])
#2 Rehabilitation timing	(rehabilitation:ti,ab OR "activities of daily living":ti,ab OR exercise:ti,ab OR exercises:ti,ab OR therapy:ti,ab OR therapies:ti,ab OR mobilization:ti,ab OR mobilisation:ti,ab OR [mh Rehabilitation] OR [mh "Exercise Therapy"]) AND (time:ti,ab OR timeframe:ti,ab OR timing:ti,ab OR early:ti,ab OR "enhanced recovery":ti,ab OR accelerated:ti,ab OR traditional:ti,ab OR conservative:ti,ab OR delay*:ti,ab OR weeks:ti,ab)
#3 Edema management	("edema management":ti,ab,kw OR "edema control":ti,ab,kw OR "manual edema mobilization":ti,ab,kw OR compression:ti,ab,kw OR "edema glove":ti,ab,kw OR massage:ti,ab OR elevate*:ti,ab OR elevati*:ti,ab OR "hand exercises":ti,ab,kw OR "hand movements":ti,ab,kw OR "home exercise":ti,ab OR [mh ^"Compression Bandages"])
#4 Therapeutic modalities	("physical therapy":ti,ab OR "physical therapies":ti,ab OR physiotherapy:ti,ab OR physiotherapies:ti,ab OR rehabilitation:ti,ab OR [mh Rehabilitation] OR [mh "Physical Therapy Modalities"]) OR (cryotherapy:ti,ab,kw OR cryotherapies:ti,ab,kw OR "cold therapy":ti,ab,kw OR "cold therapies":ti,ab,kw OR ice:ti,ab OR icing:ti,ab OR "heat therapy":ti,ab,kw OR "heat therapies":ti,ab,kw OR heating:ti,ab OR thermotherapy:ti,ab,kw OR "local hyperthermia":ti,ab OR "induced hyperthermia":ti,ab OR "ultrasound therapy":ti,ab,kw OR "ultrasound therapies":ti,ab,kw OR "ultrasonic therapy":ti,ab,kw OR "ultrasonic therapies":ti,ab,kw OR "electric stimulation":ti,ab,kw OR "electrical stimulation":ti,ab,kw OR "nerve stimulation":ti,ab,kw OR "stimulation therapies":ti,ab,kw OR "neuromuscular re-education":ti,ab,kw OR "electromagnetic therapy":ti,ab,kw OR "electromagnetic therapies":ti,ab,kw OR "magnetic field therapy":ti,ab,kw OR "PEMF therapy":ti,ab OR [mh Cryotherapy] OR [mh "Ultrasonic Therapy"] OR [mh ^"Hyperthermia, Induced"] OR [mh "Electric Stimulation"] OR [mh "Electric Stimulation Therapy"] OR [mh "Transcutaneous Electric Nerve Stimulation"])
#5 Therapeutic exercises	("therapeutic modality":ti,ab OR "therapeutic modalities":ti,ab OR "exercise therapy":ti,ab OR "exercise therapies":ti,ab OR "therapeutic exercise":ti,ab OR "therapeutic exercises":ti,ab OR stretching:ti,ab OR "exercise movement":ti,ab OR "exercise movements":ti,ab OR strengthen:ti,ab OR strengthening:ti,ab OR "resistance training":ti,ab OR "strength training":ti,ab OR weight-lifting:ti,ab OR ("range of motion" NEXT exercise*):ti,ab OR "range of motion therapy":ti,ab OR "range of motion therapies":ti,ab OR ("joint flexibility" NEXT exercise*):ti,ab OR "joint flexibility therapy":ti,ab OR "joint flexibility therapies":ti,ab OR "active mobilization":ti,ab OR "active mobilizations":ti,ab OR "active mobilisation":ti,ab OR "active mobilisations":ti,ab OR proprioception:ti,ab OR "sensorimotor training":ti,ab OR "sensorimotor feedback":ti,ab OR [mh "Exercise Therapy"] OR [mh "Resistance Training"])
#6 Joint/passive mobilization	(("musculoskeletal" NEXT manipulation*):ti,ab,kw OR ("wrist" NEXT manipulation*):ti,ab,kw OR "manual therapies":ti,ab,kw OR "manual therapy":ti,ab,kw OR "manipulation therapy":ti,ab,kw OR "manipulation therapies":ti,ab,kw OR "manipulative therapies":ti,ab,kw OR "manipulative therapy":ti,ab,kw OR ("joint" NEXT manipulation*):ti,ab,kw OR ("joint" NEXT mobilization*):ti,ab,kw OR ("joint" NEXT mobilisation*):ti,ab,kw OR ("passive" NEXT mobilization*):ti,ab,kw OR ("passive" NEXT movement*):ti,ab,kw OR "passive motion":ti,ab,kw OR ("passive" NEXT mobilisation*):ti,ab,kw OR [mh ^"Musculoskeletal Manipulations"])
#7 Orthoses management	("orthotic device":ti,ab,kw OR "orthotic devices":ti,ab,kw OR "orthotic management":ti,ab,kw OR orthoses:ti,ab,kw OR "dynamic orthosis":ti,ab,kw OR "static progressive":ti,ab,kw OR splint:ti,ab OR splints:ti,ab OR splinting:ti,ab OR [mh ^"Orthotic Devices"])
#8 Management types	(("home" NEXT exercise*):ti,ab,kw OR home-exercise*:ti,ab,kw OR home-based:ti,ab,kw OR self-training:ti,ab,kw OR "self training":ti,ab,kw OR self-rehabilitation:ti,ab,kw OR "self rehabilitation":ti,ab,kw OR ("supervised" NEXT exercise*):ti,ab,kw OR "supervised therapy":ti,ab,kw OR "supervised therapies":ti,ab,kw OR "supervised physical therapy":ti,ab,kw OR "supervised physical therapies":ti,ab,kw OR "supervised rehabilitation":ti,ab,kw OR "supervised program":ti,ab,kw OR therapist-supervised:ti,ab,kw OR "therapist instruction":ti,ab,kw)
#9 Combined	#1 AND (#2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8)
#10 Filters	#9 NOT ([mh Animals] NOT [mh Humans]) NOT ([mh Pediatrics] NOT [mh Adult]) NOT ([mh Child] NOT [mh Adult]) NOT [mh Cadaver] AND Cochrane Library publication date from Jan 1995 to Nov 2023, in Trials

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APPENDIX B

ARTICLE INCLUSION AND EXCLUSION CRITERIA

Inclusion Criteria

Study Population

Primarily adults (18 years old or greater) who sustain distal radius fracture

Study Designs

Articles providing evidence of the following types: systematic reviews or meta-analyses of randomized controlled trials, experimental randomized controlled trials, prospective or retrospective cohort studies, case-control, case series studies

Prognostic Studies

Predictors: demographic (age, sex, education level, socioeconomic status, BMI, living/marital status), health (comorbid burden), injury-related (high vs low energy, intra-articular vs extra-articular DRF, concurrent injuries to same or other extremity including LE injuries, baseline impairment levels (along any of the ICF domains), mental health issues (pain catastrophizing, depression, anxiety, fear of movement), polypharmacy (≥4 medications) OR number of medications

Outcomes: Pain (CRPS or non-CRPS), function, wrist/hand ROM, strength, dexterity, return to work, or any other wrist/hand/upper extremity-related outcome that is meaningful to physical therapy practice and amenable to PT interventions (eg, risk of contractures, risk for future falls or fall-related injuries), physical activity, development of CTS or nerve dysfunction

Interventions

Studies for which the primary aim was to investigate the efficacy of various interventions that clinicians (PTs and OTs) may commonly utilize during the rehabilitation of DRF following either nonoperative or operative fracture management. These interventions included the decisions on therapy initiation timing and therapy supervision dosage levels. Other types of intervention categories within the scope of physical therapy practice consisted of edema control (MLD and compression gloves), manual therapy techniques (Maitland, Kaltenborn, and MWM joint mobilization techniques), therapeutic exercises (ROM and strengthening exercises), SM training exercises (sensory re-education, proprioception, and GMI), orthosis management (static progressive and dynamic), and numerous therapeutic modalities (thermal, light-emitting, electrical, and mechanical agents).

Comparisons

Early versus traditional timing of therapy initiation following operative treatment. Regular compared to limited supervised therapy frequency or compared to iHEP education only or no therapy. The addition of edema control methods to standard care versus standard care alone. Maitland as compared to Kaltenborn or MWM mobilization techniques. Single or multimodal SM training exercises as compared to standard therapy. Exercise approaches that included early finger AROM, strengthening of the uninvolved side, scapula stabilization, dart-throwing exercises, gamification, or robot-assisted training as compared to standard care. The addition of orthosis management to standard care as compared to no orthosis utilization, and the addition of various therapeutic modalities to standard care versus standard care alone.

Outcomes

All validated short- and long-term outcomes within the scope of physical therapy (ie, pain, sensation, proprioception, patient-reported function, ROM, strength) following operative and nonoperative DRF management were considered in this CPG.

Exclusion Criteria

Studies published before 1995

Narrative review articles and reports, case studies/reports

Non-English, non–peer-reviewed published articles (eg, abstracts, dissertations, etc)

Any experimental study of unacceptable quality (level V) appraised using the APTA CAT EI tool, including those studies that reported on nonvalidated or nonrelevant outcome measures for DRF patients

Articles reporting on:

- DRF in primarily children or adolescents (less than 18 years old)
- Polytrauma where DRF is one of the injuries
- Surgical (fracture union, infection) or radiological (ulnar variance, deformities) outcomes
- Articles that investigated the efficacy of interventions strictly on patients with CRPS-1 following DRF, or interventions that were outside the scope of physical therapist practice such as treatment for osteoporosis, pharmacological advice, and therapeutic agents primarily aiming on fracture healing
- Topics outside the scope of physical therapist practice:
  - Decision to order radiologic tests (magnetic resonance imaging, etc)
  - Extracorporeal shockwave therapy (unless it is compared to physical therapy intervention)
  - Diagnostic ultrasound

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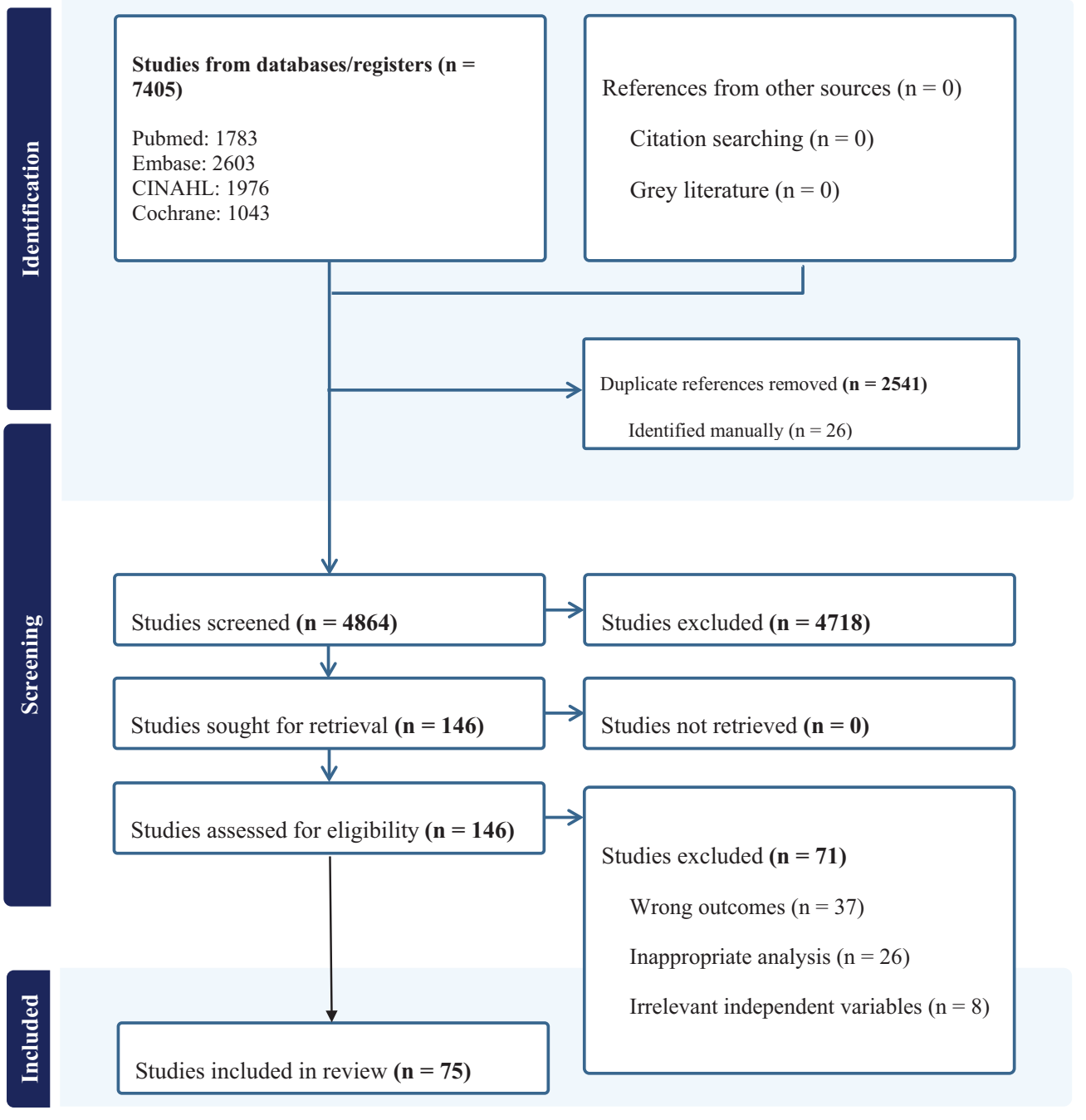
APPENDIX C

FLOW CHART OF ARTICLES

Flow Chart of Articles - Prognosis



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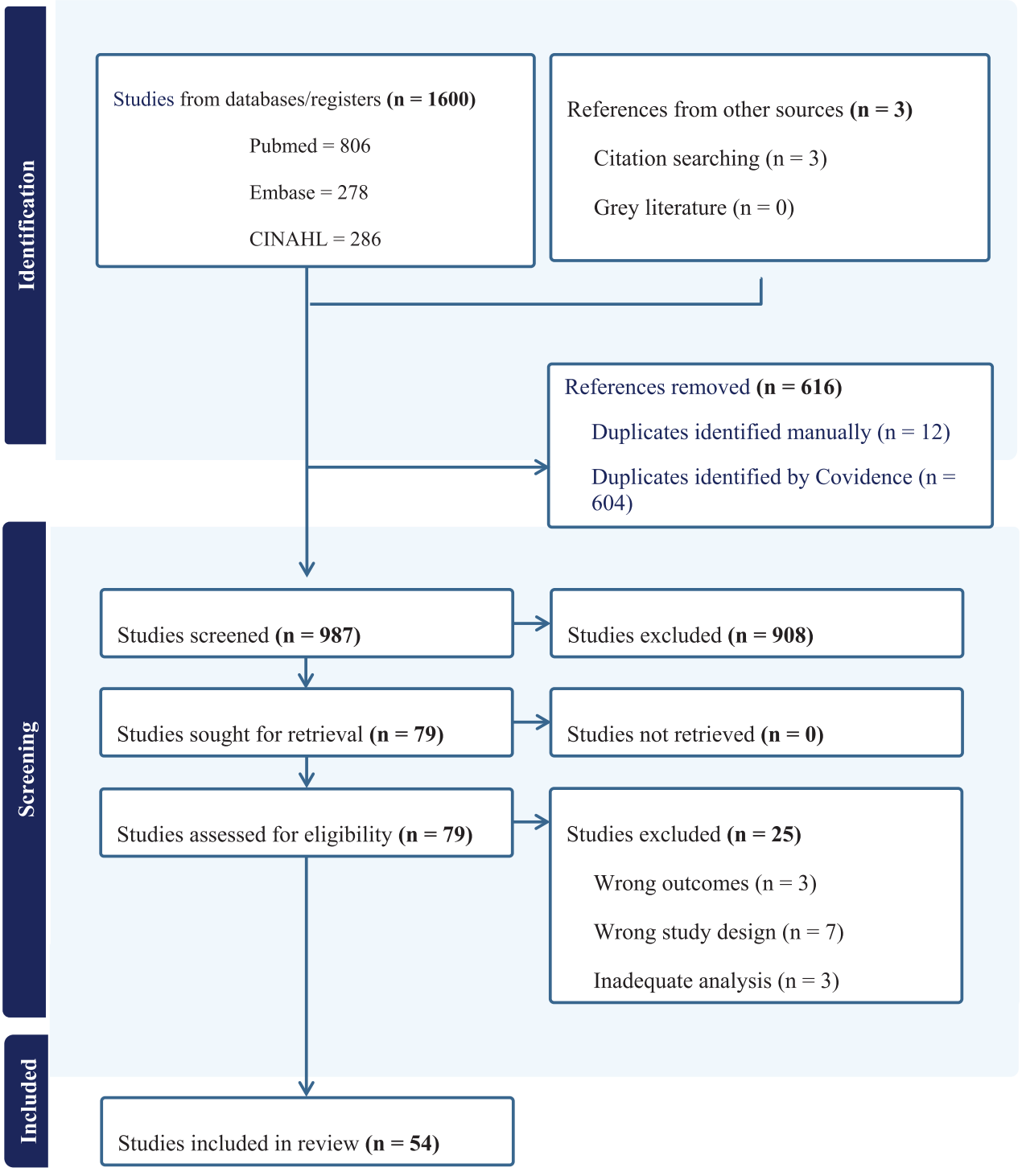
APPENDIX C (CONTINUED)

Flow Chart of Articles - Examination



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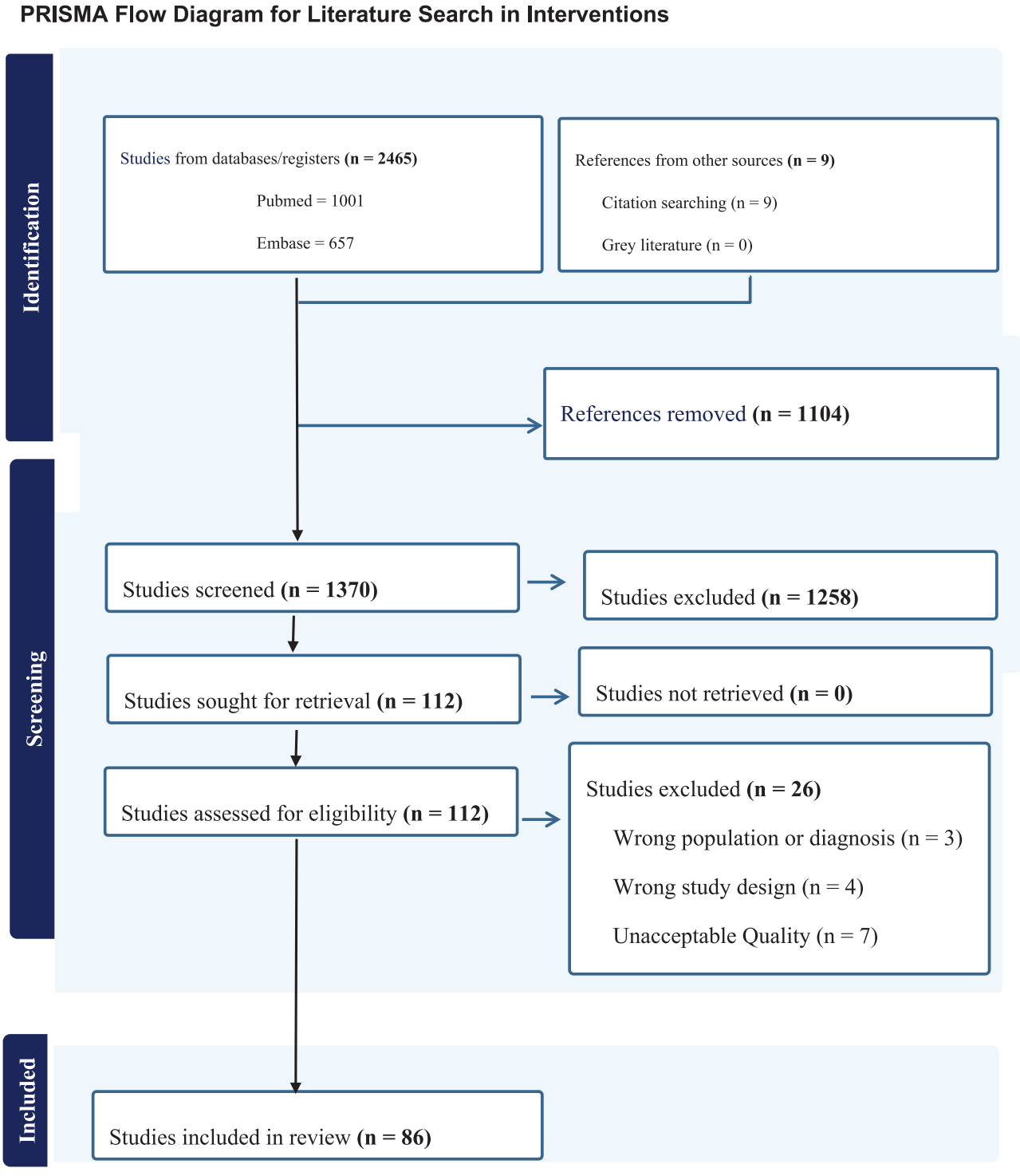
APPENDIX C (CONTINUED)



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APPENDIX D

LEVELS OF EVIDENCE TABLE[a]

Level	Intervention/Prevention	Pathoanatomic/Risk/Clinical Course/Prognosis/Differential Diagnosis	Prognosis	Prevalence of Condition/ Disorder	Exam/Outcomes
I	Systematic review of high-quality RCTs High-quality RCT[b]	Systematic review of prospective cohort studies High-quality prospective cohort study[c]	Evidence obtained from systematic reviews of inception cohort studies	Systematic review, high-quality cross-sectional studies High-quality cross-sectional study[d]	Systematic review of prospective cohort studies High-quality prospective cohort study
II	Systematic review of high-quality cohort studies High-quality cohort study[c] Outcomes study or ecological study Lower-quality RCT¶	Systematic review of retrospective cohort study Lower-quality prospective cohort study High-quality retrospective cohort study Consecutive cohort Outcomes study or ecological study	Evidence obtained from high-quality inception cohort studies	Systematic review of studies that allows relevant estimate Lower-quality cross-sectional study	Systematic review of lower-quality prospective cohort studies Lower-quality prospective cohort study
III	Systematic reviews of case-control studies High-quality case-control study Lower-quality cohort study	Lower-quality retrospective cohort study High-quality cross-sectional study Case-control study	Cohort studies or control arm of randomized trials	Local nonrandom study	High-quality cross-sectional study
IV	Case series	Case series	Case series, case-control studies, or poor quality cohort studies		Lower-quality cross-sectional study
V	Expert opinion	Expert opinion	Expert opinion	Expert opinion	Expert opinion

Abbreviation: RCT, randomized clinical trial.
[a]Adapted from the Center for Evidence-based Medicine 2009 levels of evidence. See also **APPENDIX E.**
[b]High quality includes RCTs with greater than 80% follow-up, blinding, and appropriate randomization procedures.
[c]High-quality cohort study includes greater than 80% follow-up.
[d]High-quality prevalence study is a cross-sectional study that uses a local and current random sample or censuses.

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APPENDIX E

PROCEDURES FOR ASSIGNING LEVELS OF EVIDENCE

- Level of evidence is assigned based on the study design using the Levels of Evidence table (**APPENDIX D**), assuming high quality (eg, for intervention, randomized clinical trial starts at level I).
- Study quality is assessed using the critical appraisal tool, and the study is assigned 1 of 4 overall quality ratings based on the critical appraisal results.
- Level of evidence assignment is adjusted based on the overall quality rating:
  - High quality (high confidence in the estimate/results): study remains at the assigned level of evidence (eg, if the randomized clinical trial is rated high quality, its final assignment is level I). High quality should include:
    - Randomized clinical trial with greater than 80% follow-up, blinding, and appropriate randomization procedures
    - Cohort study includes greater than 80% follow-up.
    - Diagnostic study includes consistently applied reference standards and blinding.
    - A prevalence study is a cross-sectional study that uses a local and current random sample or censuses.
  - Acceptable quality (the study does not meet requirements for high quality and weaknesses limit the confidence in the accuracy of the estimate): downgrade 1 level.
    - Based on critical appraisal results.
  - Low quality: the study has significant limitations that substantially limit confidence in the estimate: downgrade 2 levels.
    - Based on critical appraisal results.
  - Unacceptable quality: serious limitations - exclude from consideration in the guideline.
    - Based on critical appraisal results.

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