

**APTA-CSM, Orthopaedic Section**  
**Tuesday, January 22, 2013, 3:00-5:00 pm**  
**San Diego, CA.**

**FUNCTIONAL TESTING ALGORITHM AND CLINICAL DECISION MAKING FOR  
RETURN TO PLAY CRITERIA FOR THE LOWER EXTREMITY**

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- I. Introduction
- II. Importance of establishing discharge criteria: safety for patient, legal implications, etc.
- III. Literature review
- IV. **Quantitative and qualitative functional testing algorithm for clinical decision making for criteria for return to play**
- V. **Functional Testing Algorithm:**
  - Visual Analog scale
  - Basic Measurements
    - Time/soft tissue healing
    - VAS (0-10 scale) (<3+1)
    - Physical Examination
    - Anthropometric measurements
    - AROM (<10%)
    - PROM
    - Core testing
    - Quantitative & Qualitative LE-Movement assessment
    - Outcome rating scales: IKDC, KOOS, Tegner, Etc.
    - Etc.
  - Gait Evaluation
  - Sensorimotor System Testing: Kinesthetic/Proprioceptive Testing/Balance testing
    - Angular joint replication testing
    - 3-D Angular joint replication testing
  - OKC Isokinetic Testing
    - Manual Muscle Testing
    - Hand Held Dynamometer
    - Isokinetic Testing
  - Closed Kinetic Chain – Linea Isokinetic Testing
  - 2-Legged Jump Test
  - 1-Legged hop tests: single, triple, timed, cross-over
  - Sergeant Vertical Jump test
  - Lower Extremity Functional Test (LEFT): agility tests
  - Sport Specific Testing
  - Time/soft tissue healing
  - Subjective Examination

- Demographic information
- Location of symptoms
- Dominant arm
- MOI
- History: present & past
- Behavior of symptoms: rest, ADL's, work, sports, AM/PM
- Diagnostic tests & Imaging Studies
- Lab tests
- Medical systems review: questionnaire and interview (Differential DX.)
- Meds
- Previous treatments
- Previous functional status
- Patient's goals
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- **Basic Measurements**
  - Visual Analog Scale (0-10 scale) (<3+1)
  - Physical Examination
  - Observation/Posture
  - KT1000 measurements
  - Gait Evaluation
  - Related/referral Joints
  - Core testing
  - Sensorimotor System Testing (Neurological Examination): Sensation, reflexes, Kinesthetic/proprioceptive, Neural TT
  - Anthropometric measurements
  - Palpation
  - AROM (<10%)
  - PROM Physiological PROM, Accessory/Jt. Play PROM
  - Flexibility Tests
  - RROM OKC Testing (MMT, HHD) Special Tests
  - Computerized Dynamic Closed Kinetic Chain – Linea Isokinetic Testing
  - Computerized Dynamic Open Kinetic Chain – Isokinetic Testing
  - Functional Testing
  - Quantitative & Qualitative LE-Movement assessment
  - 2-Legged Jump Test
  - 1-Legged hop tests: single, triple, timed, cross-over
  - Sergeant Vertical Jump test
  - Lower Extremity Functional Test (LEFT): agility tests
  - Sport Specific Testing
  - Imaging Studies
  - Lab Studies
  - Outcome rating scales: IKDC, KOOS, Tegner, Etc.
  - Etc.

### **LOWER EXTREMITY FUNCTIONAL TESTING**

- I) Introduction to Lower Extremity Functional Tests
  - A) Characteristics of Closed Kinetic Chain Environments
- II. Correlation of Lower Extremity Functional Tests to Lower Extremity Performance and Injury
  - A) Myer et al, No Association of Time from Surgery with Functional Deficits in Athletes after ACLR. AJSM 40(10):2256-2263, 2012
  - B) Logerstedt et al, Single legged Hop Tests as Predictors of Self-Reported Knee Function after ACLR: The Delaware-Oslo Cohort Study, AJSM, 40(10):2348-2356, 2012
  - C) Wilk et al, JOSPT 1994, Correlation of concentric quadriceps peak torque to single leg hop test (r=0.41-0.62)
- III. Reliability of Lower Extremity Functional Tests
  - A) Reid et al, 2007 Phys Ther – hop tests
- IV. Reiman & Manske – Functional Testing in Human Performance – Human Kinetics 200

- V. Interpretation of Lower Extremity Functional Tests
- A) IKDC One Leg Hop Tests
  - B) Additional Hop Tests
  - C) Vertical Jump Tests
  - D) Contribution of Lower Extremity Segments to Functional Tests (Application)

**Table 4.4 Functional (Relative/Normalized) Jump and Hop Test**

	<b>Males (distance as % of height)</b>	<b>Females (distance as % of height)</b>
Jump test (R + L)	90–100	80–90
Hop test (uninjured leg)	80–90	70–80
Hop test (injured leg)	80–90	70–80

**Table 2.2 Average Relative Contributions of Lower-Extremity Segments in Vertical Jump Performance**

<b>Segment</b>	<b>Hubley and Wells 1983</b>	<b>Robertson and Fleming 1987</b>
Hip	28%	36%
Knee	49%	24%
Ankle	23%	40%

**Table 4.5 Sequence of the LEFT**

1. Forward run
2. Backward run
3. Side shuffles (both ways)
4. Cariocas (both ways)
5. Figure-eight run (both ways)
6. 45° angle cuts (outside foot, both ways)
7. 90° angle cuts (outside foot, both ways)
8. 90° crossover cuts (both ways)
9. Forward run
10. Backward run

**Table 4.6 Lower-Extremity Functional Test Descriptive Normative Data**

	<b>Norms</b>				
	<b>Males</b>			<b>Females</b>	
90 s	100 s*	125 s	120 s	135 s*	150 s

\* Average.

Case Example: Return to Sport Following ACLR in a elite junior tennis player (Case Study with application of population specific descriptive data

- A) Needs Analysis: Specificity of functional movement matched to LE Functional Tests
- B) IKDC – One leg hop test
- C) Hexagon Test
- D) Spider Test
- E) Sideways Shuffle Test

**Table 3.13 Spider Run (in seconds)**

	Female		Male	
	Adult	Junior	Adult	Junior
Excellent	<17.30	<17.10	<15.00	<14.60
Good	17.30–18.00	17.10–17.16	15.00–15.30	14.60–15.00
Average	18.00–18.30	17.16–17.34	15.30–16.00	15.00–15.40
Needs improvement	>18.30	>17.34	>16.00	>15.40

**Table 3.11 Hexagon (in seconds)**

	Female		Male	
	Adult	Junior	Adult	Junior
Excellent	<12.00	<10.48	<11.80	<11.10
Good	12.00–12.10	10.48–11.70	11.80–13.00	11.10–11.80
Average	12.10–12.40	11.70–12.30	13.00–13.50	11.80–12.70
Needs improvement	>12.40	>12.30	>13.50	>12.70

**Table 3.14 Sideways Shuffle (in seconds)**

	Female		Male	
	Adult	Junior	Adult	Junior
Excellent	<6.0	<7.0	<6.4	<5.5
Good	6.0–7.0	7.0–7.1	6.4–6.7	5.5–5.6
Average	7.0–7.3	7.1–7.4	6.7–7.0	5.6–5.7
Needs improvement	>7.3	>7.4	>7.0	>5.7

**Sport Specific Testing for the Lower Extremity in Athletes**

- I. Introduction
  - A. Knee Injuries are common in sports & strenuous work environments
    - a. ACL injuries in the USA annually
  - B. When can I...
    - a. Begin to run?
    - b. Initiate sport specific drills
    - c. Return to play
      - How do we as clinicians determine when a patient is ready?
  - C. Decision to return to sport specific activities based on numerous factors
    - a. Type of sports
      - i. High risk sports
      - ii. Moderate risk sports
      - iii. Low risk sports
      - iv. Also, position of the athlete in that sport varies / demands
    - b. Decision to initiate sport specific drills & sports
      - i. Based on several potential factors
        - 1. What the clinician thinks (Physician says it's ok to start)
        - 2. Subjective information from patient (how they feel)
        - 3. Pathology specific (healing constraints etc.)
        - 4. Objective testing (functional tests, strength, etc...)
        - 5. Rehabilitation progression

II. What do we use

A. We use a combination of Objective & subjective data points to decide if someone is ready to initiate sport specific training or return to sports

B. Specific data points:

- a. Noyes subjective knee rating scale (CKRS)
- b. Knee laxity testing (manual & mechanical)
- c. Isokinetic testing (specific criteria)
- d. Hop test (for some athletes but not all)
- e. Sport specific testing on field
- f. Return to sport specific activities or sports (play) is also based on rehabilitation progression, symptoms, and patient's limb confidence

C. Specific Tests & References

- a. Subjective Knee Scores:
  - i. Cincinnati Knee Rating Scale (CKRS)  
Barber & Noyes AJSM '99  
Noyes, Barber, Mangine: JBJS '90
  - ii. International Knee Documentation Committee (IKDC)  
Irrgang et al: AJSM '01  
Irrgang et al: AJSM '06
- b. Knee Laxity testing (Knee Arthrometer Testing)  
Shelbourne et al: AJSM '91  
Daniel et al: AJSM '85

Our Goal: <2.5 mm of uninvolved knee

c. Isokinetic Testing

Wilk et al: JOSPT '94

Davies: Compendium of Isokinetics '92

There exists a correlation between isokinetics & function!!

Our Goals:

1; QPT/BW ratio: Males: 60-65%, Females 50-55%

2: H/Q ratio: Males: 66-72%, Females: 75%>

3: QPT @ .2 sec: 80% or more of peak torque

4: Fatigue ratios: at 300 o/sec: Quads 15% or >, Hamstrings 10%>

Wilk et al: JOSPT '94

Wilk et al: JOSPT '12

d. Hop Test

Noyes et al: AJSM '91

Fitzgerald et al: JOSPT '01

Rudolph et al: Knee Surg Sports Traumatol Athros '00

Our Goals: 85% of the uninvolved side  
(Especially on repeated jumps)

e. Rehabilitation progression:

Our goals: have performed the following without problems/pain

- 1) Front step down from 8 inch step
- 2) Successful perturbation test
- 3) 4 corner test
- 4) Reaction test
- 5) Running without difficulty, or abnormality

f. Functional sport specific drills

NFLE Players Following Injury:

LE Functional Test: (Filmed)

- 1) 10 yd forward/backward running
- 2) 10 yd side shuffle
- 3) 10 yd high knee carcoca
- 4) 10 yd shuffle change of direction
- 5) 35 yd shuttle run with abrupt stop

g. Patient confidence

Chmielewski et al: Phys Ther '11

Chmielewski et al: JOSPT '11

Lentz et al: J Sports Health '07

III. What do others use

A. Other methods of testing:

- a. Single leg leg press – bilateral comparison
- b. LEFT test - (*Davies*)
- c. Step & holds (30 reps) – (*Irrgang*)
- d. Step down test – 12 inch step down to parallel (*Boyle*)
- e. Run 1 mile on treadmill

IV. Conclusions:

a. Key Points:

- i. No consensus on which test(s) are best or most reliable/valid
- ii. No consensus on which values to use
- iii. Numerous really excellent test methods available
- iv. What's appropriate for your practice  
*Professional Athlete ----- Recreational Athlete*  
*Football Player ----- Basketball Player*
- v. If you do test – you will not know if a deficit exists
- vi. ***We need objective criteria***

V. Outcomes

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