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. 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.
  - 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

- 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/proprrioceptive, 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.

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
   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

<table>
<thead>
<tr>
<th></th>
<th>Males (distance as % of height)</th>
<th>Females (distance as % of height)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jump test (R + L)</td>
<td>90–100</td>
<td>80–90</td>
</tr>
<tr>
<td>Hop test (uninjured leg)</td>
<td>80–90</td>
<td>70–80</td>
</tr>
<tr>
<td>Hop test (injured leg)</td>
<td>80–90</td>
<td>70–80</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Segment</th>
<th>Hubley and Wells 1983</th>
<th>Robertson and Fleming 1987</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip</td>
<td>28%</td>
<td>36%</td>
</tr>
<tr>
<td>Knee</td>
<td>49%</td>
<td>24%</td>
</tr>
<tr>
<td>Ankle</td>
<td>23%</td>
<td>40%</td>
</tr>
</tbody>
</table>

### 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

<table>
<thead>
<tr>
<th>Males</th>
<th>Norms</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 s</td>
<td>100 s*</td>
<td>125 s</td>
</tr>
<tr>
<td></td>
<td>120 s</td>
<td>135 s*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150 s</td>
</tr>
</tbody>
</table>

* Average.
Case Example: Return to Sport Following ACLR in an 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

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

1. **Introduction**
   A. Knee injuries are common in sports & strenuous work environments
      i. 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
         International Knee Documentation Committee (IKDC)
         Irrgang et al: AJSM '01
         Irrgang et al: AJSM '06
      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

   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:

<table>
<thead>
<tr>
<th>Our goals: have performed the following without problems/pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Front step down from 8 inch step</td>
</tr>
<tr>
<td>2) Successful perturbation test</td>
</tr>
<tr>
<td>3) 4 corner test</td>
</tr>
<tr>
<td>4) Reaction test</td>
</tr>
<tr>
<td>5) Running without difficulty, or abnormality</td>
</tr>
</tbody>
</table>

f. Functional sport specific drills

<table>
<thead>
<tr>
<th>NFLE Players Following Injury:</th>
</tr>
</thead>
<tbody>
<tr>
<td>LE Functional Test: (Filmed)</td>
</tr>
<tr>
<td>1) 10 yd forward/backward running</td>
</tr>
<tr>
<td>2) 10 yd side shuffle</td>
</tr>
<tr>
<td>3) 10 yd high knee caroca</td>
</tr>
<tr>
<td>4) 10 yd shuffle change of direction</td>
</tr>
<tr>
<td>5) 35 yd shuttle run with abrupt stop</td>
</tr>
</tbody>
</table>

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

References:


Barber-Westin, SD, Noyes, FR. Factors used to determine return to unrestricted sports activities after ACL-R. Arthroscopy. 27:1697-1705, 2011


Versteegen, M, et.al. Suggestions from the field for return to sports participation following ACL-R: American football. JOSPT. 42:337-344, 2012


Myer, GD, et.al. An integrated approach to change the outcome Part II: Targeted neuromuscular training techniques to reduce identified ACL injury risk factors. JSCR. 26:2272-2292, 2012

Barber-Westin, SD, Noyes, FR. Factors used to determine return to unrestricted sports activities after ACL-R. Arthroscopy. 27:1697-1705, 2011


