Proper Evaluation Techniques for the Upper and Lower Extremities: An Evidence Based Approach

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Objectives

• After the presentation, the viewer should be able to discuss:
  – Basic concepts related to biostatistical analysis
  – Scientific validity of common physical exam tests
  – Techniques, pearls, and pitfalls of physical examination of the knee and shoulder
History is key to physical exam

TO BE COMPLETELY HONEST, I HAVE NO IDEA WHAT I'M LOOKING FOR IN HERE.
Sensitivity vs Specificity

• Sensitivity
  – Percentage of patients with the condition that have a positive test
  – A Sensitive test helps rule out disease (when the result is negative). Sensitivity rule out - "Snout"

• Specificity
  – Percentage of patients without the condition that have a negative test
  – A very specific test rules in disease with a high degree of confidence. Specificity rule in - "Spin"
Likelihood Ratios

- **LR+**
  - Dictates how much the odds of the disease increase when a test is **POSITIVE**

- **LR-**
  - Dictates how much the odds of the condition decrease when a test is **NEGATIVE**
## 2 x 2 Table

<table>
<thead>
<tr>
<th></th>
<th>Disease +</th>
<th>Disease -</th>
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<tbody>
<tr>
<td><strong>Test</strong></td>
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<tr>
<td>+</td>
<td>True +</td>
<td>False +</td>
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<td>(a)</td>
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<tr>
<td>-</td>
<td>False -</td>
<td>True -</td>
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<tr>
<td></td>
<td>(c)</td>
<td>(d)</td>
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**Sensitivity**
\[
\text{Sensitivity} = \frac{a}{a + c} = \frac{\text{TP}}{\text{TP} + \text{FN}}
\]

**Specificity**
\[
\text{Specificity} = \frac{d}{b + d} = \frac{\text{TN}}{\text{FP} + \text{TN}}
\]
Physical exam

• Inspection
• ROM
• Palpation
• Stability
• Special tests
Inspection/ROM

• Effusion
  – Ballotment vs minimal effusion test
• Atrophy
• Scars
• Alignment
Patellofemoral Grind/Compression

- Described by Kulowski in 1933
- Varying descriptions
- (+) test?
- No data for sensitivity/specificity

Patellar Instability

- Fairbanks apprehension test
- Hughston, 1968
- 1996 – Sallay et al 39% sensitive
  - 83% large effusion
  - 70% tenderness of MPFL

Lachman Test

• Described originally by Torg et al
  – 95% sensitive (88 of 93 individuals)

• Numerous studies
  – Range of sensitivity from 80-90%
  – Specificity of 95% under anesthesia

• Most sensitive and specific test for diagnosis of ACL tears

Lachman Test Pitfalls

- Small hands, Large thighs
- Modifications?
  - Prone vs. Stabilized
- Little research on reliability of modified exams

Anterior Drawer

• George Noulis describes in 1875 thesis
  – “abnormal anterior-posterior mobility”
• Acute vs chronic and awake vs anesthesia
  – 22-41% and 50-95% respectively
• False (-) and False (+)

Posterior Sag/Drawer

- Mayo Robson – 1903
- Rubenstein et al publishes DB/RCT in 1994
  - Sensitivity 79%
  - Specificity 100%
- Paessler and Michel recount original description by Noulis in 1992
  - Redefinition of flexion
- Rubenstein et al RCT
  - “Most accurate test”
    - Sensitivity 90%
    - Specificity 99%

Pivot shift test

• Groves and Palmer published photographs in 1920 and 1938
• Initial description of the test – 1972 by Galway et al

Pivot shift test (cont.)

- Lucie et al
  - Sensitivity: 95%
- Katz and Fingeroth
  - Sensitivity: 98.4%
  - Specificity: >98%
- Donaldson et al
  - Sensitivity: 35%
  - Sensitivity (UA): 98%

The “Lever Sign”

- Dr. Alessandro Lelli described in 2005 and published in 2014
- “….diagnostic for both partial and complete tears of the ACL regardless of elapsed time from injury.”
Lever Sign description

- The patient is placed supine with the knees fully extended on a hard surface such as the examining table. The examiner stands at the side of the patient and places a closed fist under the proximal third of the calf. This causes the knee to flex slightly. With his other hand, he applies moderate downward force to the distal third of the quadriceps.

Fig. 1  a Force diagram of negative Lever Sign test. With the fist acting as a fulcrum under the calf and a second hand pushing down on the quadriceps (large arrow), the ACL is able to counteract the downward force on the foot due to gravity (small arrow). b Force diagram of positive Lever Sign test. With the fist acting as a fulcrum under the calf and a second hand pushing down on the quadriceps (large arrow), the ruptured ACL is not able to counteract the downward force on the foot and the foot remains on the examination table (small arrow).
The “Lever Sign” (cont.)

• Prospective study of 400 patients with MRI findings of ACL injury
• 4 groups
  – Acute phase with (+) full thickness injury on MRI
  – Chronic phase with (+) full thickness injury on MRI
  – Acute phase with partial injury on MRI
  – Chronic phase with partial injury on MRI
• Uninjured knee as control
• Performed Lachman, Anterior drawer, Pivot shift, and Lever Sign test.

Results

• Mean sensitivity data
  – Lachmans: 0.62
  – Ant Drawer: 0.72
  – Pivot Shift: 0.47
  – Lever Sign: 1.00

Table 2: Percentage of patients successfully diagnosed with the three most common physical examinations and the proposed Lever Sign test

<table>
<thead>
<tr>
<th>Group</th>
<th>Lachman test (%)</th>
<th>Anterior Drawer test (%)</th>
<th>Pivot Shift test (%)</th>
<th>Lever Sign test (%)</th>
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<tbody>
<tr>
<td>A</td>
<td>66 %</td>
<td>75 %</td>
<td>23 %</td>
<td>100</td>
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<tr>
<td>B</td>
<td>100 %</td>
<td>100 %</td>
<td>98 %</td>
<td>100</td>
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<td>C</td>
<td>42 %</td>
<td>29 %</td>
<td>11 %</td>
<td>100</td>
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<td>D</td>
<td>39 %</td>
<td>83 %</td>
<td>56 %</td>
<td>100</td>
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<tr>
<td>Contralateral knees</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
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</table>

Group A (n = 100) comprised patients with an acute, complete tear of the ACL, while group B (n = 100) comprised patients with chronic, complete tears. Group C (n = 100) comprised patients with acute, partial tears and group D (n = 100) comprised patients with chronic, partial tears. All tears were unilateral, but only the Lever Sign test was performed on the uninjured (contralateral) knees (n = 400).
Lever Sign Discussion

• Single clinician bias?
• Subjective nature of special testing
• Learning curve?
• No specificity data on controls
• Level III evidence
Varus and Valgus stress tests

• Unclear origination but Palmer describes “abduction and adduction rocking” in 1938

• Valgus stress
  – Hughston et al 1976
    • (+) at 30° and (-) at 0°
      – MCL +/- post capsule
    • (+) at 0°
      – PCL + medial ligaments
  – Sensitivity: 86-96%
  – Specificity: Not reported

• Varus stress
  – Isolated injuries rare
  – Little data
  – Marshall and Rubin (1977)
    • (+) in flexion – LCL only
    • (+) in ext – combination injury (LCL, popliteus, cruciates)

Meniscal Tears

- Difficult clinical diagnosis
- Largely avascular and uninervated
- 1803 – Hey describes “internal derangement”
- McMurray describes testing in 1940

Hey W. Practical observations in surgery. Philadelphia: James Humphreys; 1805
Meniscal Injuries

- Joint line tenderness
- McMurray test
- Apley grind test
- Thessaly test
Joint Line Tenderness

• Sensitivity ranges: 55% - 85%
• Specificity ranges: 29% - 67%
• Clinical implications?

Fowler PJ, Lubliner JA. The predictive value of five clinical signs in the evaluation of meniscal pathology. Arthroscopy 1989; 5:184-6
McMurray Test

- Originally described in 1940
- 4 prospective evaluations since:
  - Anderson and Lipscomb (AJSM 1986)
    - Sensitivity: 58%
    - Specificity: Not defined
  - Fowler and Lubliner (Arthroscopy 1989)
    - Sensitivity: 29%
    - Specificity: 95%
  - Evans et al (AJSM 1993)
    - Sensitivity: 16%
    - Specificity: 98%
  - Kurosaka et al (Int Orthop 1999)
    - Sensitivity: 37%
    - Specificity: 77%
Apley Grind Test

• Described by Apley in 1947
• Test description:
  – Distraction (+): “rotation sprain”
  – Compression(+): meniscal damage
• Fowler et al
  – Sensitivity: 16% Specificity: 80%
• Kurosaka et al
  – Sensitivity: 13% Specificity: 90%
  – “Overall accuracy of 28%”

Gould JA, Dabies GJ. Orthopaedic and sports physical therapy. Toronto: CV Mosby; 1985
Fowler PJ, Lubliner JA. The predictive value of five clinical signs in the evaluation of meniscal pathology. Arthroscopy 1989; 5:184-6
Thessaly Test

- Published in 2005 by Karachalios et al (JBJS)
- All knees >4 weeks from injury
- Average age 30
- Performed at 5° and 20°

Thessaly Test Results

- At 20° has low rates of false positive and false negative
- First line screening exam
- Decreased cost of diagnostic imaging

<table>
<thead>
<tr>
<th></th>
<th>Thessaly test at 5° of flexion</th>
<th>Thessaly test at 20° of flexion</th>
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<tbody>
<tr>
<td>Sensitivity</td>
<td>66%</td>
<td>89%</td>
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<tr>
<td>Specificity</td>
<td>96%</td>
<td>97%</td>
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<tr>
<td>False positive</td>
<td>2.9%</td>
<td>2.2%</td>
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<tr>
<td>False negative</td>
<td>11.4%</td>
<td>3.6%</td>
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<tr>
<td>Accuracy</td>
<td>86%</td>
<td>94%</td>
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</tbody>
</table>

Sensitivity: The percentage of test results that are true positives. Specificity: The percentage of test results that are true negatives. False positive: The percentage of false alarms. False negative: The percentage of missed cases. Accuracy: The overall accuracy of the test.
# Systematic Review of Meniscal Tests

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean age (range)</th>
<th>Mean symptom duration</th>
<th>Number and sex</th>
<th>Criterion standard</th>
<th>Affected meniscus</th>
<th>Test(s)</th>
<th>SN</th>
<th>SP</th>
<th>LR+</th>
<th>LR−</th>
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<tr>
<td>Akseki <em>et al</em>[^29]</td>
<td>35.7 (17–73)</td>
<td>32.4 months</td>
<td>110M 40F</td>
<td>Arthroscopy</td>
<td>Med</td>
<td>McMurray’s</td>
<td>0.67</td>
<td>0.69</td>
<td>2.16</td>
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<td>Lat</td>
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<td>JLT</td>
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<td>Corea <em>et al</em>[^67]</td>
<td>25.3 (18–40)</td>
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<td>93 sex not stated</td>
<td>Arthroscopy/arthrotomy</td>
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<td>Eren[^30]</td>
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<td>Galli <em>et al</em>[^31]</td>
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<td>0.84</td>
<td>0.71</td>
<td>2.93</td>
<td>0.23</td>
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</tbody>
</table>
Thessaly investigated

- Konan et al could not reproduce original data published by Karachalios et al (2009)
- Mirzatolooei et al also evaluated in ACL deficient knees
  - Sensitivity: 79%
  - Specificity: 40%

The more I know
the less I understand.
All the things I thought
I figured out
I have to learn again.

iliketoquote.com

I feel like it's getting complicated
now that we are trying
not to complicate
things.
Break
Physical Examination of the Shoulder

• Inspection
• ROM
• Palpation
• Special testing:
  – Rotator Cuff exam
  – Instability exam
  – Scapulothoracic exam
Inspection

- Appropriate exposure
- View posteriorly
- Static vs dynamic
ROM Evaluation

• Active FE/ABD/IR/ER
  – Bilateral comparison
  – Document arc of motion for throwers

• If ↓ ROM:
  – Pain?
  – Neuro?
  – Don’t forget supine exam!!
Palpation

• Bony landmarks:
  – Sternoclavicular joint
  – AC joint
  – Acromion
  – Coracoid process
  – Bicipital groove
  – Greater tuberosity
“Rotator Cuff” exam

• Many coexisting pathologies
• Include:
  – AC joint pathology
  – Subacromial impingement
  – Biceps pathology
  – Rotator cuff tears
AC Joint pathology

- Acute vs. Chronic
- Cross body adduction
  - Jia et al reported in 2009 a sensitivity and specificity of 77% and 79% respectively
- Beware of active compression test (O’Brien)

Neer Impingement Test

- Originally described in 1983
- Pain in “arc of motion” 70-130°
- Several authors have investigated
  - Sensitivity ranges from 54-64%
  - Specificity from 30-95%

Hawkins Sign

• Hawkins and Kennedy published in 1980 impingement as a clinical “syndrome”
  – Stage I - edema and hemorrhage
  – Stage II - fibrosis and tendonitis
  – Stage III - tendon degeneration, bony changes, and tendon ruptures

• Original description included flexing the shoulder with forcible IR which “jams the greater tuberosity on the undersurface of the acromion”

Hawkins Sign

• Kelly et al
  – 74%/50%
• Michener et al
  – 63%/62%
• Silva et al
  – 74%/40%
• Fodor et al
  – 72%/89%

Proximal biceps pathology

• Speed’s Test
• William Bennett, M.D. later published study in 1998 which revealed sensitivity of 90% and specificity of 13.8%
• Hegedus et al
  – Sensitivity: 50-70%
  – Specificity: 69-81%

Bennett WF. Specificity of the Speed’s test: arthroscopic technique for evaluating the biceps tendon at the level of the bicipital groove. Arthroscopy 1998;14(8):789-96
Hegedus EJ. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. Br J Sports Med 2012;46:964-78
Proximal biceps pathology

• Yergason’s Test
  – “Supination sign” - 1931

• Holtby et al compare Speeds and Yergasons in Arthroscopy (2004)
  – 43%, 79%, 60%, and 65%

• A review of tests in 2010 by Karlsson
  – Only test that passed study criteria were Speed’s and Yergasons
    • Sensitivity 32%/43%
    • Specificity of 79%/75%

RC Tears: Contribution of clinical tests

- Jobe Drop-arm
- Empty can vs. Full can
- ER strength
- ERLS
- Lift-off
- Belly press
Jobe Drop-arm

- Published in 1983 and thought to help diagnose pathology of supraspinatus tendon
- Noel et al demonstrated 95% sensitivity when studied in 1989
- 1999 – Itoi et al looked at pain AND weakness
  - (+)Pain – 63%/55%
  - (+)Weakness – 77%/68%
- 2010 – Bak et al evaluated and found to be 41% sensitive and 83% specific for FTT

Itoi E, Kido T, Sano A, et al. Which is more useful, the “full can test” or the “empty can test”, in detecting the torn supraspinatus tendon? Am J Sports Med 1999;27:65-8
Itoi E, Kido T, Sano A, et al. Which is more useful, the “full can test” or the “empty can test”, in detecting the torn supraspinatus tendon? Am J Sports Med 1999;27:65-8
External Rotation Lag Sign (ERLS)

• Described in 1996 by Hertel et al in hopes of ↓ pain effect of testing outcome
  – >90% sensitivity, 100% specificity
• 2009 Castoldi et al re-examined ERLS
  – FTT (SS): 56%/98%
  – FTT (IS): 97%/93%
  – FTT(TM): 100%/93%

Internal Rotation Lag Sign (IRLS)

• Published by Hertel at the same time as the ERLS (1996)
  – PPV: 97%
  – NPV: 96%

• Miller demonstrated similar results in 2008 for IRLS
  – 84% specificity
  – 100% sensitive (NLR of 0)

Lift-off Test

- Gerber popularized in 1991 with case series of 16 patients
- Barth et al (2012) performed a prospective multi-center study
  - 18% couldn’t perform
  - Sensitivity: 74%
  - Specificity not reported

Belly-press/Bear Hug

• Gerber reports slightly improved sensitivity with BPT compared to LOT (76%)
• 25% of tears still unrecognized until arthroscopy

• 2006 – Barth and Burkhart develop and publish the BHT
  – Upper 2/3 of subscap
  – Improved sensitivity (82%)

“Instability” Exam

• SLAP Tears
• Anterior Instability
• Posterior Instability
• MDI
Active Compression/O’Brien

- Originally described by O’Brien in 1998
- Prospective study on 318 patients
  - Sensitivity: 100%
  - Specificity: 98.5%
  - PPV: 94.6%
  - NPV: 100%

• Stetson and Templin (2002)
  – S/S: 54%/31%

• Guanche and Jones (2003)
  – S/S: 63%/73%

Dynamic Labral Shear Test (DLS)

- O’Driscoll – 1999
- Evaluated in 2009 by Kibler et al
  - Thought to recreate “peel back” position
    - Sensitivity: 72%
    - Specificity: 98%

SLAP tears (cont.)

• 2012 – Cook et al examined 5 common orthopedic tests for SLAP tears

Shoulder Instability

- Dating back to ~300 BC – Hippocrates
- TUBS vs AMBRI
  - Anterior vs. Posterior vs. Multidirectional
    - Patients report about 95% correctly
- Clinical history imperative
  - Arm position? Severity of trauma?
Anterior Instability

• Apprehension/Relocation
  – Originally described by Jobe in late 80’s
  – Surprise/release test added in 1994
  – Interpretation for internal impingement

• Evaluated by Speer et al in 1994
  – Specificity <50% when response was pain
  – Specificity >80% when response was apprehension

• Lo et al reevaluated in 2004
  – Sensitivity of 53%, 45%, and 64%
  – Specificity of 99%, 54%, and 99%

Load and Shift Test

- Description of test by Hawkins et al in 1993
- Seated vs Supine
- Grading system:
  - I: up the face to the rim
  - II: over the rim but spontaneously reduces
  - III: over the rim and dislocates
- Sensitivity: 72%
- Specificity: 90%

MDI and Ligamentous Laxity

- Well described in early 80’s by Neer
- Excess inferior capsular volume?

- Sulcus sign
- Hyperextensible tissue testing
- Gagey Test
  - \( > \) or \( < 90^\circ \)
- Beware the young patient with voluntary instability

Final Wrap Up

• History is the key
• Appropriate exposure
• Reproduce patient complaints
• Multiple tests
• Stay informed of ever changing techniques