Plyometrics
Plyometric upper extremity research agenda
(Modeling after LE)
CKC-UE
OKC-UE-Plyos

Plyometrics
Comparison of ground reaction forces between four plyometric pushup variations
Koch, J, Riemann, BL, Davies, GJ

Methods
- Electromagnetic tracking system captured kinetics
  - trunk
  - dominant arm
  - both hands
- Kinetics measured using two ATMI force plates

Push-Up Variations
BD1: 3.8 cm (1.5 in)
BD2: 7.6 cm (3.0 in)
BD3: 11.4 cm (4.5 in)
CPU

Plyometric Push-Ups

Plyometric Clap Push-Ups

Peak Forces

UE Plyometrics
Kinematic and Kinetic Analysis of Four Plyometric Push-Up Variations
Moore, LH, Tankovich, MJ, Riemann, BL, Davies, GJ
Biodynamics and Human Performance Center
Armstrong Atlantic State University
Savannah, Georgia
Future Research

Kinetics: Gold standard for LE power
- Vertical jump VGRF measures
- using two force plates
- Replicate testing for the UE

Research Agenda

- One of the goals of the plyometric pushup research is to develop a classification system and a hierarchy of plyometric exercises for the upper extremity
- There are numerous examples and guidelines for lower extremity
- However, there is no research and no guidelines for the upper extremity

Hierarchy of plyometric exercises for the upper extremity

<table>
<thead>
<tr>
<th>Low-Level Intensity</th>
<th>Medium-Level Intensity</th>
<th>High-Level Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>OKC - 1-arm Plyoback Activities</td>
<td>OKC - 1-arm Plyoback Activities (arm at side)</td>
<td>OKC - High depth Drop Box Plyos</td>
</tr>
<tr>
<td>OKC - Push-ups</td>
<td>OKC - low depth Drop Box Plyos</td>
<td>OKC - Clap Pushups</td>
</tr>
</tbody>
</table>

Why use OKC tests for the U.E.?

- Sport Specific Testing
- Undercoffler Overhand Softball Throw for Distance
- Functional Throwing Performance Index
- 3-Arm Seated Shot Put - Medicine Ball Power Test
- Closed Kinetic Chain - Upper Extremity Stability Test
- OKC 3-D muscle power testing - BBI
- OKC Isokinetic Testing
- Sensorimotor System Testing: Kinesthetic/Proprioceptive Testing
- Basic Measurements
- Visual Analog scale

Functional Testing Algorithm - Shoulder - 2013

- Closed Kinetic Chain - Upper Extremity Stability Test
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Strength and Power Assessment for Shoulder

Lack of research correlating U.E.

- There is a need for a device or protocol to discriminate performance within an athletic population

Functional Testing Algorithm

Last few years we have been searching for a reliable, valid, responsive, minimal equipment, easy to administer U.E. power test

(Field Test)

Multi-Center Research

- Subjects: 180 healthy adults (13-45 yo) (111 females, 69 males)
- AAGU, Florida Hospital Celebration, U Central Florida
- Athletes = 83; Non-athletes = 97
- Ansley, M, McBride, B, Overstreet, A, Davies, G, Riemann, BL.
- Multicenter study for the correlation between field tests of upper extremity function and power.
- AAGU, DPT Capstone Project, 2009
Multi-Center Research

- UE Functional tests:
  - 3-arm seated shot put DOM arm - (66)
  - 1-arm seated shot put NDOM arm - (66)
  - Push up tests for 3 sets of 15 seconds
  - Modified pull-up test for 3 sets of 15 seconds
  - Underkoffler Overhand Softball throw for distance using the 1-step (crow hop) throw approach
  - Davies closed kinetic chain upper extremity stability test for 3 sets of 15 seconds
- Analyses, M, McBride, B, Overstreet, A, Davies, GJ, Riemann, BL
- Multicenter study for the correlation between field tests of upper extremity function and power.
  - AASU, DPT Capstone Project, 2009

Functional Testing Algorithm

1. Seated Shot Put - medicine ball - U.E. power test
   Analogous to single-leg hop test

Seated Shot Put Reliability and Validity

- 57 males
- Bench power test by moving 50 lbs through extension of arms with distance and time measured compared to 6 lb seated shot put distance with angle of release controlled and not controlled.
- Found to be reliable and valid for both controlled and uncontrolled angle of release.

One-arm seated shot-put throw

- 6 lb ball was placed in dominant hand, palm up with 0° of shoulder abduction
- 4 gradient sub-max to max warm-up throws
- 3 maximal effort throws
- Average recorded to the nearest meter
One-arm seated shot-put throw
- 46 subjects - Reliability - ICC's
- Seated shot put tests (64) - DOM: 0.988
- Seated shot put tests (64) - NDOM: 0.971
- Negrete, RJ, Hanney, WJ, Kolber, MJ, Davies, GJ, et.al. Reliability, minimal detectable change and normative values for tests of upper extremity function and power.

Research, NAJ SPT, 2011
- Multi-Center Study:
  - 180 subjects - normative values for power tests of Upper Extremity
- Negrete, RJ, Davide, GJ, Hanney, WJ, Riemann, BL. Modified pull-up is the best predictor of a softball throw for distance.

Research, JSCR, 2010
- Minimal Detectable Changes (MDC)
- Seated shot put tests - DOM: 17 inches
- Seated shot put tests - NDOM: 18 inches
- Negrete, RJ, Hanney, WJ, Kolber, MJ, Davies, GJ, et.al. Reliability, minimal detectable change and normative values for tests of upper extremity function and power.

Overhead Athletes
- BASICS OF THE THROWING MOTION

Seated Shot Put - Power Test - D/ND or U/I
- <10% bilateral comparison
- Norms:
  - MDC: D-17
  - MDC: ND-18
- Descriptive norms:

Normative Data Interpretation
- Males:
  - Ht: 181 cm.
  - Ht: 71 in.
  - Wt: 82 lbs.
  - Wt: 180 lbs.
- Dom-SSP: 118 in/ 46 cm (10%)
- NDom-SSP: 106 in/ 42 cm (LSI)

Seated Medicine Ball Throw
- Example: Males, Dom Arm
- Distance/height:
  - 46 cm / 181 cm = 25% ± SD
- Distance/height:
  - 46 cm / 180 lbs = 26% ± SD

Normative Data Interpretation
- Males:
  - Distance/height:
    - 118 in / 181 cm = 65% ± SD
    - 118 in / 71 in = 1.66% ± SD
    - 46 cm / 181 cm = 25% ± SD
    - 46 cm / 71 in = 65% ± SD
  - Distance/1/2 height:
    - 118 in / 91 cm = 3.30% ± SD
    - 118 in / 36 in = 3.3% ± SD
  - Distance/weight:
    - 118 in / 82 kg = 1.44% ± SD
    - 118 in / 180 lbs = 66% ± SD
    - 46 cm / 82 kg = 56% ± SD
    - 46 cm / 180 lbs = 26% ± SD

Normative Data Interpretation
- Test-retest reliability for the SMBT was r=0.958
- Test-retest reliability for the explosive push up (EPU) was r=0.844
- The SMBT is an inexpensive, safe, and repeatable measure of upper body power for the older adult (72.4±5.2 years).
Seated Shot Put, 2012

Martin, CS, et.al. Allometric scaling of body mass is a predictor of distance thrown on the unilateral seated shot put test. JOSPT. 42:SPL42, 2012

Functional Testing Algorithm - Shoulder -2013
- Sport Specific Testing
- Underkoffler Overhand Softball Throw for Distance
- Functional Throwing Performance Index
- 3-Arm Seated Shot Put - Medicine Ball Power Test
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- Basic Measurements
- Visual Analog scale

Biomechanical Analysis
- Qualitative analysis
- Quantitative analysis

Why use OKC tests for the U.E.?

Functional Testing Algorithm
- Testing
  - Lab Tests
  - Clinical Field Tests

Functional Testing Algorithm - Functional Throwing Performance Index (FTPI)
**Functional Throwing Performance Index**

- Line on floor - 15' from wall, 1' x 1' square, 4' from floor
- 4 sub-max to max controlled gradient warm-ups (25/50/75/100%)
- Controlled maximum number of accurate throws in 30 seconds
- 3 sets
- Divide total number/accurate number of throws x 100 = %

**Norms**

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
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<tbody>
<tr>
<td>Throws</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>Accuracy</td>
<td>7</td>
<td>4</td>
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<tr>
<td>FTPI</td>
<td>47%</td>
<td>29%</td>
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<tr>
<td>Range</td>
<td>33-60%</td>
<td>17-41%</td>
</tr>
</tbody>
</table>

**Performance Index Functional Throwing**

- ICC's - > .90
- Davies, GJ, et.al. JOSPT, 1993
- Malone, T, et.al (Master's Thesis)
- 1 month interval between tests:
- ICC's - > .80
- 1995

**Functiona Testing Algorithm - Shoulder - 2013**

- Sport Specific Testing
- Underkoffler Overhand Softball Throw for Distance
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- Basic Measurements
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**Underkoffler Overhand Softball Throw for Distance**

- 4 gradient sub-max to max warm-up throws
- 3 maximal volitional testing repetitions
- average was recorded to the nearest meter

Reliability study:
ICCs: .90
Collins, et. al. (1978)

Criteria:
Normative data
Test-retest data

Functional Testing Algorithm - Shoulder - 2013
- Sport Specific Testing
- Underkoffler Overhand Softball Throw for Distance
- Functional Throwing Performance Index
- 1-Arm Seated Shot Put - Medicine Ball Power Test
- Closed Kinetic Chain - Upper Extremity Stability Test
- OKC 3-D muscle power testing - BMI
- OKC Isokinetic Testing
- Sensorimotor System Testing: Kinesthetic/Proprioceptive Testing
- Basic Measurements
- Visual Analog scale

In Search for the Gold Standard
Rex, at. al. Power testing of the upper extremity.
Searching for reliable, valid, responsive, minimal equipment needed, easy to administer UE power tests that can be used as field tests.
Compared and looking for correlations between:
1) force plate kinetics
2) CKCUEST
3) velocity spectrum power profile isokinetic testing of the shoulder muscles
4) seated shot put power test
5) upper extremity dynamic balance test.

Specificity Testing
- This is individualized to the patient and his/her specific recreational or competitive sports

Sports Specific Tests
- 1
Other Considerations

- Psychological

- Pain
- Apprehension
- Fear
- Kinesiophobia

Kinesiophobia !!!

Other-Fear Avoidance

- Presence of symptoms longer than 3 months, average pain intensity, flexion ROM index, and fear-of-pain scores all contributed to baseline shoulder function. The immediate clinical relevance of these findings is unclear...

- Lentz, TA, et.al. The relationship of pain, intensity, physical impairment, and pain-related fear to function in patients with shoulder pathology.
  - JOSPT. 39:270-277, 2009

- Elevated fear-avoidance beliefs were associated with poorer improvement in functional status from intake to discharge among people in the following 2 of the 8 shoulder disease categories:
  1) Muscle, tendon, & soft-tissue disorders
  2) Osteopathies, chondropathies, & musculoskeletal deformities


Psychometric Considerations

- Reliability - consistency
- Validity - accuracy
- Responsiveness - ability to detect change

Evaluative Outcome Measures

Important Psychometric Considerations:

- Reliability:
  - Repeat observations over time should remain stable when the individual's condition remains stable (i.e. within subject variation should be small)

- Validity:
  - Change in score should be related to change in other measures of the construct

- Responsiveness:
  - Score should change when the underlying condition measured by the instrument changes

How much change is needed to say that the individual's condition has changed or improved???
Precision of Measurement

Minimal Detectable Change

- Amount of change necessary to be certain change is greater than measurement error

\[ \text{MDC}_{\text{sys}} = 1.96 \times \sqrt{2 \times \text{SEM}} \]

\[ \text{SEM} = \text{SD}_{\text{baseline}} \times \sqrt{1 - r} \]

Responsiveness

Minimum Clinically Important Change

- Amount of change that patients perceive as being important
- Requires use of external criterion measure of change (e.g., global rating of change)
- Sensitivity & specificity determined for multiple "cut points" of change score

Functional Testing Algorithm

- Outcome performance scales:
  - Clinician-generated impairment measurements
  - Patient-centered self-reported values
- Generic/Global Health-Related Quality of Life (HRQOL) scales
- Specific Joint/pathology scales

Patient-Reported Outcome Measures for the Shoulder

- Region-Specific Scales:
  - DASH
  - DASH Sports Scale
  - ASES
  - KOC Functionality Assessment for Overhead Athlete
  - SPADI
  - Simple Shoulder Test

- Disease-Specific Scales:
  - Rotator Cuff Scale
  - WORC
  - Shoulder Instability Scale
  - WOSI

Psychometric Considerations:

- MCID 10.2
- MDC 2.8 - 5.2

- Reliability: .82 - .98
- Responsiveness: .84 - .96
- Function: .88

Patient-Reported Outcome Measures for the Shoulder

- DASH:
  - 10-item measure of physical disability & symptoms for people with disorders of the shoulder, elbow, wrist & hand
  - Upper extremity physical function (21 items)
  - Pain & symptoms (5 items)
  - Social & emotional function (4 items)
  - Score ranges from 0 to 100 with higher scores representing greater disability
  - Good evidence for reliability, validity & responsiveness

- KOC Functional Assessment for Overhead Athlete:
  - 10-item scale (3 items) measures functional & athletic performance & less symptoms
  - Evidence for reliability, validity & responsiveness provided by Alberta et al.

- ASES:
  - 44-item scale that measures impact of arm, shoulder or hand condition on playing musical instrument or sport - difficulty:
    - "Using normal technique"
    - "Playing sport as well as you would like"
    - "Spending usual time practicing or playing sport"
  - Score ranges from 0 to 100 with higher scores representing greater disability
  - Little evidence for reliability, validity & responsiveness

- Beaton et al 2011

- Richards et al 1994

- Psychological Considerations:

<table>
<thead>
<tr>
<th>Measure</th>
<th>DASH</th>
<th>ASES</th>
<th>KOC</th>
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</thead>
<tbody>
<tr>
<td>Reliability</td>
<td>.82</td>
<td>.84</td>
<td>.86</td>
</tr>
<tr>
<td>Effect Sizes</td>
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<td>-.80</td>
<td>.7</td>
</tr>
<tr>
<td>MDC</td>
<td>2.5</td>
<td>5.2</td>
<td>9.4</td>
</tr>
<tr>
<td>MCID</td>
<td>10.2</td>
<td>6.4</td>
<td>.7</td>
</tr>
</tbody>
</table>

- Bay et al 2009
- Alberta et al 2010
Return to Activity

For athletic population, the ultimate outcome after injury &/or surgery is the ability to return to prior level of sports in terms of intensity, frequency, duration & absence of symptoms.

Functional Testing Algorithm

- After passing the tests, the athlete returns to:
  - Sport specific training programs
  - Practice simulations
  - Practices
  - scrimmages
  - Competition

Return to Activity

Shoulder Activity Scale
- 5 questions comprising:
  - Shoulder eps, weightlifting with arms
  - Lifting over head exceeding 25 lbs
  - Visual analog scale
  - OKC isokinetic testing
  - OKC 3D muscle power testing

OKC 3D muscle power testing – BBI norms
- 23 touches; 21 touches for CKCUEST
- 21 touches for FTPI
- 22 touches for CQCEST

Summary

And Conclusions

- Clinical decision making (CDM)
  (based on history, subjective exam, objective physical exam, imaging, etc.) states the athlete is ready to return to activity.

- But if we also have all the functional tests to support the CDM, it strengthens the argument to return the athlete back to activity safely.
Perspective!

- Instead of listening to the old cliché to live life to the fullest,
- But to encourage you to really live life to the fullest every day!

Perspective

- So you might ask, if I am saying to live life to the fullest, what am I doing here?
- MY PASSION is to teach and treat patients!
- So I am actually really doing one of my passions – hopefully teaching

Cancer Survivor

- YES,
- I am a cancer survivor
- Metastases from the primary site
- Cancer Surgery
- 25 external beam radiation treatments
- AVN – femoral head
- THR –
- 4 additional surgeries
- So why do I mention this?
- Use any one of the above as an excuse.....
- But - here to try to CREATE a great day and have FUN !!!!
Inspiration and Motivation

- So if an old emaciated CANCER patient like me can be a CANCER SURVIVOR, and still teach, treat patients, do clinical research, publish, present continuing education courses, participate in numerous scientific meetings, cover games as an ATC, and exercise regularly, etc...........
- Then everyone can certainly be successful!

Challenge to our profession and YOU !!!

- Although the literature demonstrates that most of you are going to back to the clinic and just keep doing the same thing you have been doing, my PASSION this weekend is to change your mind, attitude, and practice patterns !!!!!

Challenge You !!!

- So if we do not present evidence that you should change some things in your practice - then DO NOT change.
- But if we do present updated evidence that it probably is best for you as the clinician and more importantly for your patient, then
- PLEASE CHANGE MONDAY !!!!!

Inspiration & Motivation

Ordinary people become extraordinary because they are willing to give that little “extra”!

P R I O R I T I E S

- Play hard and enjoy every moment!
- We all talk about “FUNctional” rehab for our patients; 1st 3 letters !!!
- If you are not having FUN in the clinic, then you know your patient’s aren’t!

Life is a gift!

- Don’t worry about the past (you can’t change it)
- Don’t worry about tomorrow (plan for it)
- Since life is a gift, live the present, which has been give to us, to the fullest!

Professionalism

Ordinary professions become extraordinary because they are willing to give that little “extra”!

I would not want to do anything else !!!!!

Great Profession, but we all need to give that little extra!
In Closing.....

- Contribute to the profession to make it even better
- Contribute to the literature to improve the quality of patient care
- Good luck with your patients who have shoulder dysfunctions, you are going to need it, because I do every day
- It was indeed an honor and privilege to be invited to participate and present this information with you
- Thank you for allowing me to share this time with you

Thank You

Thank you for the very kind invitation to share information with you.

Please use me as a resource and if you have any additional questions, please feel free to call me at:

- GLSM: 608-775-8600
- AASU: 912-344-2855
- Gundersen Lutheran Sports Medicine-SMPT-Rehab Protocol

Website: http://www.uk.armstrong.edu/davies

Email: George.Davies@armstrong.edu

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