Course Objectives

• Recall evidence-based implications for incorporating specific exercise strategies to the shoulder and knee in clinical practice.
• Discuss the principles of exercise dosing and prescription.
• Examine clinical and basic science research related to exercise progression at the shoulder and knee.
• Recognize appropriate rehabilitation exercises for the shoulder and knee.

Exercise

• Load placed on the body in order to achieve a physiological response
• Goal: functional movement pattern improvement
  – Motor Control
  – “Timing” “Activation”
  – Strength: eccentric, concentric, isometric
  – Hypertrophy
  – Power
  – Speed
  – Endurance
Other Benefits to Consider

- Reversing pathophysiology
- Stress/injury tolerance
- Desensitization
- Reduce fear of movement
- Reducing systemic disease risk factors

Treatment Progression

- Endurance, Power, Functional
- Motor Control, Strength, Proprioception
- Mobility and Palliative Care

Considerations

- Patient goals
- Tissue healing
- Bio-psychosocial variables (coping skills)
- Limitations (i.e. number of treatment sessions)
**Exercise Order**

- Complex movements first
  - Fatigue will impair movement patterns
  - Warm up exercises should be very short in duration
- Exercise order example: ACL rehab 6 weeks post surgery
  - Squat 2 x 8
  - Leg Press 3 x 15
  - Single leg proprioception training 3 x 45 seconds
  - Side stepping with resistance band 30 feet x 4
  - Side plank 2 x 1 minute
  - Straight leg raise 3 x 25

**Intensity**

- Inversely related to duration of rest period
- Can not increase intensity without sacrificing some other parameter
  - i.e. higher intensity = lower volume
- Intensity should be modified based upon specific exercise goal

**Frequency**

- Most common parameter that is arbitrarily chosen
  - i.e. 3 times per week, home exercise program every day
- Total session volume
- Frequency must match the goal of the exercise program
  - Reversing inhibition
  - Motor control/movement re-learning
  - Strength development
  - Power development
Dosing Strategies

- What are your goals?
  - Timing or activation?
  - Strength vs. endurance vs. power vs. hypertrophy?
  - Is there atrophy?
  - What muscle fiber type needs to be recruited?
  - What about bioenergetics?
  - How will you know you are dosing correctly?

Resistance Training Variables

<table>
<thead>
<tr>
<th>Power</th>
<th>Hypertrophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity: 75-90% 1RM</td>
<td>Intensity: 67-85% 1RM</td>
</tr>
<tr>
<td>Sets: 3-5</td>
<td>Sets: 3-6</td>
</tr>
<tr>
<td>Repetitions: 1-5</td>
<td>Repetition: 6-12</td>
</tr>
<tr>
<td>Rest: 2-5 min</td>
<td>Rest: 30-90 seconds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Strength</th>
<th>Endurance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity: &gt; 85% 1RM</td>
<td>Intensity: &lt; 67% 1RM</td>
</tr>
<tr>
<td>Sets: 2-6</td>
<td>Sets: 2-3</td>
</tr>
<tr>
<td>Repetition: ≤ 6</td>
<td>Repetition: ≥ 12</td>
</tr>
<tr>
<td>Rest: 2-5 min</td>
<td>Rest: ≤ 30 sec</td>
</tr>
</tbody>
</table>

*Rest = between sets & exercises

Muscle Performance Impairments

Ideal goals for exercise selection:
- Maximal activation
- Maximal isolation

Reality:
- Exercises that maximally activate: perpetuate imbalances

Early rehabilitation needs:
- Exercises that activate (timing) key muscles
- Minimize undesirable recruitment

Late rehabilitation:
- Maximal activation
Shoulder Complex

- Weakness/Impairment
  - External rotators
  - Serratus anterior
  - Lower trapezius

- Imbalances
  - Internal/External rotation
  - Abduction/External rotation
  - Upper/Lower trapezius
  - Upper trapezius/Serratus anterior

Muscle Imbalances: Strength/Timing

- **Internal*/External Rotation**

- **Abductor/External Rotation**

- **Upper Trapezius/Serratus Anterior**

- **Upper/Lower Trapezius**

Talking Point: Prone Scapular “Y”

<table>
<thead>
<tr>
<th>Muscle</th>
<th>% MVIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower trap</td>
<td>97</td>
</tr>
<tr>
<td>Middle trap</td>
<td>100+</td>
</tr>
<tr>
<td>Upper trap</td>
<td>79</td>
</tr>
<tr>
<td>Serratus ant</td>
<td>43</td>
</tr>
<tr>
<td>Lat delt</td>
<td>90</td>
</tr>
<tr>
<td>Post delt</td>
<td>88-100+</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>Up to 85</td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>65-82</td>
</tr>
</tbody>
</table>

Impairment: External Rotator Weakness

Exercise Progression Strategies for the Knee & Shoulder: An Evidence-Based Approach
Eric J. Chaconas
Morey J. Kolber

External Rotator Muscle Performance

ER at side:
- Teres minor: 84% MVIC
- Infraspinatus: 46-73% MVIC
- Supraspinatus: 20-51% MVIC
- Lower trapezius: 48% MVIC
- Lateral deltoid: 8-21% MVIC
- Posterior deltoid: 88% MVIC

Tip: Add towel roll & consider EMS


External Rotator Muscle Performance

ER at 90°:
- Teres minor: 89% MVIC
- Infraspinatus: 51% MVIC
- Supraspinatus: 50% MVIC
- Lower trapezius: 88% MVIC
- Lateral deltoid: 50% MVIC
- Posterior deltoid: 60% MVIC

External Rotation: Sidelying

Infraspinatus 62-85% MVIC
Lat. deltoid < 40% MVIC
Posterior deltoid 64% MVIC
Supraspinatus 51% MVIC
Teres minor 67-80% MVIC

Consideration:
-Conscious scapular correction leads to ↑ LT activity (13%)*

*De Mey et al, J Orthop Sports Phys Ther, 2013; Andersen et al, Phys Ther, 2010

External Rotation: Prone

<table>
<thead>
<tr>
<th>Muscle</th>
<th>% MVIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infra</td>
<td>Up to 130</td>
</tr>
<tr>
<td>Supra</td>
<td>68</td>
</tr>
<tr>
<td>Low Trap</td>
<td>79</td>
</tr>
<tr>
<td>Up Trap</td>
<td>20</td>
</tr>
<tr>
<td>Serratus Ant</td>
<td>57</td>
</tr>
<tr>
<td>Post Delt</td>
<td>79</td>
</tr>
<tr>
<td>Lat Delt</td>
<td>49</td>
</tr>
</tbody>
</table>


Impairment: Lower Trapezius Weakness
Lower Trapezius: Modified Cobra

Lower Trapezius: Prone “Y”

<table>
<thead>
<tr>
<th>Muscle</th>
<th>% VMIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower trap</td>
<td>97</td>
</tr>
<tr>
<td>Middle trap</td>
<td>100+</td>
</tr>
<tr>
<td>Upper trap</td>
<td>79</td>
</tr>
<tr>
<td>Serratus ant.</td>
<td>43</td>
</tr>
<tr>
<td>Lat delt</td>
<td>90</td>
</tr>
<tr>
<td>Post delt</td>
<td>88-100+</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>Up to 85</td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>65-82</td>
</tr>
</tbody>
</table>

Disadvantage: 1 upper trapezius & lateral deltoid recruitment

Exercise Progression Strategies for the Knee & Shoulder: An Evidence-Based Approach
Eric J. Chaconas
Morey J. Kolber
**Impairment: Serratus Anterior Weakness**

**Exercise Progression Strategies for the Knee & Shoulder: An Evidence-Based Approach**
Eric J. Chaconas
Morey J. Kolber

**Serratus Anterior**

- **Punches:** 50-80% MVIC
  - "UT activation 7% MVIC"
  - Myers et al, J Athl Train, 2005

- **Push up plus:** 73-80% MVIC
  - "UT activation 8-19% MVIC"

**Serratus Anterior**

- **Upper Cut**
  - Serratus ant. MVIC 100%
  - Upper trap MVIC 66%

- **Scaption above 120°**
  - Serratus ant. MVIC 96%
  - Upper trap MVIC 79%
Additional Exercise Considerations

- Scapular retraction
- Empty-Full can
- Return to gym

Scapular Retraction with Elastic Tubing

Rhomboids: 59% MVIC
Lower trapezius: 51%
Subscapularis: 74% MVIC
Infraspinatus: 31% MVIC
Teres minor: 101% MVIC


Supraspinatus: Empty Can

0-60° recommended angle for empty can

Supraspinatus: Full Can

*Improved isolation compared to empty can
*Potentially less activation than empty can
*Possibly ↓ Anterior scapular tilting compared to empty can
*↓ concern over improper form


Supraspinatus Considerations

–Empty can: possible ↓ AHD - 1 anterior tilt - poor form (SIS)
–Full can: alternative to empty can
–Empty & full can both have significant deltoid recruitment
  • Both may perpetuate imbalance of force couples & impingement
–Prone scapular Y activates supraspinatus (>65% MVIC) although significantly activates lateral deltoid (90% MVIC) & upper trap
  • Alternatives:
    –Sidelying external rotation
      • Significantly ↓ anterior & lateral deltoid (<40% MVIC) activity
      • Supraspinatus activity: 51% MVIC (Empty/Full/Y 64.85%)
    –Prone external rotation
      • Significantly ↓ anterior & lateral deltoid (49% MVIC) activity
      • Supraspinatus activity: 68% MVIC


Exercise Program Design

List key exercises for each muscle in a 3-stage progression

<table>
<thead>
<tr>
<th></th>
<th>Acute</th>
<th>Sub-acute</th>
<th>Sport Return</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscapularis</td>
<td>Stand IR T-band</td>
<td>Push-up plus</td>
<td>Rebounder</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serratus Ant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Trap</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Exercise Program Design**

- Secondary Impingement with supra/infra tendinosis
- Patient does not play sports or exercise

**List 5 key exercises for muscle performance**

<table>
<thead>
<tr>
<th>First week</th>
<th>Discharge</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
</tr>
</tbody>
</table>

**Return to Gym and/or Sport**

**Considerations: Gym**

- Adjustment/advancement of volume & load
- Atrophy is common…..consider……..
- Rehabilitation vs. Post rehabilitation volume & load
- Rest between sets?
- Gym/exercises: require consideration of biomechanics
- Rotator cuff disorders
- Anterior instability

**Weight-Training Injuries**

- Descriptive epidemiological reports comprise majority of literature pertaining to WT injuries
- Injury surveillance (NEISS) ER
  - 35% injury rate ↑ in past two decades
  - **Males comprise > 80% injuries** *Jones et al., Phys Sportsmed, 2000*
  - Injury surveillance (NEISS) ER 1990 -2007
  - **Males > 80% with “48.4% ↑ from 1996 to 2006”** *Kerr et al, Am J Sports Med, 2010*
- **Primary site of injury: Shoulder complex**
Shoulder Pain During Weight Training

<table>
<thead>
<tr>
<th>Exercise (N = 110)</th>
<th>Pain Reported During WT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency (%)</td>
<td>3 days</td>
</tr>
<tr>
<td>Rear lat pull-downs (52)</td>
<td>0.40</td>
</tr>
<tr>
<td>Military press (58) Behind the neck</td>
<td>0.57</td>
</tr>
<tr>
<td>External rotation (52)</td>
<td>-0.40</td>
</tr>
</tbody>
</table>

Pectoral Stretching

Modifications: Anterior Instability

Avoid High-Five Position
Seated Barbell Press: Deltoids (A &L)
Modification: Anterior Instability

What we know: Both behind the neck pull-downs & military press have a significant association with shoulder pain & clinical symptoms of anterior shoulder instability. Kolber et al, J Strength Cond Res, 2013

Machine Chest Fly: Pectorals
Modification: Anterior Instability

Seated Dumbbell Press: Deltoids (A&L)
Modification: Anterior Instability & SIS
**Chest Fly: Pectorals**

*Modification: Anterior Instability*

- **Dumbbell Chest Fly**
- **Dumbbell Chest Press**

**Shoulder Press: Deltoids (A/L)**

*Modifications: Anterior Instability & SIS*

- **Shoulder Press**

**Bench Press: Pectorals & Triceps**

*Modifications: Anterior Instability & AC Disorder*
Seated Bench Press: Pectoral & Triceps
Modification: Anterior Instability & AC Disorders

Latissimus Pull-Downs: Posterior Musculature
Modifications: Anterior Instability

Considerations:
1. Wide grip to front instead of rear
   - Increase activation of latissimus
     Lehman et al., Dyn Med, 2004
     Signorelli et al., J Strength Cond Res, 2002
   - ↓ propensity for anterior instability/pain
     Kolber et al., J Strength Cond Res, 2013
2. Add scapular depression to ↑ LT activity

Seated Rows: Posterior Musculature

Consideration:
Scapular retraction may mildly ↑ middle trap, lats & rhomboid activity
Lateral Deltoid Raise: Lateral Deltoid
*Modifications: Impingement Syndrome*

Upright Row: Upper Trapezius/Lat. Deltoid
*Modifications: Impingement Syndrome*

Overhead Triceps Extension: Triceps
*Modification: Biomechanics at End-Range*
**KNEE**

“You can’t control the knee at the knee”

- Weakness Impairment
  - Hip external rotators and extensors
  - Gluteus maximus and medius
  - Quadriceps
- Applicable diagnoses
  - PFPS (anterior knee pain)
  - Knee osteoarthritis, ligament injury, patella tendinopathy

---

**Step Down Test**

![Step Down Test Image]

---

**Step Down Trunk Control**

![Step Down Trunk Control Image]
Drop Jump

Glute Amnesia

• Common problem is poor control of the glutes with overcompensation from adjacent muscles
• Glute medius to tensor fascia latae (TFL)
• Gluteus maximus to hamstrings ratio

Early Hip Control Principle

• Maximize abduction, external rotation and extension motor control
• Optimize glute to TFL and glute to hamstring ratio
• Minimize dynamic valgus
What doesn’t work?

- Why should we avoid ball between the knees?
- What is wrong with side lying hip abduction?

Hip Movement Pattern Strategies

- Foundational motor control
- Tactile instruction
- Visual/cognitive

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Gluteal to TFL Activation Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clam</td>
<td>115</td>
</tr>
<tr>
<td>Sidestep</td>
<td>64</td>
</tr>
<tr>
<td>Quadruped Hip Extension</td>
<td>50</td>
</tr>
<tr>
<td>Sidelying Hip Abduction</td>
<td>38</td>
</tr>
<tr>
<td>Step-up</td>
<td>32</td>
</tr>
</tbody>
</table>

Selkowitz 2013
Clam Plus

Early Phase Gluteus Medius

- Side bridge (side plank)
  - Endurance holds
- Side step progression

Slow Eccentric
Early Phase Gluteus Maximus

- Bridge with abduction of hips to improve glute/hamstring ratio
- Add resistance
- Unilateral

Extension Diagonals
**Side Bridge Progression**

![Side Bridge Progression Image]

**Side Step Progression**

![Side Step Progression Image]
Single Leg Squat

Single Leg Deadlift
Squat Progression

Step Up/Down

Quadriceps

- Quadriceps inhibition in the presence of knee pain
  - Knee osteoarthritis
  - Ligament Injury
  - Knee joint effusion
  - Patella femoral pain syndrome
  - Most knee surgical procedures
- Does quadriceps weakness cause knee pain?
**Quadriceps Rehabilitation**

- Open kinetic chain: straight leg raise, knee extension
- Closed kinetic chain: Deeper knee flexion angle = greater quadriceps activation

**Quadriceps**

- NMES is effective
- Consider
  - Electrode size
  - Motor point
  - Max intensity tolerated
- Diagnoses
  - Total knee
  - Knee OA
  - ACL

**Home Program**

- Patient adherence is the #1 concern
- Less is more
- Instruction: video, patient smartphone
- Adherence to an exercise program directly associated with level of Self-determination theory
**Self-determination Continuum**

<table>
<thead>
<tr>
<th>Controlled Regulations</th>
<th>Autonomous Regulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>External Regulation:</td>
<td>Internal Motivation:</td>
</tr>
<tr>
<td><em>Because I feel pressure from others</em></td>
<td><em>Because I receive support</em></td>
</tr>
<tr>
<td>Intentional Regulation:</td>
<td>Internal Motivation:</td>
</tr>
<tr>
<td><em>Because I feel the need to justify the selection of the activity</em></td>
<td><em>Because I rely on others</em></td>
</tr>
<tr>
<td>Identified Regulation:</td>
<td>Identified Motivation:</td>
</tr>
<tr>
<td><em>Because I feel the need to comply with the activity</em></td>
<td><em>Because I feel the need to comply with the activity</em></td>
</tr>
<tr>
<td>Intuited Regulation:</td>
<td>Intuited Motivation:</td>
</tr>
<tr>
<td><em>Because I intuit that the activity is useful</em></td>
<td><em>Because I intuit that the activity is useful</em></td>
</tr>
<tr>
<td>Intuited Motivation:</td>
<td>Intuited Motivation:</td>
</tr>
<tr>
<td><em>Because I intuit that the activity is useful</em></td>
<td><em>Because I intuit that the activity is useful</em></td>
</tr>
</tbody>
</table>

Lonsdale, 2012

**5 A’s to Maximize Patient Self-Determination**

- **Ask**: Open ended questions, paraphrase, empathize
- Gauge patient readiness to accept advice
- **Advise**: Provide rationale, request patient input and use autonomy focused phrases
  - “Here are some things that will help you overcome”
- **Agree**: Active participation in goal setting, decide on objective, measurable and time based goals
- **Assist**: Identify barriers, identify solutions
- **Arrange**: Provide patient with a rehabilitation diary, follow up appointment and contact information for questions

References (Lower Quarter)