Vitae

• Nova Southeastern University
  – Associate Professor
  – Orthopaedics
  – Exercise Physiology

• Boca Raton Orthopaedic Group
  – Director of Physical Therapy

• Research Agenda/Clinical Interest
  – Shoulder Complex
Eccentric Training: Topics

- Introduction & nomenclature
- Biological adaptations & evidence
- Indications
- Eccentric interventions
  - Dosing
  - Videos
  - Recovery & contraindications
Eccentric Action Defined

“…….muscle lengthens because the contractile force is less than the resistive force. Forces generated within the muscle are less than external forces acting on it.”

Essentials of Strength Training & Conditioning, 3rd, 2011
Intentional Eccentric Training

“An effort is made to intentionally overload the eccentric phase of a movement.”

Whereby……
Supportive Evidence

• Clinical utility
• Risk & injury prevention
• Hormonal & growth factor response
• **Mechanotransduction**
  – Muscle
  – Tendon
Evidence for *Clinical Prescription*

- General conditions with “supporting” evidence
  - Shoulder impingement/tendinopathy/RTC tears
  - Lateral epicondylalgia
  - Bicep tendinopathy
  - Hamstring strains
  - Patellofemoral pain syndrome
  - Patellar tendinopathy
  - Achilles tendinopathy
  - Tibialis posterior tendinopathy
Outcome-Based Clinical Evidence

• **Patellar tendinosis**: *Ecc vs. Conc*
  – ↓ pain, ↑ satisfaction, ↑ sport return, ↓ future care
    *Johnsson et al, Br J Sports Med, 2005*

• **Achilles tendinosis**: *Ecc vs. Conc*
  – Premorbid activity return (82 vs 36%) & ↓ pain
    *Mafi et al, Knee Surg Sports Traumatol Arthrose, 2001*

• **Lateral epicondylalgia**: *Usual vs. Usual + Ecc*
  – ↓ pain, ↑ strength, ↓ disability & US improvement
    *Croisier et al, Br J Sports Med, 2007*

• **Shoulder impingement**: *Usual vs. Usual + Ecc*
  – ↑ function, ↓ pain, ↓ surgical decision (OR 7.7)
    *Holmgren et al, BMJ, 2012*
Injury Risk & Prevention: Evidence

• Elite sprinters: *Pre-season screening*
  – Eccentric hamstring weakness predicted injury
    

• Soccer players: *Ecc hamstring vs. Control*
  – Ecc training ↓ rate of new and recurrent injury
    

• Patellofemoral (PFPS): *Patients vs. Controls*
  – PFPS associated with ↓ ecc hip abd/ER torque
    

• Volleyball players: *Injured vs Non-Injured*
  – Prev. injured shoulder associated w/ecc ER weakness
    
Hormonal & Growth Factor Responses

• ↓ Myostatin & ↑ IGF-MGF in muscle: Ecc > Conc  
  Heinemeier et al, J Appl Physiol, 2007

• GH response of Ecc@ 90% 1RM > 70% 1RM  
  Ojasto et al, J Strength Cond Res, 2009

• Ecc training: ↑ MGF mRNA found on biopsy  

• Conc vs Ecc: ↑ IGF mRNA with Ecc  
  Bamman et al, AM J Physiol Endocrinol Metab, 2001

• Ecc training (> 1 bout): ↓ myostatin & ↑ myogenin  
What is Myostatin?

• Growth differentiation factor
• Inhibited by overload training & supplements
Mechanotransduction

- Process whereby body converts “mechanical” loading into a cellular response.
  - Cellular response = Change
  - Change = Upregulation of cellular DNA
    - Protein/collagen synthesis
    - Satellite cell activation
    - Autocrine expression of IGF & MGF
  - Key attribute = “Overload”
    - Eccentric training
Mechanotransduction
Activated cells have 2 options:
Mechanotransduction

• ↑ rate of collagen synthesis: Achilles tendinosis

• Achilles tendinosis: resembled normal tendon (3.8 yr)

• Lat. Epicondylalgia: Ecc vs Control
  • Homogenous appearance w/ ↓ thickness in Ecc group

• ↓ intratendinous signal w/Ecc (3 mo & 4.2 yr)
  Gardin et al, Skeletal Radiol, 2010

• ↑ satellite cell per fiber w/ eccentric training
  Dreyer et al, Muscle Nerve, 2006
Eccentric Prescription

• Evidence vs. Individual patient considerations

• Injury prevention/training versus tendon remodeling
  – Frequency: ________________________________
  – Load/Intensity: ___________________________
  – Training “range of motion”

• Considerations:
  – Strain vs. pain
  – D.O.M.S.
  – Repeated bout effect
Eccentric Prescription Strategies

• **Isolated training:**
  • Eccentric only (progression = ↑ reps & load)
    • Assisted concentric throughout
  • Reps: 3 sets of 6-15  (2X DAY) Remodeling Evidence

• **Combined within or at end of concentric set**
  • 1. LE: 2(up)-concentric & 1(down)-eccentric
  • 2. Concentric f/b extra ISOLATED eccentric reps
    • Contralateral to assist concentric at end of set
  • 3. Positional length-tension/lever modification
    • Short concentric: Long eccentric
Lower Quarter Eccentric Exercises

• Achilles tendon/triceps surae
• Patellar tendon/quadriceps
• Hamstring muscle/tendon
Achilles Tendon/Tricep Surae

  ➢ N=26  mean age 50
  ➢ Painful-chronic tendinosis
  ➢ Ultrasound diagnosis & follow up
  ➢ Rx = BID Heel drops  6* x  15
  ➢ 7x week for 12-weeks
  ➢ Work through pain
  ➢ Results:
    ➢ Tendon structure normal in 19/26 (3.8 yr follow-up)
    ➢ 22/26 satisfied with treatment
Achilles Tendon/Tricep Surae

Calf raises (2-up:1-down) w/ progressively ↑ dorsiflexion range
*Add backpack load as progression
Achilles Tendon/Triceps Surae

Calf raises (2-up:1-down) w/ progressively ↑ dorsiflexion range
*Add backpack load as progression
Patellar Tendon/Quadriceps

  - N=19  mean age 25
  - Patellar tendinopathy
  - Ultrasound diagnosis
  - RCT: Eccentric vs. Concentric
  - Rx = BID Decline squats (slant board)
    - 3x15: 7x week for 12-weeks w/ pain
  - Results:
    - ↓ pain & ↑ VISA in eccentric group
    - 9/10 eccentric group returned to pre-injury sports
Patellar Tendon/Quadriceps

Wall Squats w/ Contralateral Unload  Squats w/ Decline Slant Board
Patellar Tendon/Quadriceps

2-up with 1-down  Leg Press w/ Unilateral Ecc Return
Patellar Tendon/Quadriceps
Hamstring Musculature/Tendons

Leg Curl: 2-down & 1-up

Swiss Ball Curl Ups w/ Unilateral Eccentric Return
Hamstring Musculature/Tendons

- Nordic Hamstring Curl
Upper Quarter Eccentric Exercises

- Supraspinatus/Infraspinatus/Teres minor
- Wrist extensors
- Wrist supinators
Posterior Cuff

• Holmgren et al, *BMJ*, 2012 (RCT)
  - N=97 age 30-65
  - Recalcitrant subacromial impingement
  - Onset > 6 months & scheduled for surgery
  - Rx = BID eccentric 3 sets of 15
    - Posterior shoulder stretch & scapular stabilization
  - At week 8 ↓ frequency to daily
  - Results:
    - O.R. 7.7 for intervention group to defer surgery
    - O.R. 7.6 for intervention: "recovered/sig.improvement"
      - Improved function & ↓ pain (night only)
External Rotators Standing
Focused Supraspinatus
Elbow & Wrist
Extensor & Supinator Groups

  - N=92  mean age 38-40
  - Lateral Epicondylalgia
  - Rx = 3x week for 9-weeks
    - Eccentric extensor/supinator training
  - Results:
    - Tendon status improved with US
    - Improved function & ↓ pain
    - Normal strength
Wrist Extensors
Eccentric Considerations

• Consider………
  o Tendonitis versus tendinosis
  o Acute/Subacute tears  Corticosteroids
• Range of motion loss: timing of stretching
• Delayed onset muscle soreness/Repeated bout effect
• Strength assessment considerations
• Recovery interventions
  o Cold therapy
  o Compression
  o NSAIDs
  o Antioxidants & Omega-3 fatty acids
Final Thoughts

- Eccentric: Anything is better than “nothing”
- Use strain vs. pain and D.O.M.S to gauge intensity
- Muscle performance & Recovery
- Begin with mid-range and progress to end-range
Questions

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