The mechanisms of muscle injury rehabilitation

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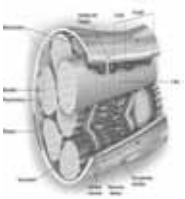
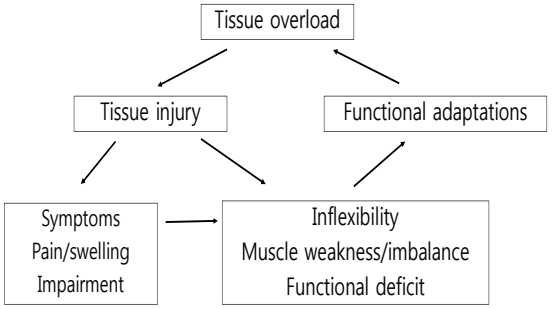
Characteristics (Loitz-Ramage 1996)

- Elasticity: change in length
- Extensibility: shorten and return to normal length
- Excitability: respond to nerve stimuli
- Contractility: shorten and contract in response to neural command from the CNS



Vicious cycle of muscle overload (Kibler 1990)



Tissue response (Houglum 1992)

- Inflammatory
  - Vasodilation and ↑ permeability
  - Activities of leukocytes and chemical mediators
  - Pain, swelling, redness, heat, and loss of function
- Repair (proliferative)
  - Fibroblasts & keratinocytes
  - Granulation & capillary buds
- Remodeling (maturation)
  - Collagen fiber realignment & scar tissue formation
  - ↑ stress and strain

Typical treatments (Prentice 2011; Houglum 2010)

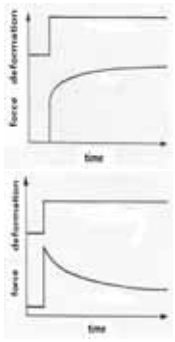
- Inflammatory
  - Pain & swelling control (modalities & NSAIDs)
  - Early movements
- Repair
  - Light stretching
  - Isolated resistance exercises (OKC)
- Remodeling
  - Continued stretching and strengthening (add CKC)
  - Proprioception & neuromuscular control exercises
  - Functional exercises- jogging, sprinting, sports-specific drills

Why stretch?

- More stretching sessions decreased the time returning to normal ROM and full activity/competition (Malliaropoulos 2004)
  - 30s static; 4 sessions/daily vs. 1 session/daily
  - 5.6 vs. 7.3 days; 13.3 vs. 15.0 days
- Viscoelastic change (Shrier 1999)
  - Neither perfectly elastic nor perfectly plastic
  - Stretching causes
    - ↓ muscle stiffness & tension at that length (stress relaxation)
    - ↓ actin-myosin bridge (due to reflex inhibition)
    - ↑ stretching tolerance → ↓ pain

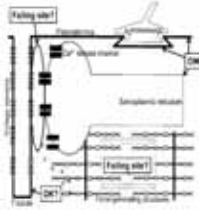
Mechanisms behind it

- It should begin in the proliferation and progress through remodeling
- Constant load causes a slow increase the length (creep)
  - Enhance a re-alignment of extracellular matrix (Nimni 1983)
- Stretching causes a slow loss of tension (stress relaxation)
  - New tissues become more resilient to applied stress (Houglum 2010)



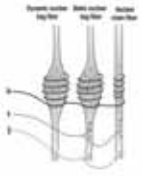
Strength deficit following injuries

- The mechanisms can be from: (Warren 2002)
  - a failure to activate intact force-generating structures
    - Mostly from the voltage sensor communicating with the sarcoplasmic reticulum
  - force-generating structures
    - Damage to the thin & thick filament (influence to cross-bridges)
    - Frank loss of contractile protein (desmin)



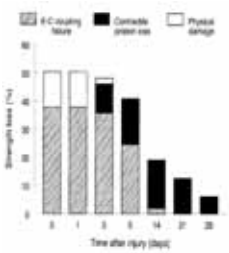
Neural mechanism?

- Problems at the intrafusal fibers (Lundy-Ekman 2007)
  - From primary or secondary activity
  - May affect α-γ co-activation
- Problems at the synapses (Latash 2008)
  - Pre- and post-synaptic inhibition
  - AP generation may be impaired



How long does it take? (Lowe 1995)

- Failure of excitation-contraction coupling does not seem to stay longer than 3 days
  - Acute stage of injury
- Contractile protein is further degraded after inflammatory response
- Can contractile protein loss be restored by voluntary contraction?
  - Combined with modalities?



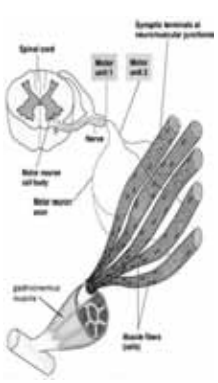
Biomechanics of force generation

Type of contraction	External resistance	Speed of contraction
Isometric	Accommodated	None
Isotonic	Constant	Vary
isokinetic	Accommodated	constant

- Which type of contraction is the best during rehab?
  - Assuming the injured joint is in a full ROM and there is no swelling/pain

Strength rehabilitation

- Strength loss following injury due to neural inhibition
  - Does muscle mass change after an injury?
  - Decreased neural efficiency
- If the rehab goal is to reverse neural inhibition, isotonic mode is the best (Knight 2001)



When do we begin volitional exercises?

- Traditionally performed after a restoration of full ROM with pain-free
- Recently, optimal loading has been proposed (Bleakly 2012)
  - Optimal loading in early stage of injury enhances tissue leaning and function
  - Isometric contraction
  - Range of motion (passive or active)
  - Simple weight bearing (shifting body weight)
  - Progressed resistance exercise
  - The use of modalities could facilitate optimal loading

Open & closed kinetic chain activity

- Open
  - The distal segment moves freely in space
  - High-velocity activities
- Closed
  - The distal segment is weight bearing and the body moves over the hand or foot
  - Functional & producing less shearing force

Questions and comments

- Thank you for your attention!

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