Regaining Muscular Strength, Endurance and Power

- Regaining strength in rehabilitation
- Types of skeletal muscle contraction
- Factors determining strength
- Physiology of strength development
- Techniques of resistance training
- Core stabilisation
- Open vs. Closed Kinetic Chain

Readings
- Chapter 9

Why is muscular strength, endurance and power critical to the rehab process?

Critical not only for achieving competitive fitness levels and return athlete to functional level following injury

Ability to generate force against some resistance
- Important to maintain normal levels of strength for normal ADL
- Imbalance or weakness can impair normal function

Ability to perform repetitive muscular contractions against some resistance

Ability to generate force quickly
- Combination of strength and speed
- High-load speed strength
- Low-load speed strength
- Performance is limited without power

Types of Skeletal Muscle Contraction?

- **Isometric contraction**
- **Concentric contraction**
- **Eccentric contraction**

Strength training must focus on functioning of muscle:
1. Multi-planar
2. Various contractions

Factors That Determine Levels of Strength, Endurance and Power

- Size of Muscle
  - Atrophy
  - Hypertrophy

- Strength
- Endurance
- Power

Number of Muscle Fibers

Neuromuscular Efficiency
- Strength directly related to efficiency of the NM system
- Initial increases in strength during first 8-10 weeks are attributed to neuromuscular efficiency
- Enhanced strength in 3 ways
  - Increase motor unit recruitment
  - Increase in firing rate
  - Enhance synchronization of motor unit firing
**Relative roles of neural and muscular adaptation to strength training**


**RT-Induced Changes in Neural Function**


**Age**
- Men and women increase strength throughout puberty and adolescence.
- Peaks at age 20-25
- After age 25, max strength declines 1% annually
- Decline is related to physical activity.
- Able to retard decline in performance through activity
Significant (p<.05) decrease in strength did not occur until the eighth decade (70 yr of age) of life.

Chronic endurance training can delay the age of significant decline in peak torque and change in muscle morphology characteristics of the vastus lateralis.

Age-relatedDecline in Strength

Biomechanical Considerations

1. Position of tendon attachment
   - Relative position of tendon attachment to fulcrum of the joint
   - Change in attachment will alter force generating capabilities

2. Length-Tension Relationship
   - Length of muscle determines tension that can be created
   - Varying lengths will produce varying tensions
   - Determined by overlap of actin-myosin filaments

Relationship of Tension to Muscle Length

Overtraining

- Imbalance between exercise and recovery
  - Training exceeds physiological/psychological capacity of individual
  - Negative effect on strength training
- May result in psychological or physiological breakdown
  - Injury, illness, fatigue can be indicators
- How will you monitor OT?

Fast-Twitch vs. Slow Twitch

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<thead>
<tr>
<th>Muscle Fibers</th>
<th>Twitch properties</th>
<th>Metabolic properties</th>
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<td>Name based on twitch and metabolic properties</td>
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<td>Other characteristics</td>
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<td>Recruitment threshold</td>
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- **Muscle Hypertrophy**
  - Hyperplasia – increase in number of muscle fibers
    - Genetically determined and does not seem to increase with training
  - Increased number of capillaries
    - No new capillaries
    - Increase in dormant capillary activity to meet needs of muscle
  - Increased size and number of myofilaments
    - Actin and myosin
  - Reversibility – adaptations of muscle due to training can begin to reverse within 48hr of removing training

- **Other Physiological Adaptations to Resistance Exercise**
  - Strength of non-contractile structures
    - Tendons and ligament increase
    - Increased bone-mineral content
  - Improved oxygen uptake
    - If intensity high enough to elicit a CV response/adaptation
    - Functional training
  - Increased metabolic enzymes
    - Glycolytic and oxidative enzymes
    - Increase its oxidative phosphorylation capacity
Resistance Training Techniques

- To improve strength, muscle must be worked at a level higher than it is accustomed to.
- Capable of ↑ muscle strength at specific joint angles.
- Provides stabilisation strength maintaining normal length tension and force couple relationships.
- ECC greater force generated due to lower number of motor units recruited allowing other motor units to be recruited to generate increased force.
- Needs of the body – acceleration and deceleration.
- Must be able to control body movements – deceleration and ECC
- Machines are relatively safe.
- Disadvantage: generally only allow single-plane motion.
- Neuromuscular control: Free weights present greater NM demands.

Resistance training acute variables and training principles

Resistance training program design

- 1 set 8-12 reps at a slow speed
- 3 exercises for 1 muscle group, 2-4 sets with no rest
- 2-3 warm-up sets with progressively increasing resistance followed by several sets at the same resistance
- multiple exercises, agonist/antagonist pairing, with multiple sets of 8-10 repetitions
- multiple sets decreasing reps/increasing resistance
- Workouts exercise different groups of muscles on different days

Techniques of Resistance Training Used in Rehabilitation

- DeLorme’s 1945
- Oxford method 1951
- MacQueen 1954
- Berger 1962
- Sander’s 1997
- Knight (DAPRE) 2001

For rehabilitation
1. Base program on pain and healing process
2. Should be performed daily early on
3. Reduce workout to every other day as progress is made

Plyometric Exercise

Encompass a rapid stretch of muscle eccentrically followed by a rapid concentric contraction to facilitate the development of explosive power

1. __________ is emphasized over magnitude
2. __________ of dynamic movements
3. __________: Exercises should be performed technically correct
Core Stabilization Strengthening

- Fundamental component of rehabilitation
  - Strengthening of core (lumbo-pelvic complex)
- Used to
  - Improve dynamic postural control
  - Ensure appropriate muscular balance and joint movement about the core
  - Improve neuromuscular efficiency and expression of dynamic functional movement
- Provide optimal stabilization of kinetic chain
  - Balanced muscular functioning throughout the chain

Open vs. Closed Kinetic Chain Exercises

- Anatomical and functional relationships that exist in the upper and lower extremity
- Open kinetic chain
  - Foot or hand not in contact with ground or some other surface
- Closed kinetic chain
  - Foot or hand is weight bearing
  - Useful in rehabilitation
    - Most activities call for weight bearing of foot or hand
    - May be more functional than OKC activities


Resistance Training Differences Between Males and Females

- Females tend not to develop significant muscle bulk due to reduced levels of testosterone
  - Muscle tone and strength will increase through training in females
  - Gains are primarily NM related and tend to plateau for females
- Absolute strength differences
  - Reduced when body size and composition are compared
  - Leg strength can actually be stronger in females with upper extremity strength greater in males
Resistance Training in Young Athletes


Guidelines for resistance exercise in children