Chapter 33:
Strengthening and Exercise

Barbra J. Koczan, PT, CHT, DPT

Basic Anatomy and Physiology of Skeletal Muscle

I. Striated/Skeletal Muscle
   A. 40% of total body weight
   B. Powers both axial skeleton and limbs producing voluntary movement
   C. Contains both Type I (slow twitch) and Type II (fast twitch) muscle fibers

II. Components of Striated Muscle[1,2,3]
   A. Slow-twitch (tonic/sustained activity muscles)
      1. Type I–Slow Oxidative
      2. Slow contraction, low threshold, fatigue resistant, high oxidative metabolism, high level of aerobic endurance (with oxygen)
      3. Contains: myoglobin, granular material, mitochondria, and sarcoplasm
      4. Small motor neurons innervate slow–twitch fibers primarily for functional activities
      5. Associated with endurance activities (i.e. marathon running)/sustained contractions (i.e. maintain posture)
   B. Fast-twitch (phasic/mobility muscles)
      1. Contains low amount of myoglobin and granular material
      2. Large motor neurons innervate fast-twitch fibers
      3. Fast contraction; high force productivity; high threshold
      4. Type IIa–Fast Oxidative Glycolytic
         a. Moderate oxidative metabolism; high anaerobic (without oxygen) metabolism; moderate fatigue
         b. Used for short, high intensity endurance activities (i.e. mile run)
      5. Type IIb–Fast Glycolytic
         a. Fast fatigue, high anaerobic metabolism, respond more rapidly to stimuli
         b. Used for contractions for great strength, speed or power (i.e. 100 yard dash)
   C. All skeletal muscles contain slow and fast twitch fibers
   D. Force produced by fast-twitch and slow-twitch motor units is due to the number of muscle fibers per muscle unit, not the force generated by each muscle fiber

III. Connective Tissue: an important component of skeletal muscle which runs from end to end, blending in with the muscle tendons origin and insertion
   A. Endomysium – connective tissue covering individual muscle fibers
   B. Perimysium – connective tissue surrounding bundles of muscle fibers
   C. Epimysium – outer connective tissue covering an entire muscle

IV. Contractile Unit[1,2,3]
   A. Myofibril–contractile element of striated muscle; individual muscle fibers contain

hundreds to thousands of myofibrils

B. Sarcomere – the active unit of the myofibril that contains an arrangement of actin and myosin. When activated by a motor nerve, the actin and myosin filaments comprising the sarcomere draw toward one another, resulting in muscle shortening.
    1. Myosin – thick filament
    2. Actin
        a. Thin filament, during contraction slides together shortening the muscle
        b. Striated muscle can shorten 1/3 of resting length
        c. Sliding Filament Theory – explains how muscle fibers shorten; when a myosin cross-bridge attaches to actin, conformational changes cause the actin and myosin to slide in opposite directions.
        d. The number of links between actin and myosin is directly correlated to the strength of each myofibril
        e. When attracted to each other, actin and myosin overlap, the amount of overlap influences the amount of muscular contraction.

V. Nerve Intervention
    A. One or several nerves are supplied to each muscles fiber
    B. Most of the nerves entering the muscle are sensory in character (proprioception/pain)
    C. Cortico Spinal Pathway – Neural pathway that initiates at cerebral cortex, descends through the brainstem, crosses over to the opposite side of the spinal cord and provide input to the motor neurons supplying the muscles to initiate movement

VI. Motor Unit
    A. Is comprised of the axon (structure that conducts electrical signals to the synaptic terminal), cell body (metabolic center of the neuron) and innervating muscle fiber
    B. All or none law[1,2]
        1. Refers to facilitating each muscle fiber and nerve cells
        2. All muscle fibers relax or contract simultaneously within a motor unit
        3. More force is produced by activating more motor units, thus activating more muscle fibers

VII. Membrane Potential[4]
    A. The membranes of cells are designed so that there is a difference in electrical charge between the inside and outside of the cell; the difference is called the resting membrane potential.
    B. Resting membrane potential - negative polarity on the inside in relation to outside the cell membrane (normal is -70mV)
    C. The cell membrane is highly permeable to potassium (K+) and not as

permeable to sodium (Na+)

D. Resting potential is maintained by sodium-potassium pumps in the cell membrane which use metabolic energy to maintain a constant concentration of ions within the cell by moving 3 sodium ions out of the cell for each 2 potassium ions it brings into the cell

VIII. Action Potential[1,4]

A. Wave of depolarization (decrease of negative voltage within a cell) and repolarization (return to resting state of the cell) across the membrane of a neuron or muscle cell
    1. A stimulus is applied to an excitable cell (nerve or muscle)
    2. Increase in cell membrane permeability
    3. Rapid exchange of (+) and (-) ions
    4. Cell becomes depolarized
    5. Immediate repolarization (to establish resting membrane potential)
B. Nerve impulse – electrical signal passed along a neuron which goes to another neuron or to a group of muscle fibers
C. Sequela of a muscular contraction–A nerve impulse reaches the nerve ending which releases the neurotransmitter acetylcholine (ACh), Acetylcholine binds to receptors, changes membrane permeability, increases sodium ions inside cell, cell depolarizes, action potential travels length of muscle fiber, increases calcium ions, actin-myosin binding occurs, myosin binds to adenosine triphosphate (ATP) releasing energy, creating a contraction

IX. Endoplasmic Reticulum

A. Sarcoplasmic reticulum – stores and releases calcium ions during contraction
B. Transverse tubular system – transmit the muscle action potential throughout muscle fiber

X. Blood Supply

A. Muscle – Highly vascularized; two veins and one artery run with nerve into the muscle. Also gain additional vessels from other areas.
B. Damage to blood vessel can effect one muscle rather than other muscles in the same group
C. Blood supply provides oxygen and glucose and eliminates metabolic wastes
D. Muscle ischemia – decrease blood supply causing build-up of metabolites leading to pain, fatigue and decreased strength
E. Gangrene – disruption of blood supply causing death of muscle
F. Tendon – sparse blood supply

XI. Motor Receptors[1,4]

A. Joint Receptors
    1. Several types of sensory receptors in the joint capsule and ligaments of the joint
    2. Continuous feedback of the rate of movement and the angle of the joints
B. Muscle Spindle – specialized (embedded within striated muscle, activated by

stretch; once activated, sends a message to the nervous system about the muscle's length, this triggers reflexive muscle contraction to prevent further stretching)
    1. Afferent and efferent information
    2. Function –stretch reflex (important for posture, muscle tone, and movement)

C. Golgi Tendon Organ – located at the myotendinous junction, senses change in tension in the musculotendinous structure; is activated by muscle contraction or excessive stretch. Once activated, it sends a message to the nervous system that then inhibits the contracting (agonist) muscle and excites the opposing (antagonist) muscle.
    1. Sensory – near tendon attachment
    2. Rapid afferent axons (IB fibers) to spinal cord and cerebellum leads to inhibition of motor neurons

XII. Mechanical Properties of Muscle: Factors that Influence Strength

A. Optimal length (length-tension relationship)
    1. Muscle produces the greatest tension when it is on slight stretch at the time of the contraction

XIII. Force Velocity/Speed of Contraction

A. Greater torque is produced at lower speeds because of greater opportunity for recruitment during concentric contractions
B. Contraction velocity depends on the force resisting the muscle
C. During eccentric contraction, the faster the velocity, the greater the muscle force is exerted

XIV. Shape of Muscle[2]

A. Fusiform/parallel: fibers run length-wise, typically long muscle fibers, small number of muscle fibers; therefore, a greater range of motion is produced (i.e. sternocleidomastoid, biceps).
B. Pennate: fibers are oblique, typically short muscle fibers, large numbers of muscle fibers; therefore, more strength is created but less range of motion is produced
C. Unipennate: fibers angle to one side of the central tendon (i.e. Flexor Pollicis Longus)
D. Bipennate: fibers angle to both sides of the central tendon, most strength

XV. Cross Sectional Size of Muscle

A. Muscle force proportional to the number of sarcomeres acting in parallel. For example bipennate muscle types have a capacity to generate great force.

XVI. Levers[1]

A. Almost all levers of the body are 1st class or 3rd class
    1. 1st class: axis is between the force (effort) and resistance (weight); very few 1st class levers in human body (i.e. force of triceps on ulna and

external resistance on the distal ulna; force and resistance is separated by the elbow joint axis)

2. 2nd class: resistance (weight) is between the axis and force (effort); an example of this is doing a push-up (feet are axis, body's center of gravity is the resistance and the hands pushing against the ground is the force)
3. 3rd class: force (effort) is closer to the axis than the resistance (weight); resistance arm always longer than force arm, built for speed; most muscles are 3rd class levers (i.e. the point of muscle attachment is closer to the joint axis than the external resistance–biceps attaches closer to the elbow joint than the external resistance at the distal radius).

B. Increase speed by use of multiple levers (throwing a ball)

XVII. Recruitment of Motor Units[1]

A. The greater the number of motor units firing, the greater the force output.
    1. Smaller motor units are 1st to be recruited, they tend to be muscles containing more type 1, slow-twitch fibers which fatigue slowly
    2. Larger motor units are recruited last, as more strength is needed
B. Motor unit fired depends on size of neuron
    1. Small motor neurons innervate small fibers and fewer number of fibers(fatigue resistant, slow-twitch and low contraction)
    2. Large motor neurons innervate large fibers and numerous fibers (high contraction, fast-twitch)

XVIII. Fatigue

A. Inability of intact muscle to do required contraction over a period of time
    1. Caused by peripheral or central origin metabolic changes (decrease ATP) or an accumulation of metabolic byproducts (lactic acid)
    2. Excessive fatigue of a weak muscle may be harmful causing more weakness

XIX. Change in Muscle Size[1]

A. Atrophy
    1. Disuse, due to immobilization > 2 weeks, causes a decrease in the amount of actin/myosin which decreases diameter of fibers and decreases strength
        a. Example: Four weeks s/p flexor tendon laceration Zone II with primary Repair – visual inspection and circumferential measurement of proximal forearm muscle mass notes significant decrease in girth of affected side secondary to disuse. By this time, the dorsal forearm based orthosis may have required adjustment to fit the smaller diameter proximal forearm, as well as secondary to bandage removal and edema reduction at hand and wrist.
    2. Disease or injury to lower motor neuron leads to denervation and unless reinnervated by nearby or regrowing motor axons, myofibrils becomes fibrotic within 1-2 years
        a. Example: Median nerve denervation at distal forearm/proximal

carpal row articulation results in atrophy of thenar eminence and intrinsic muscles: abductor pollicis brevis, lumbricals (lateral two muscles); or with multiple sclerosis, secondary to damage to nerves innervating muscle tissue, muscle weakness and atrophy can occur.

B. Hyperplasia – growth due to increase in cell number
C. Hypertrophy – an increase size of the muscle caused by cell size increase.

Introduction to Strengthening and Therapeutic Exercise

The purpose of therapeutic exercise is to restore, develop, and improve mobility, flexibility, strength, endurance, coordination and relaxation.

To use exercise in hand rehabilitation we must understand the functional biomechanics, tissue healing, and the physiological effects of disuse.

Soft tissue healing occurs generally by forming scar tissue. It is commonly divided into three phases: Inflammatory, Proliferative and Maturation. The management of an injury is divided into acute, subacute and rehabilitation stages (as outlined below). These stages are used as a general guideline for treatment during the Inflammatory, Proliferative and Maturation stage respectively.

Acute Management [5]
- Minimize joint effusion and interstitial edema
- Reduce pain
- Active range of motion as tolerated
- Protection (of injury, wound, surgical repair)

Sub Acute Management [5]
- All of the Acute Management techniques
- Passive range of motion
- Early controlled mobilization with tendon repairs

Rehabilitation Management [5]
- Restore range of motion, muscular strength, and endurance
- Prepare for return to work and ADL's

Principles/Rationale for Strengthening

I. Definition
   A. Work: Biomechanically, this is defined as the product of the force applied times the distance moved in the direction of force. The unit of measurement for work is Newtonmeters or joules. Work (W) = Force (F) times Distance (D)
   B. Force: Any applied action that may change an object's state of rest or motion
   C. Power: The rate of performing work. It is calculated as the derivative of work with respect to time or the product of force and velocity. The unit of measure is the

watt.[1]

$$\text{Power} = \frac{\text{Work X Distance}}{\text{Time}}$$

D. Endurance: The time limit of a person's ability to maintain either a specific isometric force or a specific power level that involves combinations of concentric or eccentric muscle contractions
E. Strength: The force output of a contracting muscle. Work is directly related to the amount of tension a contracting muscle can produce.

II. Types of Strengthening Exercises[1,2,5,6]
A. Isotonic: muscles move joint through ROM
    1. Concentric: muscle shortens as it develops tension
    2. Eccentric: Muscle lengthens as it develops tension
    3. Two types of isotonic strengthening:
        a. Delorme Technique[6] of **Progressive** Resistive Exercise (see below)
        b. Oxford Technique of **Regressive** Resistive Exercise (see below)
B. Isometric: static muscle contraction with no perceivable change in muscle length
C. Isokinetic: maximum contraction at a constant speed and resistance through partial or full range of motion. Usually done with Cybex. Also called accommodating resistance.
D. Plyometric: form of specificity training, which facilitates rapid strength and endurance (i.e. Rebounder—Fig. 1)
    1. Calls into play type II fast twitch muscle fibers.
    2. Uses stretch reflex to facilitate the recruitment of additional motor units.

III. Weight Determination
A. To strengthen muscles, they must be exercised against resistances greater than normally encountered
    1. Calculate tolerance
        a. Maximum weight at which patient can complete ten repetitions (10 repetition maximum=10 RM)
    2. Delorme technique of progressive resistive exercises[6]
        a. Rapid movement
        b. Patient performs sets of 10 repetitions starting with a weight 50% of 10 RM during set one then 75% of 10 RM during set 2 and finally 100% of 10RM during set 3
    3. Oxford technique of regressive resistive exercises
        a. More tolerable than Delorme, less fatigue
        b. Slower improvement
        c. Patient performs sets of 10 starting at a weight 100% of 10 RM, then 75% of 10RM, 50% of 10 RM, 25% of 10 RM
    4. Perform 1 set of 10-15 repetitions only, if 15 repetitions performed easily, add weight, if not able to perform, continue to do 10 repetitions but reduce the weight

Evaluation of Muscle Function

I. Resistive Manual Muscle Testing
Resistive manual muscle testing stresses the contractile structures for ability to develop and sustain tension with minimal involvement of inert structures[7]

II. Grades of Resistive Manual Muscle Testing
One method of determining muscle power is graded by using the following scale:

0 – no palpable or observable muscle contraction
1 – no visible movement; palpable or observable trace contraction
2 – can achieve full range of movement with gravity eliminated
3 – can achieve full range of movement against gravity
4 – able to move through full range of movement against gravity with moderate resistance
5 – able to move through full range of movement against gravity with maximum resistance

Application of Therapeutic Exercise

Therapeutic exercise (definition): "The prescription of bodily movement or muscle contraction to correct an impairment, improve musculoskeletal function, or maintain a state of well being. (p. 129)" [8]

I. Intent of Treatment Program: establishing goals and plan of care requires integration of anatomy and physiology, evaluation of patient status, principles and rationale for strengthening, and projection of desired outcome

A. Rationale of use of exercise[5,6]
    1. Purpose of exercise: prevent, restore, develop, improve, maintain status
    2. Deficits to be addressed: mobility, flexibility, strength, power, endurance, muscle balance, coordination, skill
        a. Application method
            1. S/p wrist fracture: when time frame is appropriate for adequate healing, may utilize active assisted range of motion (AAROM), passive range of motion (PROM) and progressive static and/or dynamic orthosis to restore joint mobility and soft tissue length; progress to strengthening
            2. S/p tendon repair (utilizing a modified Duran approach): apply and instruct patient in controlled, protected mobilization program to maintain passive joint mobility and develop passive tendon glide; progress to active range of motion (AROM) with blocking and tendon gliding exercises followed by strengthening
B. Considerations in treatment planning
    1. Healing phase of involved tissue(s)
    2. Current grade of musculature

3. Exercise/activity set-up
    a. Length and angle of muscle-tendon unit
    b. Amount of resistance
    c. Duration of contraction
    d. Repetitions/fatigue tolerance
4. Patient motivation, interest and goals
5. Activity to which the patient will return

II. Analyzing Goals and Choosing Appropriate Exercises to Achieve Projected Outcome
A. Restore joint and soft tissue mobility[5,6]
    1. Passive range of motion (PROM): movement supplied by an external force
        a. Purpose: hydrates joint surface by providing joint diffusion, maintains and/or improves structure length and mechanical elasticity, assists circulation, aids in decreasing edema, decreases pain, aids in patient's awareness of movement
        b. Deficits to be addressed: used when needed for protection or to prohibit active movement, used in presence of pain and inflammation, paralysis, spasticity, severe weakness, or in the presence of severe limitations in ROM
        c. Application method: by therapist, patient, CPM unit; in controlled, protected early mobilization programs; through dynamic orthosis
    2. Joint mobilization: application of passive traction and controlled gliding to achieve capsular joint play
        a. Purpose: promotes passive joint play to reduce stiffness and elongate capsular structures and reduces pain through the application of grade I-II oscillations (gait control theory)
        b. Deficits to be addressed: used in conjunction with passive stretch to achieve soft tissue changes
        c. Application method: by manual technique of therapist with cautious awareness of joint kinematics, structural integrity and precautions
    3. Active range of motion (AROM): active muscle contraction, which produces movement through partial or full range
        a. Purpose: promote elasticity and contractility of involved musculature, stimulate circulation and increase sensory awareness of ability to move
        b. Deficits to be addressed: used when beginning movement post immobilization and in the presence of weak musculature
        c. Application method: direct movement of patient, graded by positioning of extremity and gravity influence, can be self-assisted or assisted by therapist
B. Increase muscle length[5,6]
    1. PROM and passive stretch as described
    2. Inhibition techniques: use of contract/relax and agonist/antagonist responses to achieve relaxation and; therefore, ease stretch of the tight

muscle
a. Purpose: promotes active use and patient's control of motor output
b. Deficits to be addressed: applied to reduce muscle spasm, guarding and co-contraction
c. Application method: therapist application of manual technique

3. Definitions:[2,3]
   a. Agonist (prime mover): the muscle which provides the primary movement in a particular plane
   b. Synergist (accessory mover): a muscle that assists in a particular movement, although this may not be the muscle's primary function
   c. Antagonist (opposer): the muscle that opposes the agonist, thereby providing a counterbalance force
   d. Muscle Spasm: a protective response of muscle tightening to protect injured tissue, due to a neurologic reflex, chemical or emotional reaction

C. Flexibility programs: stretching exercises incorporating conscious relaxation and sustained positioning (Fig. 2)[5,6]
   1. Purpose: promotes muscle lengthening within patient's control
   2. Deficits to be addressed: utilized for warm-ups, rest from static positioning
   3. Application method: self-administered by patient following instruction with supervision or can be manually applied by therapist
   4. Definitions: (Fig. 3)[2,6,7]
      a. Passive insufficiency: inability of a muscle that spans two or more joints to be stretched sufficiently to produce a full range of movement in all joints simultaneously
      b. Active insufficiency: inability of a muscle which spans two or more joints to exert enough tension to shorten sufficiently to cause a full range of movement in all joints at the same time

D. Achieve tendon glide, tendon excursion
   1. Place and hold: passive or active assisted motion to end range followed by muscle tensing to maintain position
      a. Purpose: promotes passive glide and muscle re-education with less stress on gliding structures than active tendon pull through (as long as therapist is mindful of the proper length-tension relationship to avoid stress on healing tissues)
      b. Deficits to be addressed: utilized when healing of structures is not yet considered sufficient for demands of active excursion; when inflammation, pain and fear limit active output
      c. Application method: by therapist or patient, is a manual technique
   2. Blocking: stabilization of adjacent joints to facilitate tendon excursion at a specific joint
      a. Purpose: produces gliding with respect to surrounding structures
      b. Deficits to be addressed: utilized to re-educate for isolated movement patterns; break-up substitution patterns
      c. Application method: by therapist or patient manual technique,

blocking orthosis

3. Differential gliding: specific active exercises and blocked positions to promote independent function of structures (Fig. 4)
    a. Purpose: reduces tissue adherence to facilitate maximal independent excursion
    b. Deficits to be addressed: utilized when scar tissue adherence causes movement as a unit vs. allowing independent function
    c. Application method: applied by active output or manual technique: tendon gliding exercises, isolated superficialis exercises, terminal extension and tabletop extension, nerve gliding programs.

E. Increase strength[1,2,5,6]

1. Power (P) is defined as work (W) divided by time (T); P = W/T
2. Strength increases power because a stronger muscle overcomes resistance more easily
3. Isometric: contraction without change in muscle length (Fig. 5)
    a. Purpose: allows for protection of injured structures during healing, tension without movement can be achieved with less pain than with movement
    b. Deficits to be addressed: utilized early post injury/surgery when resistance throughout full range is not allowed; during soft tissue inflammation or in arthritic conditions when full excursion and/or joint movement produce pain
    c. Application method: achieved with muscle setting or pressure against static or matching force
4. Isotonic: resistance during shortening or lengthening contraction
    a. Purpose: can be varied to meet the changing needs of the patient
    b. Deficits to be addressed: utilized as the basis of the majority of strengthening programs
    c. Application method: achieved with manual or mechanical resistance; effectively incorporated into functional movement patterns
5. Isokinetic: resistance applied throughout motion to maintain maximal tension
    a. Purpose: provides strengthening throughout range of motion of muscle excursion
    b. Deficits to be addressed: utilized to develop maximal muscle tension throughout maximal range
    c. Application method: primarily applied with mechanical resistance; can also be applied manually (MRE=manual resisted exercises) or simulated via aquatic therapy

F. Increase endurance[5]

1. Purpose: achieve the ability to perform low-load repeated exercise over a period of time
2. Deficits to be addressed: utilized for general conditioning, postural training and as a component of work hardening programs
3. Application method: applied in exercise and work simulation programs

with design incorporating resistance, repetition, and duration of performance

G. Additional Considerations in Designing Exercise Programs
    1. Restoration of muscle balance: restoring mobility and developing strength in the affected musculature is initial goal that must be coordinated with other movements of extremity to restore function
    2. Factors to be addressed:
        a. Co-contraction: simultaneous contraction of agonist and antagonist frequently occurs as a protective response from pain and limits patient's ease of achieving desired movement; relaxation instruction and muscle re-education are used to reduce this tendency.
        b. Muscle re-education with targeting: providing a goal (target) for the outcome of a movement helps patient conceptualize the action to be elicited (i.e. biofeedback devices)
        c. Eccentric control: tension with a lengthening contraction must be developed for smooth functional output
    3. Specificity training: performance of actual movement patterns, exercises, functional activities, sport activities and work simulation activities to specifically retrain the muscles to perform the jobs to which the patient will return
        a. Plyometrics: exercise which facilitates rapid stretch and recoil of muscles; primarily used in the rehabilitation of athletes and musicians

Biofeedback – Surface EMG (SEMG) Neuromuscular Re-Education

General Definitions:
Biofeedback: "The technique using instrumentation to reveal to human being some of their physiological events, both normal and abnormal in order to manipulate these otherwise involuntary or unfelt events." (Unknown)

Electromyography (EMG): The recording and study of the electrical properties of muscles. Specifically, it monitors the summation of motor unit activity, thereby indicating the muscle's force.

Surface Electromyography (SEMG): The use of surface electrodes to measure muscle activity used for evaluation and treatment.

Objectives of SEMG:
- Evaluation – To identify the exact circumstances under which muscle activity occurs and possibly when such activity becomes aberrant
- Treatment – To restore muscle function at rest and with activity

Needle Electromyography: The use of a needle electrode which may be placed repetitively in each muscle examined for adequate exploration. Used for diagnosis and evaluation; not used as a technique for biofeedback.

Treatment May Be Provided For:

- Carpal Tunnel Syndrome (CTS)
- Lateral Epicondylitis
- Thoracic Outlet Syndrome (TOS)
- Cerebral Vascular Accident (CVA)
- Myofascial Pain Syndrome
- Ergonomics Studies
- Soft Tissue Assessment
- Relaxation Training
- Correct recruitment of muscles during functional movement (i.e., strengthening and reconditioning)

Case Scenario Examples: Please note that comprehensive treatment may involve only the use of traditional biofeedback, or may be used in conjunction with other therapeutic intervention not mentioned here. The following are examples of SEMG application techniques. These techniques are not necessarily a substitute for comprehensive evaluation, treatment planning and goals from the rehabilitation team.

CTS

Double Crush Syndrome: SEMG evaluation notes spasm of sternocleidomastoid (SCM) and scalenes, as well as spontaneous co-firing of forearm musculature during cervical movement of rotation and flexion.

Treatment focuses on rebalancing these muscles for more symmetrical recruitment patterns. The result is, in many cases, an improvement in nerve conduction studies performed pre-versus post treatment.[9,10]

Lateral Epicondylitis

SEMG evaluation notes under-recruitment of wrist flexors, and excessive muscle activity in extensors.

Treatment involves facilitation of recruitment of wrist flexors. The result is inhibition of wrist extensors with decreased muscle spasm and soft tissue irritation at their proximal attachment.[11,12]

Ergonomics

SEMG evaluation and neuromuscular re-education is of value to assess proper positioning to aid in the prevention of acute or repetitive motion injury or to facilitate re-entry in the worksite.[13,14]

Chapter 33 Figures

Fig. 1. Example of plyometrics: Rebounder.

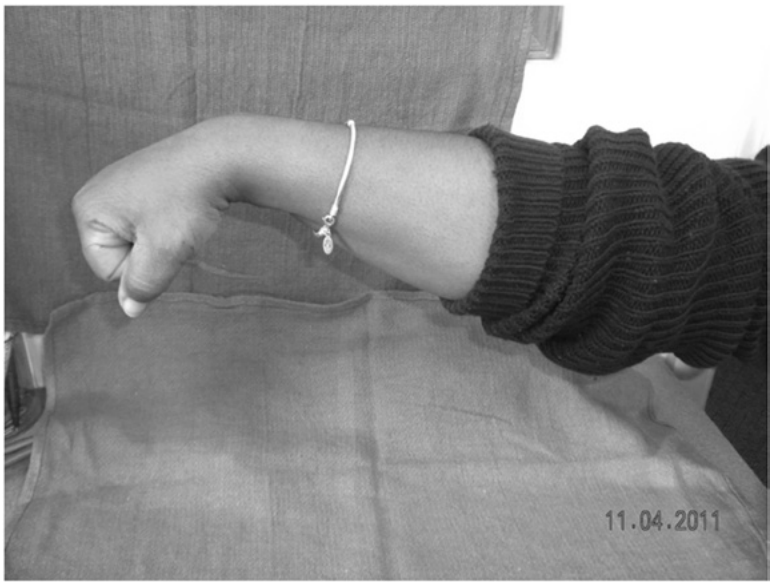

Fig. 2. Flexibility: Extrinsic extensor stretching.

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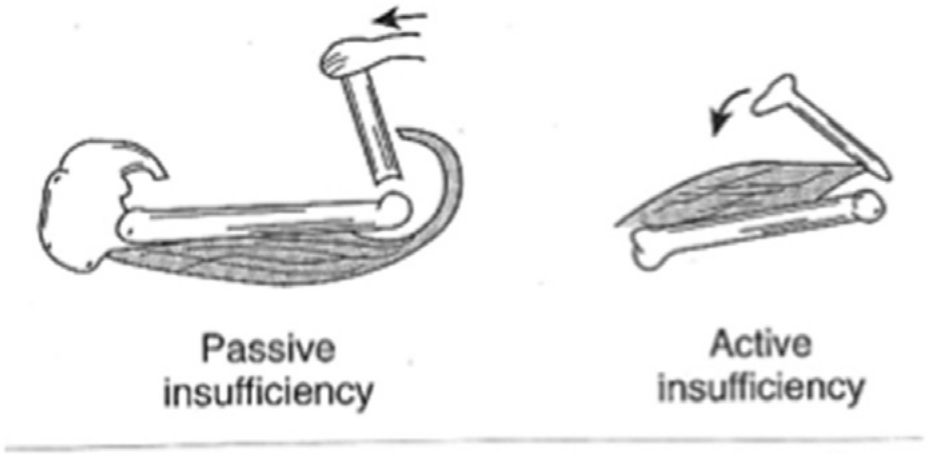

Fig. 3. Flexibility: Active and Passive insufficiency.
Printed with permission: Huber FE, Wells CL. Therapeutic Exercise: Treatment Planning for Progression. St. Louis: Elsevier, 2006, p.100 Fig 4-3.

Fig. 4. Differential Gliding: FDS Gliding.

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Fig. 5. Isometric Strengthening: Shoulder Isometric Abduction.

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Multiple Choice Questions

1. A patient wants to return to running track where his specialty is the 50 yard dash. Which muscle fibers are recruited for this type of activity?
   A. Type IIa
   B. Type I
   C. Type III
   D. Type IIb

2. Which of the following is not true regarding slow twitch muscle fibers?
   A. They function via high anaerobic metabolism
   B. They generate slow contractions
   C. They are innervated by small motor neurons
   D. They are associated with endurance activities

3. Which of the following is true regarding a muscle contraction?
   A. The sarcomere stretches during the contraction
   B. Actin and myosin filaments draw toward each other, shortening the muscle
   C. The number of links between actin and myosin is inversely related to the strength of the myofibril
   D. Actin is a thick filament that binds to the sarcomere to cause a contraction

4. Which of the following statements is true with regard to cell membranes?
   A. The resting membrane potential is +70 MV
   B. The cell membrane is highly permeable to sodium but not potassium
   C. The resting membrane potential refers to the difference in electrical charge inside the body vs. outside the body
   D. The resting membrane potential is -70 mV

5. Identify the correct match:
   A. Repolarization: return to resting state of the cell
   B. Depolarization: increase of negative voltage within a cell
   C. All or none law: within a motor unit only one muscle fiber contracts at a time
   D. Endomysium: connective tissue covering an entire muscle

6. What is the correct sequela of events that occur during a muscle contraction?
   A. Nerve impulse reaches nerve ending, actin-myosin bind together, myosin binds to ATP releasing energy
   B. ATP releases energy, nerve impulse reaches nerve ending, actin-myosin bind together
   C. Actin-myosin bind together, ATP releases energy, nerve impulse reaches nerve ending
   D. Nerve impulse reaches nerve ending, ATP releases energy, actin-myosin bind together

7. Which of the following is not true of the Golgi tendon organ?
   A. Is activated by muscle contraction or excessive stretch
   B. Is located at the tendon-bone interface
   C. Is responsible for sensing change in tension in the musculotendinous structure
   D. Is active in inhibiting the agonist and exciting the antagonist muscle

Multiple Choice Questions

8. Which of the following is the correct pair?
   A. Endurance: the force output of a contracting muscle
   B. Power: the time limit of a person's ability to maintain a specific power level
   C. Strength: the rate of performing work
   D. Force: any applied action that may change an object's state of rest or motion

9. The patient is using his uninjured hand to lift his injured wrist into extension and slowly lowering the 2 pound weight down into flexion. Which type of strengthening is this?
   A. Concentric
   B. Isometric
   C. Eccentric
   D. Plyometric

10. When initiating an early strengthening program post-operatively, what is a safe way to begin strengthening?
   A. Plyometric strengthening
   B. Isometric contraction
   C. Isokinetic strengthening
   D. Concentric contraction

11. A therapist is following the Oxford Technique for strengthening. What could they anticipate compared to the Delorme Technique?
   A. Less fatigue with better tolerance
   B. Faster improvement in strength
   C. More rapid movement would be utilized
   D. Patient would start at 50% of maximum then progress to 75% then to 100%

12. The therapist muscle tests a patient and determines that they have contraction with mobility with gravity eliminated. Which muscle test grade would they be assigned?
   A. 3/5
   B. 4/5
   C. 2/5
   D. 5/5

13. A patient is anxious to return to sport specific throwing. Which type of exercise would be best to simulate this rapid strength and endurance?
   A. Isometric
   B. Isotonic
   C. Eccentric
   D. Plyometric

Multiple Choice Question Answer Key
Chapter 33

1-D, 2-A, 3-B, 4-D, 5-A, 6-A, 7-B,
8-D, 9-C, 10-B, 11-A, 12-C, 13-D