Chapter 8
Muscular Analysis of Upper Extremity Exercises

Manual of Structural Kinesiology
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Muscular Analysis of Upper Extremity Exercises

• Upper extremity - often one of body's weakest areas
• Strength & endurance in shoulder area
  – Essential for improved appearance & posture
  – More efficient skill performance
  – Specific conditioning exercises & activities should be intelligently selected

Upper Extremity Activities

• Upper extremity
  – Limited use in modern culture
  – Weakness can impair skill development & performance in common recreational activities
  – Appropriate base of muscular strength & endurance essential for injury prevention & adequate skill development

Upper Extremity Activities

• Typical weight room exercises concentrate only on anterior shoulder
• Without balanced approach may lead to strong & light anterior muscles with weak & flexible muscles posteriorly
• Analysis of exercises is critical to appropriate exercise prescription

Concepts for Analysis

• Important to understand
  – Muscles are usually grouped together according to their concentric function
  – Muscles work in paired opposition to an antagonistic group
    • Aggregate muscle grouping activity example
      – Elbow flexors work together as an agonist group to cause flexion in opposition to the triceps brachii & anconeus (elbow extensors)
      – In this example elbow extensor are cooperating in their lengthening to allow the flexors to perform their task

Concepts for Analysis

– Muscles work in paired opposition to an antagonistic group
  • Aggregate muscle grouping activity example
    – In doing so, the triceps & anconeus may or may not be under tension
    – If there is no tension, then the lengthening is passive caused totally by the elbow flexors
    – If there is tension, then the elbow extensors are contracting eccentrically to control the amount & speed of lengthening
    – Depending, these same muscle groups can function to control the exact opposite actions by contracting eccentrically
Concepts for Analysis

• From viewing an activity
  – Determine which muscles are performing the movement
  – Know what type of contraction is occurring
  – Know what kind of exercises are appropriate for developing the muscles

Analysis of Movement

• Analyzing various exercises & sport skills
  – Break down all movements into phases
  – Number of phases varies, usually 3 - 5
  – All sport skills will have at least
    • Preparatory phase
    • Movement phase
    • Follow-through phase
    • Many begin with a stance phase & end
      with a recovery phase

Analysis of Movement

– Phase names varies from skill to skill to fit the various sports terminology
– Names may vary depending upon body part involved
– Major phases may also be divided even further
  • Ex. Baseball pitching preparatory phase is broken into early cocking & late cocking

Analysis of Movement

• Stance phase
  – Allows athlete to assume a comfortable & balanced body position from which to initiate
    the sport skill
  – Emphasis is on setting various joint angles in correct positions with respect to one another
    and to sport surface
  – Relatively static phase with fairly short ranges of motion involved

Analysis of Movement

• Preparatory phase
  – Often referred to as cocking or wind-up phase
  – Used to lengthen the appropriate muscles so that they will be in position to generate more
    force & momentum when concentrically contract in next phase
  – Most critical phase in leading toward the desired result of activity
  – Becomes more dynamic as need for explosiveness increases

Analysis of Movement

• Movement phase
  – Sometimes known as acceleration, action, motion, or contact phase
  – Is the action part of the skill
  – Summation of force is generated directly to the ball, sport object, or opponent
  – Usually characterized by near-maximal concentric activity in involved muscles
Analysis of Movement

• Follow-through phase
  – Begins immediately after climax of movement phase
  – Brings about negative acceleration of involved limb or body segment
  – Often referred to as the deceleration phase
  – Body segment velocity progressively decreases over a wide range of motion
    • Usually attributable to high eccentric activity in muscles that were antagonist to muscles utilized in movement phase

• Generally, the greater the acceleration in the movement phase, the greater the length & the importance of the follow-through phase
  – Some athletes may begin follow-through too soon
    • Inappropriately cuts short the movement phase
    • Have less than desirable result in activity

Analysis of Movement

• Recovery phase
  – used after follow-through to regain balance & positioning to be ready for the next sport demand
  – To a degree, muscles used eccentrically in follow-through phase to decelerate the body or body segment will be used concentrically in recovery to bring about the initial return to a functional position

• Baseball pitch skill analysis
  – Stance phase begins when player assumes a position with ball in glove before receiving signal from catcher
  – Pitcher begins preparatory phase by extending throwing arm posteriorly & rotating trunk to the right in conjunction with left hip flexion
  – Right shoulder girdle is fully retracted in combination with abduction & maximum external rotation of glenohumeral joint to complete this phase

Analysis of Movement

• Baseball pitch skill analysis
  – Immediately following, movement phase begins with forward movement of arm & continues until ball release
  – Follow-through phase begins at ball release as arm continues moving in same direction established by movement phase until velocity decreases to point that arm can safely change movement direction
  – Deceleration of body & especially the arm is accomplished by high amounts of eccentric activity

• At this point, recovery phase begins, enabling the player to reposition to field the batted ball
  – In actual practice the movements of each joint in the body should be analyzed into the various phases
The Kinetic Chain Concept

• Our extremities consist of several bony segments linked by a series of joints
  – Bony segments & their linkage system of joints may be likened to a chain
  • Any one link in extremity may be moved individually without significantly affecting other links if chain is open or not attached at one end
  • If the chain is securely attached or closed, substantial movement of any one link cannot occur without substantial and subsequent movement of the other links

• An extremity may be seen as representing an open kinetic chain if the distal end of the extremity is not fixed to any surface
  – Allows any one joint in the extremity to move or function separately without necessitating movement of other joints in the extremity
  – Upper extremity examples include a shoulder shrug, deltoid raise (shoulder abduction), or a biceps curl
  – Lower extremity examples include seated hip flexion, knee extension, & ankle dorsiflexion exercises

• When distal end of extremity is fixed, as in a push-up, dip, squat, or dead lift, extremity represents a closed kinetic chain
  – Movement of one joint cannot occur without causing predictable movements of other joints in extremity
  – Involves body moving in relation to relatively fixed distal segment
  – Multiple joints are involved & numerous muscle groups must participate in causing & controlling multiple plane movements
  – Very functional
    • strongly correlate to most physical activities

In determining appropriate conditioning exercises, consider open versus closed kinetic chain through analysis of skilled movements

• Most sports involve closed-chain lower extremity activities & open-chain upper extremity activities
  – Many exceptions
  • Open-chain exercises generally isolate only one segment, while closed-chain exercises work all segments in the chain, resulting in conditioning of muscles crossing each joint

Conditioning Considerations

• Overload principle
  – Within appropriate parameters, a muscle or muscle group increases in strength in direct proportion to the overload placed on it
  – The amount of overload applied varies significantly based on several factors
    • An untrained person beginning a strength training program will make significant gains in the amount of weight he/she is able to lift in the first few weeks
    • Mostly due to a refinement of neuromuscular function, rather than an actual increase in muscle tissue strength

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Conditioning Considerations

- Overload principle
  - A well trained person will see relatively minor improvements in the amount of weight that can be lifted over a much longer period of time
  - Amount & rate of progressive overload is extremely variable and must be adjusted to match the specific needs of the individual's exercise objectives.

Conditioning Considerations

- Overload principle
  - Overload may be modified by changing any one or a combination of 3 different exercise variables - frequency, intensity, or duration
  - Increasing the speed of doing the exercise, the number of repetitions, the weight, & more bouts of exercise are all ways to modify these variables in applying this principle.

SAID Principle

- Specific Adaptations to Imposed Demands
  - the body will gradually, over time, adapt very specifically to the various stresses & overloads to which it is subjected
  - applicable in every form of muscle training, as well as to the other systems of body

SAID Principle

- Example: if an individual were to undergo several weeks of strength training exercises for a particular joint through a limited range of motion, the specific muscles involved in performing the strengthening exercises would improve primarily in the ability to move against increased resistance through the specific range of motion utilized
  - Minimal strength gains beyond the range of motion utilized if the training would occur usually
  - Other physical fitness components such as flexibility, cardiorespiratory endurance or muscular endurance would be enhanced minimally, if any.
Conditioning Considerations

SAID Principle

- To achieve specific benefits, exercise programs must be specifically designed for the desired adaptation.
  - Adaptation may be positive or negative, depending on whether or not correct techniques are used and stressed in conditioning program design & administration.
  - Inappropriate or excessive demands placed on the body in too short of a time span can result in injury.

Specificity

- Muscular strength, muscular endurance, & flexibility are not general body characteristics.
  - They are specific to each body area & muscle group.
- Specific needs of the individual must be specifically addressed when designing an exercise program.
  - Often it is necessary to analyze an individual's exercise & skill technique to specifically design an exercise program to meet his/her needs.

Muscular Development

- One does not necessarily develop adequate muscular strength, endurance, & flexibility through participation in sport activities.
- One needs to develop muscular strength, endurance, & flexibility in order to be able to participate safely & effectively in sport activities.
- Adequate muscular strength, endurance, & flexibility of the entire body from head to toe should be developed through correctly employing the appropriate exercise principles.
### Muscular Development

- Development should start at an early age & continue throughout the school years
- Fitness tests results indicate there is need for considerable improvement in this area
- Adequate muscular strength & endurance are important in the adult years for the activities of daily living, as well as job-related requirements and recreational needs
- Many back pains and other physical ailments could be avoided through proper maintenance of the musculoskeletal system

### Valsalva Maneuver

- Holding breath while bearing down to lift heavy weights or trying to exhale against a closed epiglottis
  - Thought to enhance lifting ability
- Causes dramatic blood pressure increase followed by equally dramatic drop
- Can cause lightheadedness & fainting
- Lead to complications in heart disease patients
- Do not use Valsalva, instead breath rhythmically & consistent
- Exhale during lifting & inhale during lowering

### Shoulder Pull

- Maintain attempt to pull interlocked fingers apart for 5 to 20 seconds
- Isometric exercise
  - Antagonistic contraction is as strong as the agonist contraction
  - Agonists in right upper extremity are antagonistic to agonists in left upper extremity & vice versa
  - Isometric contractions of wrist, hand, elbow, shoulder joint, & shoulder girdle muscles
  - Strength of contraction depends on angle of pull & leverage of the joint involved

### Arm Curl

- Subject stands
- Barbell is held in hands with palms to front
- Barbell is curled upward & forward until elbows are completely flexed
- Return to starting position
Triceps Extension

- Use opposite hand to assist in maintaining full shoulder flexion
- Subject begins with elbow in full flexion
- Elbow is extended until fully straight with dumbbell overhead
- Return to starting position

<table>
<thead>
<tr>
<th>Joint</th>
<th>Action</th>
<th>Agonists in Lifting</th>
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<th>Agonists in Lowering</th>
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Barbell Press

- A.K.A. as overhead or military press
- Barbell is held high in front of chest, with palms facing forward, feet comfortably spread, back & legs straight
- Barbell is pushed upward until arms are fully flexed overhead
- Return to starting position

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Chest Press (bench press)

- Subject lies supine on exercise bench
- Subject grasps barbell & presses weight upward through full range of arm & shoulder movement
- Weight is then lowered to starting position
Chest Press (bench press)

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<td>Shoulder flexors &amp; horizontal adductors (eccentric</td>
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<td>Shoulder joint flexors &amp; horizontal adductors (eccentric</td>
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Chin-up (pull-up)

- Subject grasps horizontal bar with palms away from face
- From hanging position, subject pulls up until the chin is over the bar
- Return to starting position

Latissimus Pull (lat pull)

- Subject, sitting, reaches up & grasps a horizontal bar
- Subject pulls bar down to a position behind the neck & shoulders
- Bar is returned slowly to the starting position
### Latissimus Pull (lat pull)

<table>
<thead>
<tr>
<th>Joint</th>
<th>Action</th>
<th>Agonists in Variation</th>
<th>Agonists in Return</th>
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<tbody>
<tr>
<td>Wrist &amp; hand</td>
<td>Flexion</td>
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<td>Pectoralis major, PE, PE</td>
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<td>Shoulder</td>
<td>Abduction</td>
<td>Shoulder joint abductors (isometric contraction)</td>
<td>Pectoralis major, Posterior deltoid, Latissimus dorsi, Teres major</td>
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<tr>
<td>Shoulder girdle</td>
<td>Abduction, elevation, &amp; upward rotation</td>
<td>Shoulder girdle adductors, depressors, &amp; downward rotators (isometric contraction)</td>
<td>Triceps (lower &amp; middle), Pectoralis minor, Rhomboids</td>
</tr>
</tbody>
</table>

### Push-up

- Subject lies prone on floor with legs together, palms touching floor, and the hands pointed forward & approximately under the shoulders
- Keeping back & legs straight, subject pushes up to the up position
- Return to starting position

### Push-up (fingertip)

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<td>Shoulder joint horizontal adductors</td>
<td>Pectoralis major, Anterior deltoid, Biceps brachii, Coracobrachialis</td>
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<td>Shoulder girdle</td>
<td>Abduction</td>
<td>Shoulder girdle adductors</td>
<td>Serratus anterior, Pectoralis minor</td>
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</table>

### Prone Row

- A.K.A as bent-over row
- Subject is kneeling on a bench using contralateral arm to support the body
- Involved arm is free from contact with floor
- With dumbbell in hand, arm & shoulder hanging straight to the floor, subject adducts shoulder girdle & horizontally adducts shoulder joint
- Then slowly lower dumbbell to the starting position

### Web Sites

- **American College of Sports Medicine**
  - [www.acsm.org](http://www.acsm.org)
  - Scientific research, education, and practical applications of sports medicine and exercise science to maintain and enhance physical performance, fitness, health, and quality of life
- **Concept II**
  - [http://www.concept2.com/05/training/training/GettingStarted.asp](http://www.concept2.com/05/training/training/GettingStarted.asp)
  - Information on the technique of rowing and the muscles used.
- **Fitness World**
  - [www.fitnessworld.com](http://www.fitnessworld.com)
  - The information at this site is about fitness in general and includes access to Fitness Management magazine.
Web Sites

National Council of Strength & Fitness
www.ncsf.org
- Personal Training Certification & Continuing Education for the Fitness Professional
National Strength and Conditioning Association
www.nsca-lift.org
- Information on the profession of strength and conditioning specialists and personal trainers
NSCA Certification Commission
www.nsca-cc.org
- The certifying body for the National Strength and Conditioning Association
Presidents Council on Physical Fitness and Sports
www.fitness.gov
- Information and links from the U.S. government on fitness

ExRx.net
www.exrx.net/Lists/Directory.html
- A resource for the exercise professional, coach, or fitness enthusiast consisting of over 1500 pages of exercises and anatomy illustrations
National Academy of Sports Medicine
www.nasm.org
- Offers specific certifications for health and fitness exercise specialists and a valuable resource for continuing education on exercise techniques, etc.
Upper Extremity Conditioning Program
www.eatonhand.com/hw/nirschl.htm
- Shows strengthening exercises for the upper body

Rehab Team Site: Passive Stretching
http://calder.med.miami.edu/points/upper.html
- Passive Range of Motion Exercises
Body Map
http://www.athleticadvisor.com/Injuries/general_injuries.htm
- Describes specific injuries and how to properly rehab with weights
Physician and Sports Medicine: Weight Training Injuries
www.physportsmed.com/issues/1998/03mar/laskow2.htm
- Article that is about upper body injuries and how to strengthen the upper body

NISMAT Exercise Programs
www.nismat.org/orthocor/programs/
- Step by step instructions of strengthening exercises along with diagrams
Runner Girl.com
www.runnergirl.com
- Strengthening and stretching exercises as well as other health and fitness information for women