Using Therapeutic Exercise in Rehabilitation

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Athletic Trainer’s Approach to Rehabilitation

- Begins immediately after injury
- Initial first aid has a substantial impact on the injury
- One of ATC’s primary responsibilities is to design, implement and supervise rehab plans
- Easy part is designing the program based on short and long term goals
• Short term goals
  – Control pain and inflammation
  – Maintain or improve ROM
  – Restore and increase strength
  – Re-establish neuromuscular control
  – Maintain levels of cardiorespiratory fitness
• Long term goals
  – Return athlete to practice and competition quickly and safely
• Difficult part is knowing when and how to progress relative to the injury
• Progress should be based on specific criteria
• Return to play must be based on functional outcomes
• Due to competitive nature of sports, rehab must be aggressive
  – Must return to competition quickly and safely
• Rehab should be based on framework of healing process
  – Understand time and sequence of healing and physiological principals
• Provide optimal healing environment
• ATC must have broad theoretical knowledge base of rehab techniques in order to select appropriately for each case
• No cookbook approach to rehab
Therapeutic Exercise Versus Conditioning Exercise

- Basic principle of strength training apply to rehabilitation
- Use conditioning to prevent injury and also to recover from injury
- Training and conditioning limit and minimize possibility of injury just as rehab works to return to play and prevent re-injury
Sudden Physical Inactivity and Injury Immobilization

• Body requires physical activity to maintain proper physical functioning

• When injury occurs
  – Generalized loss of physical fitness due to loss of activity
  – Specific inactivity of injured part resulting from immobilization or splinting of soft tissue

• Effects of General Inactivity
  – Highly conditioned athlete will experience rapid generalized loss of fitness
– Loss of muscle strength, endurance and coordination
– Athlete must continue to work entire body w/out aggravating the injury

• Effects of Immobilization
– Cause a number of disuse problems that impact muscle, joints, ligaments, bones, neuromuscular efficiency and cardiorespiratory system
• Muscle Immobilization
  – Atrophy and fiber conversion
    • Loss of muscle mass - greatest atrophy occurring in Type I fibers
    • Immobilization in a lengthened or neutral position tends to atrophy less
    • Can be prevented through isometric contractions and electrical stimulation
    • As unused muscle decreases in size, protein is also lost
    • W/ normal activity protein synthesis is re-established
  – Decreased neuromuscular efficiency
    • Motor nerves become less efficient in recruiting and stimulating individual fibers w/in a given motor unit
    • After immobilization, function returns w/in 1 week
• Joints and Immobilization
  – Loss of normal compression leads to decreased lubrication, subsequently causing degeneration
  – Cartilage is deprived of normal nutrition
  – Continuous passive motion, electrical muscle stimulation or hinged casts help to retard loss of articular cartilage

• Ligaments and Bone and Immobilization
  – Both adapt to normal stress - becoming or maintaining their strength
  – W/out stress ligaments and bone become weaker
  – High frequency, short duration endurance activity positively enhance collagen hypertrophy
    • Full remodeling of ligament can take 12 months or more following immobilization
• Cardiorespiratory System and Immobilization
  – Resting heart rate increases approximately 1/2 beat per minute each day of immobilization
  – Stroke volume, maximum oxygen uptake and vital capacity decrease concurrently w/ increased HR
Major Components of a Rehabilitation Program

• Well-designed rehab program should routinely address several key components before the athlete can return to pre-injury competitive levels

• Minimizing Initial Swelling
  – Swelling is caused by many factors and must be controlled immediately after injury
  – Minimizing swelling significantly speeds the healing process
  – RICE!!!
• Controlling Pain
  – Some degree of pain will be experienced
  – Pain will be dependent on the severity of the injury, athlete’s response, perception of pain and the circumstances
  – RICE, analgesics and medication can be used to modify pain
  – Pain can interfere w/ rehab and therefore must be addressed throughout the rehab process

• Restoring Range of Motion
  – Injury to a joint will always be associated w/ some loss of motion
  – Due to contracture of connective tissue or resistance to stretch of musculotendinous unit
• Physiological versus Accessory Movements
  – Both occur simultaneously and ultimately work together
  – Physiological movement results from active voluntary muscle contraction - moving an extremity through a ROM
  – Accessory motion refers to the manner in which one articulating surface moves relative to another
    • Must be normal to allow for full range of physiological movement
    • If restricted, normal physiological cardinal plane movement will not occur
- Rehab plans tend to concentrate on passive physiological movements
- If physiological movement is restricted, a stretching program designed to increase flexibility should be engaged
- If accessory motion is restricted, joint mobilization techniques should be used to address capsular and ligamentous dysfunction

• Restoring Muscular Strength, Endurance and Power
  - Must work through a full pain free range of motion when working on strength
• Isometrics
  – Performed in early part of rehab following period of immobilization
  – Used when resistance through full range could make injury worse
  – Increase static strength, work to decrease/limit atrophy, create a muscle pump to decrease swelling
  – Strength gains are limited primarily to angle at which joint is exercised, no functional force or eccentric work developed
  – Difficult to motivate and measure force being applied
• **Progressive Resistance Exercise (PRE)**
  – Can be performed using a variety of equipment
  – Utilizes isotonic contractions to generate force while muscle changes length
  – Concentric and eccentric muscle contractions
    • Traditionally focus on concentric exercises
    • Eccentrics involved in deceleration of limbs
    • Facilitate concentric contractions for plyometrics & incorporated w/ functional PNF strengthening exercises
    • Both forms are contraction can be created using a variety of equipment
    • Machines tend to limit movement in functional planes
    • Machines and free weights are difficult to operate at functional speeds w/out injury
• Tubing allows for a variety exercises
• Not encumbered by design of the machine
• Wide variety at low cost
• Isokinetic Exercise
  – Incorporated in later stage of rehabilitation process
  – Uses fixed speeds w/ accommodating resistance to provide maximal resistance throughout ROM
  – Isokinetic units allow for calculation of torque, force, average power, and work ratios which can be used by the clinician diagnostically
  – Allows for work at more functional speeds
  – Work at higher speeds tends to reduce joint compressive forces
  – Can be used to develop neuromuscular pattern for functional speed and movements
• Testing Strength, Endurance and Power
  – Can be performed through
  • Manual muscle tests
  • Isotonic resistance
  • Isokinetic dynamometers
  – Isokinetic testing generally provides the most reliable and objective measures of change in strength
Re-establishing Neuromuscular Control, Proprioception, Kinesthesia and Joint Position Sense

- Following injury, body forgets how to integrate information coming in from multiple biological sources
- Neuromuscular control is mind’s attempt to teach the body conscious control of a specific movement
- Re-establishing neuromuscular control requires repetition of same movement, step by step until it becomes automatic (progression from simple to difficult task)
- Closed kinetic chain (CKC) exercises are essential for re-establishing control but can be difficult
• Must regain established sensory pattern
• CNS constantly compares intent and production of specific movement w/ stored information, constantly modifying until discrepancy in movement is corrected
• Four key elements
  – Proprioception and kinesthetic awareness
  – Dynamic stability
  – Preparatory and reactive muscle characteristics
  – Conscious and unconscious functional and motor patterns
• Must relearn normal functional movement and timing after injury - may require several months
• Critical throughout rehab - most critical early in process to avoid reinjury
• Reestablishing proprioception and kinesthesia should be of primary concern
  – Proprioception is joint position sense (determine position of joint in space)
  – Kinesthesia is the ability to detect movement

• Kinesthesia and proprioception are mediated by mechanoreceptors in muscle and joints, cutaneous, visual, and vestibular input

• Neuromuscular control relies on CNS to integrate all areas to produce coordinated movement
• Joint Mechanoreceptors
  – Found in ligaments, capsules, menisci, labra, and fat pads
    • Ruffini’s endings
    • Pacinian corpuscles
    • Free nerve endings
  – Sensitive to changes in shape of structure and rate/direction of movement
  – Most active at end of ranges of motion

• Muscle Mechanoreceptors
  – Muscle spindles - sensitive to changes in length of muscle
  – Golgi tendon organs - sensitive to changes in tissue tension
Regaining Balance

- Involves complex integration of muscular forces, neurological sensory information from mechanoreceptors and biomechanical information
- Entails positioning center of gravity (CoG) w/in the base of support
- If CoG extends beyond this base, the limits of stability have been exceeded and a corrective step or stumble will be necessary to prevent
- Even when “motionless” body is constantly undergoing constant postural sway w/ reflexive muscle contractions which correct and maintain dynamic equilibrium in an upright posture
• When balanced is challenged the response is reflexive and automatic
• The primary mechanism for controlling balance occurs in the joints of the lower extremity
• The ability to balance and maintain it is critical for athletes
• If an athlete lacks balance or postural stability following injury, they may also lack proprioceptive and kinesthetic information or muscular strength which may limit their ability to generate an adequate response to disequilibrium
• A rehabilitation plan must incorporate functional activities that incorporate balance and proprioceptive training
Balance Equipment
Maintaining Cardiorespiratory Fitness

• When injury occurs athlete is forced to miss training time which results in decreased cardiorespiratory endurance unless training occurs to help maintain it

• Alternative activities must be substituted that allow athlete to maintain fitness
Incorporating Functional Progressions

• Involves a series of gradually progressive activities designed to prepare the individual for return to a specific sport/activity
• Should be incorporated into treatment as early as possible
• Adequate program will gradually assist athlete regain pain free ROM, restoration of strength, and neuromuscular control
• Progression moves from simple to complex, slow to fast, short to long, light to heavy
• New activities must be monitored closely to assure proper mechanics and form
• If pain and swelling do not arise, the activity can be advanced -- new activities should be added as quickly as possible
• As progress is made, the athlete should be returned to sports specific activity
• The optimal functional progression would be designed to allow opportunity for practice of every skill that is required for the sport
  – This program will minimize the normal anxiety and apprehension experienced by the athlete upon return to the competitive environment
• Functional progression activities should be done during team practice - integrate athlete w/ team and coaches
• **Functional Testing**
  – Uses functional progression drills for the purpose of assessing the athlete’s ability to perform a specific activity
  – Entails a single maximal effort to gauge how close the athlete is to full return
  – Variety of tests
    • Shuttle runs
    • Agility runs
    • Figure 8’s
    • Cariocca tests
      - Vertical jumps
      - Balance
      - Hopping for distance
      - Co-contraction test
Developing a Rehabilitative Plan

• Must be carefully designed
• Must have complete understanding of the injury:
  – how it was sustained
  – major anatomical structures involved
  – the grade of trauma
  – stage or phase of healing
• Preoperative Exercise Phase
  – Only applies to those requiring injury
  – Exercise may be used as a means to improve outcome
  – By allowing inflammation to subside, increasing strength, flexibility, cardiovascular fitness and neuromuscular control the athlete may be better prepared to continue rehab after surgery
• Phase I - Acute Inflammatory Response Phase
  – May last up to 4 days
  – Immobility for the first 2 days is necessary to control inflammation
  – Primary focus is to control swelling and modulate pain w/ RICE
  – Early mobility during rehab is critical, however, being overly aggressive during the first 48 hours may not allow inflammatory process to accomplish its purpose
  – Rest should be active - avoiding aggravating injury, but working to maintain other areas
– By day 3 or 4 swelling begins to subside
– While it may be painful to the touch w/ some discoloration, gradual mobility exercises may be started (pain free ROM)
  • If it is the lower extremity, athlete should be encouraged to bear weight
– The use of NSAID’s may also be used to control swelling and inflammation
• Phase 2: Repair Phase
  – Repair is underway and pain is less
  – Pain control is still critical
  – The addition of cardio, strengthening, flexibility and neuromuscular activities should be gradually added

• Phase 3: The Maturation/Remodeling Phase
  – Longest of 3 phases
  – Pain is minimal (none to the touch) and collagen must be realigned according to tensile strength applied to them during functional activities
– Focus is on regaining sport-specific skills
– Functional training - repeated performance of athletic skill for purpose of perfecting that skill
– Strengthening exercises should be used to place athlete under stresses and strains normally associated w/ athletic participation
– Plyometrics can be used to improve power and explosiveness
– Functional testing should be done to determine specific skill weaknesses that need to be addressed prior to full return
– Thermal modalities should be used to enhance tissue environment (reduce spasm, increase circulation, waste removal and reduce pain)
– Exercise that is too intense or prolonged can be detrimental to progress

– Increases in swelling, pain, a loss or plateau in strength/ROM, an increase in laxity or exacerbation of other symptoms indicates too great a load
Adherence to a Rehabilitation Program

• Athlete must comply to be successful

• To enhance adherence
  – Provide encouragement
  – Be creative
  – Support from peers and coaches
  – Provide a positive attitude
  – Design clear plan and instructions
  – Coach must support the rehabilitation process
  – Make an effort to fit the program to the athlete’s schedule
  – Rehabilitation should be pain free
Criteria for Full Return to Activity

• Rehab plan must determine what is meant by complete recovery
  – Athlete is fully reconditioned, achieved full ROM, strength, neuromuscular control, cardiovascular fitness and sports specific functional skills
  – Athlete is mentally prepared

• The decision to return to play should be a group decision (sports medicine team)
  – Team physician is ultimately responsible
• Decision should address the following concerns
  – Physiological healing constraints
  – Pain status
  – Swelling
  – ROM, strength, neuromuscular control, proprioception, kinesthesia, cardiovascular fitness
  – Sports-specific demands
  – Functional testing
  – Prophylactic strapping, bracing, padding
  – Responsibility of the athlete
  – Predisposition of the athlete
  – Psychological factors
  – Athlete education and preventative maintenance program
Additional Approaches to Therapeutic Exercise

• Open versus Closed Kinetic Chain Exercises
  – Anatomical functional relationship in upper and lower extremities
  – Open kinetic chain exists when foot or hand is not in contact w/ ground or other surface
  – Closed kinetic chain = foot or hand is weight bearing
    • Forces begin at ground and work their way up -- forces must be absorbed by various tissues and structures, rather than just dissipating
- Most activities involve some degree of weight bearing, therefore CKC exercise are more functional than open chain activities
- Isolation exercise typically make use of one specific muscular contraction to produce or control movement
- CKC exercises integrate a combination of contractions in different muscle groups w/in the chain
- There are a variety of popular exercises
  - Mini-squats, leg presses, step-ups, terminal knee extension w/ tubing, push-ups and weight shifting exercises on a medicine ball
• Core Stabilization Training
  – Important component of all strengthening and comprehensive injury prevention program
  – Core is defined as the lumbo-pelvic complex, area where CoG is located
  – Will improve dynamic postural control, ensure appropriate muscular balance, allow for expression of dynamic functional strength, improve neuromuscular efficiency
  – Body’s stabilization system has to function optimally to effectively utilize the strength of prime movers
– A weak core is a fundamental problem of inefficient movements which leads to injury
– Facilitates balanced muscular functioning of the entire kinetic chain - offers biomechanically efficient position for the entire kinetic chain, allowing optimal neuromuscular efficiency
– Program should be systematic, progressive and functional
– Program should be safe, challenging, stress multiple planes and incorporate a variety of resistance equipment, be derived from fundamental movement skills, and be activity specific
Core Stabilization Exercises
• Aquatic Exercise
  – Water submersion offers an excellent environment for beginning a program of exercise therapy or it can compliment all phases of rehab
  – Buoyancy and hydrostatic pressure present versatile exercise environment
    • Assistive
    • Supportive
    • Resistive
  – Can engage in sports skills, restore functional capacities, perform a variety of upper and lower extremity exercises
  – Full weight bearing activities can also be performed
Aquatic Exercises
Proprioceptive Neuromuscular Facilitation Technique

- Exercise that uses proprioceptive, cutaneous, and auditory input to produce functional improvement in motor output
- Used to increase strength, flexibility and coordination
- Based on the physiological properties of the stretch reflex
- Strengthening Techniques
  - Rhythmic initiation
    - Progressive series, first of passive movement then active assistive movements, followed by active movement through an agonist pattern
    - Helps athlete w/ limited movement progressively regain strength through ROM
– Repeated Contraction
  • Used for general weakness at one specific point
  • Move isotonically against maximum resistance of the ATC until fatigue is experienced
  • At point of fatigue, stretch is applied at that point in range to facilitate greater strength production
  • Must be accommodated resistance

– Slow Reversal
  • Movement through a complete range against maximal resistance
  • Promotes normal reciprocal coordination
  • Reversal of movement pattern is initiated before previous pattern completed
– Slow-reversal-hold
  • Part is moved isotonically using agonists, immediately followed by and isometric contraction
  • Used to develop strength at a specific point in the ROM

– Rhythmic stabilization
  • Uses isometric contraction of agonists and antagonists - repeated contraction to strengthen at a particular point

• Stretching techniques
  – Contract-relax
    • Passively moved until resistance is felt; athlete contracts antagonist isotonically against resistance for 10 seconds or until fatigue; athlete relaxes for 10 seconds and then the limb is pushed to a new stretch
    • Repeated 3 times
– Hold-relax
  • The athlete moves until resistance is felt; athlete contracts isometrically against resistance for 10 seconds; athlete relaxes for 10 seconds and then the limb is pushed to a new stretch actively by the athlete or passively by the clinician
  • Repeated 3 times
– Slow-reversal-hold-relax
  • Athlete moves until resistance is felt; athlete contracts isometrically against resistance for 10 seconds; athlete relaxes for 10 seconds, relaxing the antagonist while the agonist is contracted moving the limb to a new limit
  • Repeated 3 times
• Basic Principles for Using PNF Technique
  – Athlete must be taught through brief, simple descriptions (starting to terminal positions)
  – Athlete should look at limb for feedback on directional and positional control when learning
  – Verbal commands should be firm and simple
  – Manual contact will facilitate the motions
  – ATC must use correct body mechanics
  – Resistance should facilitate a maximal response that allows smooth, coordinated motion
  – Rotational movement is critical
– Distal movement should occur first and should be completed no later than halfway through pattern
– The stronger components are emphasized to facilitate weaker components of movement
– Pressing the joint together causes increased stability, while traction facilitates movement
– Giving a quick stretch causes a reflex contraction of that muscle
PNF Patterns

• Involves 3 components
  – Flexion/extension
  – Abduction/adduction
  – Internal/External rotation

• Distinct diagonal patterns w/ rotational movements of upper & lower extremities, upper & lower trunk and neck

• D1 and D2 patterns for each body part

• Named according to movement occurring at hip or shoulder
Muscle Energy Technique

• Manually applied stretching techniques that utilize principles of neurophysiology to relax overactive muscles and/or stretch chronically shortened muscles
• Variation of PNF contract-relax and hold-relax techniques
• Based on stretch reflex
• Voluntary contraction of muscle in a specifically controlled direction at varied levels of intensity against a distinctly executed counterforce applied by the clinician
• Athlete provides intrinsic corrective force and controls intensity of muscular contraction while clinician controls precision and localization of procedure

• 5 components necessary for MET
  – Active muscle contraction by the athlete
  – A muscle contraction oriented in a specific direction
  – Some patient control of contraction intensity
  – Athletic trainer controlled joint position
  – Athletic trainer applied appropriate counterforce

• Procedure
  – Locate resistance barrier; athlete contracts antagonist isometrically for 10 seconds, relaxes, inhales and exhales maximally while body part is moved to new resistance barrier (repeat 3-5 times or until full ROM achieved
Joint Mobilization and Traction

• Used to improve joint mobility or decrease pain by restoring accessory motion - allowing for non-restricted pain free ROM

• Mobilization may be used to
  – Reduce pain
  – Decrease muscle guarding
  – Stretch or lengthen tissue surrounding a joint
  – Produce reflexogenic effects that either inhibit or facilitate muscle tone or stretch reflex
  – For proprioceptive effects that improve postural and kinesthetic awareness
• Mobilization Techniques
  – Used to increase accessory motion about a joint
  – Involve small amplitude movements (glides) w/in a specific range
  – Should be performed w/ athlete and athletic trainer in comfortable position
  – Joint should be stabilized as near one articulating surface as possible; other should be held firmly
  – Treatment occurs in parallel treatment plane
  – Maitland Grading System
    • Grade I (for pain) - small amplitude at beginning of range
    • Grade II (for pain) - large range at midrange
    • Grade III (treating stiffness) - large amplitude to pathological limit
    • Grade IV (treating stiffness) - small amplitude at end range
    • Grade V (manipulation) - quick, short thrust
• Mobilization based on concave-convex rule
  – When concave surface is stationary, convex surfaces is glided in opposite direction of bone movement
  – When convex surface is stationary, concave surface is glided in direction of movement

• Mobilization can also be used in conjunction w/ traction

• Traction
  – Pull articulating segments apart (joint separation)
  – Occurs in perpendicular treatment plane
  – Used to treat pain or joint hypomobility
Treatment Planes
Joint Mobilization Techniques
Myofascial Release

• Group of techniques used to relief soft tissue from abnormal grip of tight fascia
• Specialized form of stretching
• Fascia is essentially a continuous connective tissue network that runs throughout the body, encapsulating muscles, tendon, nerves, bone, and organs
• If damage occurs in one section it can impact fascia in sites away from the affected area
• Form of soft tissue mobilization
  – Locate restriction and move into the direction of the restriction
  – More subjective and relies heavily on experience of the clinician
  – Focuses on large areas
  – Can have a significant impact on joint mobility
  – Progression, working from superficial to deep restrictions
  – As extensibility increases in tissue should be stretched
– Strengthening should also occur to enhance neuromuscular reeducation to promote new more efficient movement patterns
– Acute cases resolve in a few treatments, while longer conditions take longer to resolve
– Sometimes treatments result in dramatic results
– Recommended that treatment occur 3 times/wk
Strain/Counterstrain

- Technique used to decrease muscle tension and normalize muscle function
- Passive technique that places body in a position of comfort - thereby relieving pain
  - Locate tender points (tense, tender, edematous spots, ≤1 cm in diameter, may run few centimeters long in muscle, may fall w/in a line, or have multiple points for one specific joint)
  - Tender points monitored as athlete placed in position of comfort (shorten muscle)
– When position is found, tender point is no longer tense
– After being held for 90 seconds, point should be clear
– Patient should then be returned to neutral position

• Physiological rationale based on stretch reflex
  – Muscle relaxed instead of stretched
  – Muscle spindle input is reduced allowing for decreasing in tension and pain
Positional Release Therapy

• PRT is based on the strain/counterstrain technique
• Difference is the use of a facilitating force (compression) to enhance the effect of positioning
• Osteopathic mobilization technique
• Technique follows same procedure as strain/counterstrain however, contact is maintained and pressure is exerted
  – Maintaining contact has therapeutic effect
Positional Release Therapy
Active Release Therapy

- ART is relatively new type of therapy used to correct soft tissue problems caused by formation of fibrotic adhesions
  - Result of acute injury and repetitive overuse injuries or constant pressure/tension
  - Disrupt normal muscle function affecting biomechanics of joint complex leading to pain and dysfunction
  - Way to diagnose and treat underlying causes of cumulative trauma disorders
• Deep tissue technique used for breaking down scarring and adhesions
  – Locate point and trap affected muscle by applying pressure over lesion
  – Athlete actively moves body part to elongate muscle
  – Repeat 3-5 times/treatment
  – Uncomfortable treatment but will gradually soften and stretch scar tissue, increase ROM, strength, and improve circulation, optimizing healing
  – Must follow up w/ activity modification, stretching and exercise
Active Release Therapy
Purchasing and Maintaining Therapeutic Exercise Equipment

- Price can range from $2 for surgical tubing to $80,000 for computer driven isokinetic and balance units
- Debate on effectiveness and availability of expensive equipment versus hands of clinician
- Must consider budget restraints when purchasing
• Must consider usefulness and durability of equipment
• Will equipment facilitate athlete reaching goals of rehabilitative program
• Must be sure to maintain equipment once purchased, use correctly and for intended purpose
• Apply manufacturers guidelines for periodic inspection and maintenance to ensure safe operating conditions