Principles and Techniques of Open Kinetic Chain Rehabilitation: The Upper Extremity

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The kinetic chain is open in the upper extremity skills used in most sports. Although closed chain exercises will increase stability, open chain strengthening is more sport specific. This article addresses general concepts of upper extremity rehabilitation, including exercises to restore normal range of motion, joint mechanics, and muscle strength. The roles of proprioceptive neuromuscular facilitation, plyometric training, and elastic band exercises are also discussed. Finally, a progression of specificity training is presented to return the athlete to successful sport performance.

The rehabilitation of the upper extremity follows the same principles of rehabilitation for other body areas yet poses some unique challenges to the therapist and athlete. The shoulder presents problems due to its inherently unstable nature as well as its somewhat complicated biomechanics; the elbow’s propensity toward the development of myositis ossificans following trauma creates another difficult challenge; and the wrist and hand are an area through which great forces are transmitted during performance of weight-training techniques designed to strengthen the upper extremity.

Because of these special structural considerations, it is prudent to analyze the athlete’s sport skill patterns and conditioning techniques to fully understand the functional goals to be addressed in rehabilitation. Some of the areas to be addressed should include range of motion in shoulder, elbow, and wrist; general strength of individual muscles, synergistic muscles, and antagonistic muscles; quality of movement (rhythm, coordination, and accessory movements); speed of movement; sport-specific skills; and ways to challenge the athlete sufficiently to allow return to sport.

Many sports medicine therapists have focused on structural components of injury as addressed by the orthopedic surgeon. There is, however, a viewpoint of “function” from which treatment may be addressed. This differentiation is becoming more clear as the focus of orthopedic physical therapy turns to changes in function rather than strictly changes in structure.

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Joint Range of Motion

Joint range of motion must be assessed to determine (a) if compensatory motor patterns have developed and (b) if the limited range causes any functional limitations.

Often, the athlete will develop motor patterns to accomplish a task while limiting the stress on the injured tissues. This patterning will often continue into the rehabilitation program unless addressed and corrected at an early stage. Most athletes will be able to reestablish the normal "correct" patterning once attention is directed to the compensatory pattern.

Occasionally, following surgical repair or reconstruction, a joint will not be able to achieve the preoperative range of motion. This is especially true in cases where excessive joint range was the indication for surgery. In these situations, a functional range of motion with normal motor patterns may be sufficient to return the athlete to his or her preinjury level of participation. Special effort must be made to ensure that the athlete is not compensating for loss of range by substituting abnormal motor patterns. Additionally, when an athlete can be returned to some functional activities, range of motion often increases as activities increase.

For example, a 300-lb offensive lineman had difficulty regaining flexion after an anterior cruciate reconstruction. Joint mobilization, stretching, and other training room procedures failed to return the knee to more than 90° of flexion. When the athlete began doing body weight squats (with support for safety), his range returned quite quickly. Thus, after tissue healing is sufficient, functional activities using the weight of the body may speed the athlete's progress in regaining range.

Joint Mobilization

Passive mobilization of the stiff joint may prove helpful alone or in combination with other rehabilitation techniques. There are several schools of thought on mobilization; each has a unique focus, but all have the same basic philosophy toward restoration of normal motion within a joint.

Maitland, the most widely taught mobilization technique, is based on a variable scale of joint motion. Full, pain-free joint motion is indicated by a solid line. The mobilization techniques involve four grades of movement, each with its own therapeutic objective. These four grades are placed upon the joint range of motion (ROM) line as shown in Figure 1.

![Figure 1 — Grades of mobilization using the Maitland approach.](image-url)
Grade 1 and Grade 2 techniques are used for a patient whose major complaint is pain. Grades 3 and 4 are used for the patient whose joint is not painful but is very stiff. Patients often present with a combined pain/stiffness problem, but usually the predominant symptom can be ascertained.

Grades 1 and 4 are both small-amplitude movements; Grade 1 is at the start of range of motion, while Grade 4 is performed at the end of the range of joint motion. Grades 2 and 3 are quite large-amplitude movements and are controlled in such a way as to not enter the painful range (Grade 2) or the end of joint motion (Grade 4).

Additionally, Maitland considers two sources of the problem. The first is physiological movement of the joint, movement that the patient is capable of performing. The other is accessory movement, which is the small motion within the joint that must occur to allow physiological movement to take place without difficulty.

To further understand Maitland’s application of joint mobilization to the stiff shoulder, first realize that an accessory motion of depression of the humeral head on the glenoid must occur if physiological abduction is to take place. Following is the suggested protocol for the patient with symptoms of stiffness predominating over the symptoms of pain (STIFF/pain):

- Grade 4 physiological movements are applied at the end of the range.
- While the physiological range is maintained, Grade 4 accessory movements are applied in a cephal to caudal direction.
- After these two applications, the joint usually is painful, so the series is finished with Grade 2 physiological movements in shoulder abduction.

Each application of graded movement should be carried out for about 2 min at the rate you would sing “Row, Row, Row Your Boat.” Protocols for PAIN/stiff patients are also available but are often less of an asset in the athletic setting.

The Maitland mobilization techniques are certainly not the only techniques of joint mobilization; however, they address the concept of physiological versus accessory joint motion, which is extremely important when one is attempting to increase joint range of motion.

Joint mobilization techniques require extensive hands-on practice in feeling the joint motions and performing the mobilization movements. Specialized courses are offered on several of the varied techniques.

**Stretching Techniques**

Injury to the contractile unit may result in a loss of range of motion, and this motion may be restored by stretching.

*Contract-relax stretching* may be done using proprioceptive neuromuscular facilitation (PNF) diagonals or conventional straight movement patterns. The athlete is asked to push as resistance is applied to the muscle group to be stretched. At the command “relax,” the athlete stops contracting as the clinician provides a gradual stretch of the agonists.

*Active stretching* may be best used prior to activity. The athlete is instructed...
in a series of stretches for specific muscles or muscle groups. The athlete should stretch the target muscle or muscles to the point of discomfort and should hold that position for 6–10 s. Each muscle or muscle group can be stretched several times to ensure that the muscles are prepared for activity.

**Passive stretching** with a partner or therapist often is best for achieving a full range of motion from a muscle or muscle group. Most athletes will avoid the painful range of joint motion in performing a stretch, but the partner can judge the “end feel” of the motion in determining at what point in the range the stretch should be held. The partner who is stretching the athlete must pay attention to the athlete’s signs of discomfort if the range of joint motion appears to lack a physiological limit. If range of motion is limited by pain, the end feel can be described as being “empty,” indicating pathology within the joint and/or muscle tissue.

**Active-assisted stretching** occurs when the athlete who is being stretched by a partner is asked to contract, against resistance, the muscle or muscles being stretched. Following a 6- to 10-s static contraction, the therapist moves the limb further into the range of motion and holds again for 6–10 s. This contract/relax/stretch procedure can be repeated several times to achieve the maximum range of motion. Each contract/relax/stretch should provide an increased range of motion from the muscle group.

**General Strengthening Techniques**

As the range of motion increases to a functional level, motor patterns should be observed and corrected as needed. Close attention is needed to help the patient reestablish correct motor patterns. Fortunately, most athletes’ proprioception is greater than that of the “average” patient, and normal movement patterns often return fairly quickly. Biofeedback may be of benefit in accomplishing this task. Simple visual feedback via a mirrored wall can serve this purpose quite well.

Once proper motor patterns are evident, strengthening may be instituted. With the plethora of specific skills of sports it is impossible to describe all strengthening techniques one might utilize. A general overview follows.

**Open Versus Closed Kinetic Chain Exercises**

Open kinetic chain exercises historically predominate the strengthening done for the upper extremity. Because the kinetic chain is open in the skills used in most sports, open kinetic chain strengthening is more sport-specific than closed kinetic chain strengthening.

Closed chain exercises for the upper extremity will increase stability, especially in the shoulder joint. Closed chain activities are beneficial in establishing early stability of the joint, while open kinetic chain exercises allow increased mobility of the proximal and distal joints.

Additionally, open kinetic chain exercises allow more functional use of the extremity and thus allow an increased development of rapid movement. A common goal in many sport skills is to increase the speed of the moving upper extremity; thus, specificity of training would lead the clinician to the open chain exercises in rehabilitation.
Specific Open Chain Rehabilitation Techniques

The skilled clinician utilizes a variety of activities designed to achieve a particular rehabilitation goal. The veritable “bag of tricks” that the clinician uses is an asset in maintaining patient interest and motivation in the daily rehabilitation routine. The more variety incorporated, the better the effort and the better the outcome. All too often, highly motivated athletes are asked to undergo rehabilitation using simple, repetitive exercises. Often, such athletes fail to return for continued rehabilitation because they “know” what the therapy will consist of and feel they can do it alone. Changing the program daily will keep the athletes guessing and encourage them to come back for more.

Often, using one day as “trainer-turnaround day” will show the clinician just how motivated an athlete really is. Trainer turnaround allows the athlete to combine any exercises used in the past programs to develop the day’s workout. The athletic trainer then works with the athlete in the program developed. The athletic trainer must reserve the right to modify the program if stresses appear too much for the stage of the healing process, yet the fact the athlete wants to increase the intensity of the workout should indicate that past programs have not been challenging enough.

Isolated Movements

Isolated movements prove useful in strengthening a single muscle group or in providing a base upon which better motor control may be developed. In isolated movements, the athlete is instructed to move the weight or resistance in a straight line, through a specific range of motion. There are several ways to provide the resistance to this straight-line movement; they include free weights, elastics, isokinetics, isotonic weight machines (accommodating resistance), and manual resistance.

Each of these types of resistance contributes to strengthening but alone will not allow the athlete to fully develop the required strength for sport. In general, the single-plane movements limit the strength development to that specific movement pattern. Since few sports rely on only one movement pattern, limiting the rehabilitation program to strengthening with these methods would create a lack of functional strength training in the program.

Synergistic Patterns

Synergistic patterns involve muscle activity in the entire extremity in a specific combination of movements. These patterns have been observed developmentally and in cerebral vascular accidents (CVA) or stroke patients suffering a loss of motor control. With activation of one muscle in the pattern, the other muscles exhibit a simultaneous increase in muscle activity. Movements that incorporate these synergistic patterns allow a natural progression of strength development. Synergistic patterns are the basis for proprioceptive neuromuscular facilitation (PNF) techniques:

Proprioceptive Neuromuscular Facilitation

PNF has long been used in physical therapy for the neurologically challenged patient, and in the past 10–15 years it has been found to be a useful tool in athletic rehabilitation.
PNF, in the true definition, is a set of precise movement patterns. These patterns are based on the neuro-physiological patterns (synergistic patterns) present developmentally in the human. The patterns are specific to the body part to be exercised and will always contain a component of flexion or extension, abduction or adduction, and rotation in the proximal joint.

Varied PNF techniques have been described to assist the clinician in providing maximal resistance to affected muscles. Some techniques that are more prevalent in athletic rehabilitation include slow reversals, rhythmic stabilization, repeated contractions, and pivots.

Each of the techniques can be applied to either of the two "diagonals" or patterns found in the extremity and are identified according to the motion occurring at the proximal joint. In the upper extremity the two patterns are D1: flexion/adduction/external rotation, and D2: flexion/abduction/external rotation. The pattern, although described in terms of flexion, also involves a return to the starting position using the opposite motions. For example, the D1 extension pattern involves extension, abduction, and internal rotation.

Proprioception and movement are elicited through nervous system reflexes such as the stretch reflex. At the start of the pattern, the therapist applies a traction, or quick stretch to the muscles, to elicit a stronger contraction.

Another asset of PNF is irradiation. Irradiation is a term used for the overflow of strength occurring when strong muscles about one joint are maximally stimulated and this force production increases the tension generated by weaker muscles in an adjacent joint. In other words, a patient with strong wrist and finger flexors but a weakened biceps will exhibit greater strength when the wrist and hand muscles are maximally stimulated to contract with the elbow contraction than if the elbow movement is isolated. This can be seen when the athlete is asked to grasp an object very tightly and then generate a biceps contraction. The contraction of the biceps will be much stronger when the hand is clenched tightly than if the hand remains flat.

Thus, the aspects that set PNF apart from other manual resistance exercises include the following:

- The use of synergistic diagonals that appear to have "neuronal" connections, making the combination movements stronger than movements in other planes
- Irradiation from stronger joints to assist the weakened area
- The use of the stretch reflex to increase the corresponding muscle contraction
- Involvement of hand, wrist, elbow, and shoulder muscles in the performance of the technique or pattern

Exercises must include these aspects to be labeled "true" proprioceptive neuromuscular facilitation. Adaptations of the PNF concepts are frequently applied to other exercises with excellent results.

Modified PNF

PNF, like joint mobilization techniques, requires extensive practice to understand the true meaning and use of the methods. Clinicians often adapt a PNF diagonal
to better suit a motor pattern they are attempting to strengthen. This modification of the PNF pattern or technique may deviate so far from true PNF that it should no longer be associated with PNF, yet better terms are unknown. Modified PNF is a term used to describe combination movements that are not synergistic patterns or pure PNF diagonals but have some of the components of PNF. Common deviations to the diagonals occur when a clinician is working with an athlete who uses a pattern similar to the PNF pattern.

Modified PNF patterns as used in sport may include modifications to the D1 pattern, as in the softball pitch, the trailing arm in golf, the rip technique in football, and ground strokes in tennis. Also, the D2 pattern is frequently modified for the following overhand throwing motions: all baseball positions (sidearm included), the tennis serve motion, the backstroke in swimming (flexion component), the front crawl in swimming (extension component), and the javelin throw.

Combination Movements

Combination movements might be a more appropriate label for some of the many movement patterns currently referred to as modified PNF. The combination of shoulder, elbow, wrist, and hand movements on the involved side is an important developmental aspect of returning the athlete to sport.

The combination of movements of the uninvolved extremity with the involved extremity is another important aspect in sport rehabilitation. The athlete often uses the nondominant arm as a counterbalance for the dominant or active upper extremity.

Ultimately, most sports require total body combination movements, golf being the sole intercollegiate exception. Moving the upper body while the lower body is in motion is the root of dynamic sport skills. A thorough upper extremity rehabilitation program must incorporate combination movements that focus on the development of coordination, balance, and proprioception in total body movement. An athlete must develop coordination between the upper and lower extremities, often while focusing his or her eyes on another player!

Quality of Movement Analysis

It is essential that the quality of movement be assessed and analyzed. This analysis should begin the day the athlete steps into the training room and should continue throughout the rehabilitation process. Initially, the clinician will observe for compensatory motor patterns, but as the athlete becomes able to perform sport skills, the clinician begins looking at the biomechanics of the sport skill. This biomechanical analysis is of paramount importance as the athlete makes a gradual return to sport skills.

It certainly is not wise to change an entire movement pattern, yet subtle changes such as the degree of knee flexion at release of a throw, or the position of the elbow at contact in the serve, may prove to be critical issues in returning the athlete to previous levels of performance.

A videotape taken of the athlete performing sport skills will help the therapist, coach, and athlete understand biomechanical compensation patterns. Whenever possible, the athlete should be filmed from side, front, and rear views to fully reveal the movement pattern. Discussing the skill pattern with the coach
will clarify the techniques that the athlete is to use in the sport skill. Allowing the coach to participate in the analysis will often give the athlete additional motivation and will create a better support system between the coach and the recovering athlete. In working with the athlete’s motor skills, the clinician should attempt to provide verbal and sensory cues common to the sport and to the coach’s teaching style to avoid conflict between rehabilitation and return to sport.

Speed Development

Most sports require great strength at very high speeds. The speeds at which the muscles must respond to the forces of sport are rarely replicated in controlled rehabilitation settings. The tennis player generates great angular momentum during the preparatory phase of the serve, and at the moment of contact the player must fire the antagonistic muscles to quickly decelerate the limb.

In addition to the very well documented biomechanics of the throwing motion, the biomechanics of all sport skills must be understood. The strongest of athletes are still prone to sudden contact that forces a joint beyond its normal range of motion. A football defensive lineman, using the swim technique over his opponent, is struck by another opponent while his arm is overhead. This sudden impact requires a very rapid response of the internal rotators, first to stop the motion the athlete initiated and second to resist the motion imposed by the opponent. Various situations arise, especially in contact sports, which require strength development that must be supplemented by the development of rapid muscle response to a load.

High-Speed Isokinetics

Companies manufacturing isokinetic devices have long recognized the speed of the arm in the pitching motion. Advances in technology allow a much closer replication of the angular velocity of the shoulder during overhead skills. The clinician with access to high-speed isokinetics may incorporate these exercises into the total rehabilitation program.

Plyometric Training

Long known and respected as an asset to speed development in the lower extremity, plyometrics are now seen as an adjunct to exercises in the upper extremity. Plyometrics are excellent in the development of the eccentric to concentric change in muscle activity that is critical to injury prevention in the upper extremity.

Sports that place the shoulder in a vulnerable position and impose high forces subject the athlete to the greatest risk. Diving, tackling, sliding into base, moves in wrestling, and many other activities are well known as the mechanisms of injury in the upper extremity. The athlete who is able to absorb the imposed force and generate a reversal of force, to become force producing, often can avoid traumatic injury.

The use of increasingly heavier weighted balls or “plyo-balls” will assist the intuitive practitioner in developing a variety of exercises to challenge the athlete’s ability to resist the forces applied through the shoulder, elbow, and wrist.
Elastic Band Exercises

Elastic resistance exercises can be very beneficial as low-load exercises incorporating concentric/eccentric muscle activity. The shoulder and elbow positions may be modified to any position as the resistance is directed from above, from below, or from the sides. Various tensions are available in elastic tubing and bands, and with careful design of the athlete’s position and the direction of elastic pull, speed may be developed in short arcs of movement.

Other Specialized Open Chain Exercises

Several techniques and tools may be incorporated into the rehabilitation program. The “BodyBlade” is a graphite material which, when oscillated, aids in the development of joint stability. The “Impulse” utilizes pulleys and weights to provide an eccentric/concentric challenge to the athlete. Various positions may be used, and forces may become very great. A simple rebounding apparatus will allow unattended plyometric activity and may be used to incorporate combination movements. Repetitive movements, such as tapping a ball against a wall in an overhead position, can be used in the early phases to begin developing shoulder stability in the more vulnerable ranges of joint movement.

Specificity Training

The goal of all training, whether initial training or retraining, must involve specific motor patterns. This means that the athlete should practice the movements that he or she will use in sport performance.

Specificity of movement in the rehabilitation of an athlete must be addressed in a very controlled progression to avoid reinjury. Each sport, each skill, and each athlete present with unique motor pattern requirements. Those requirements must be realized and exercises must be developed to facilitate a steady progression to the athlete’s full return. The basketball player needs motor patterns for jump shots, set shots, blocking, rebounding, and passing skills. Each of those motor patterns should be incorporated into the rehabilitation program by the use of manual resistance, PNF, weights, elastics, plyo-balls, the basketball, and other creative exercise techniques.

Toss Programs

The most widely understood specificity retraining program is an interval throwing program for baseball players. These interval programs have been designed to gradually return range of motion and strength to the throwing arm after injury by slowly progressing the athlete through graduated throwing distances and by gradually increasing the throwing speed.

In a typical toss program, the athlete usually throws on the flat ground, from 45, 60, 90, 120, 150, and 180 ft. Each session would include a progression from one or two sets of 20–25 throws up to three sets of 20–25 throws from the prescribed distance. Each set of throws should be preceded by a series of warm-up throws, a rest period should be imposed between sets, and a warm-down and...
stretch-out session should end each day’s work. In the following example, all throws progress from 45 ft to 60, 75, 90, and up to 180 ft on level ground:

**Stage 1**
1. Warm-up throwing
2. 20–25 throws
3. Rest 15 min
4. Warm-up throwing
5. 20–25 throws
6. Warm-down, stretch-out

**Stage 2**
1. Warm-up throwing
2. 20–25 throws
3. Rest 10 min
4. Warm-up throwing
5. 20–25 throws
6. Rest 10 min
7. Warm-up throwing
8. 20–25 throws
9. Warm-down, stretch-out

The athlete works on progressively faster and harder throws at each distance prior to working on the next distance. The athlete who can throw with good speed and control from 180 feet is then allowed to begin throwing off the mound. This progression blends distance with speed and controls the number of repetitions. Similar programs may be developed for other sport skills requiring throwing or hitting skills, incorporating distance or accuracy with the speed of the projectile.

**Skill Development**

Just as a coach would create greater and greater challenges for the young athlete unfamiliar with the sport, the therapist must find specific skill-related activities to challenge the rehabilitating athlete.

**Overhead Patterns**

Interval throwing programs can be modified to apply to any overhead pattern of force production. One of the biggest challenges in baseball is preparing an athlete to return to throwing off an incline (mound), and careful attention must be paid to proper mechanics. Most sport skills do not impose the additional stressors of a mound; thus, the development of the skill tends to involve greater and greater force production. With the increased forces through the shoulder, the muscles must also have an increased ability to eccentrically contract to slow down the limb motion.
Functional Patterns

Attention must be given to the function of the body in the execution of the skill. Some patterns may appear "functional" and the athlete is able to do the job, but the normal biomechanics of the body are compromised.

Previously, clinicians would observe the athlete's upper extremity motions to ensure proper glenohumeral rhythm. Close attention has been paid to compensatory movements of the involved extremity. Yet, for example, little emphasis has typically been given to the trunk in the rehabilitation of the shoulder.

In the future, clinicians will pay more attention to returning proper body mechanics not only to the affected joints but also to the adjacent systems, including the rib cage and abdominal wall musculature; the cervical, thoracic, and lumbar spine; and even the diaphragm and respiratory system.

Preparation for Return to Sport

The rehabilitation program for the upper extremity, whether using open or closed chain activities, must follow a systematic overload of the injured tissues and supportive structures.

Progressive Overload

Overloading the tissues develops strength, and with the development of strength comes the ability to withstand the tremendous forces sport places upon tissues.

Rehabilitation without overload would be as foolish as the assumption that a football player is ready to return to his linebacker position after a mild brachial-plexus stretch simply because he can "hold" a few joint positions. The sudden load placed upon the shoulder in an arm tackle far exceeds any force the clinician could apply in the sideline evaluation. Sport overloads the joints; clinically applied stresses do not. The clinician must understand the forces the athlete is subjected to, understand the subtle differences in the requirements of various situations, and then find ways to gradually increase stresses to the point of mimicking sport.

To fully prepare the athlete for return to a sport where the forces applied to the joint are difficult if not impossible to control, the therapist must overload the joint in a variety of situations. If an athlete is involved in a sport in which he or she is in full control of the forces through the joint, then these forces can be easily reproduced in the clinic, and rehabilitation may well take place there.

Return to Full Weight Training

Weight training can be the savior for the athletic trainer. Strong, well-conditioned athletes tend to resist injury more effectively. A freshman football player who has little or no previous weight training work often suffers from injuries directly related to his lack of strength.

As the athlete recovers from injury, weight training should begin gradually. Weight training is limited by the athlete’s condition, and adjustments to the program are usually required. As much as possible, the weight coach and the athletic trainer must communicate regarding the athlete’s condition and together
must modify the program to allow a gradual return to full participation in team and individual lifting sessions.

Sport Drills in the Rehabilitation Setting

Developing sport-related drills in the rehabilitation setting requires creativity. Often, this phase will find the athlete and the athletic trainer alone on the field. Another player can be asked to “go one-on-one” with the athlete/patient. The athletic trainer’s sport skills are occasionally less than those of a skilled teammate! A coach can assist the athletic trainer in providing feedback for technique development in team sports and in the mechanics of the sport skill in individual sports.

Eventually, the rehabilitation of the athlete necessitates the use of the playing field or court during team practice. This return to the playing environment provides both positive and negative rewards. The positive rewards certainly include an increase in motivation (and enjoyment) for the athlete, which can promote a feeling of the athlete’s pending “return.” But occasionally the athlete’s presence increases the expectations of the teammates and coaching staff, and increases the athlete’s own expectations as well, which could result in a loss of control of the athlete’s systematic rehabilitation.

Part of the solution to this potential difficulty is communication. If the athlete, coaches, and teammates known the athlete is in a controlled environment, fewer assumptions will be made. Communication alone is often not sufficient. A person from the rehabilitation team should be present to oversee each activity in which the athlete is allowed to participate. An occasional “check” by the athletic trainer on the field is not enough to show that the athlete’s activities are under control of the rehabilitation team rather than the coach. As the athlete’s condition improves to the point that he or she is merely restricted from drills or situations, the coach and athlete should be made aware of the restrictions.

Summary

All rehabilitation is inherently boring to the competitive athlete. Rehabilitation that is routine and nonchallenging often leads the athlete to feel he or she can “go it alone.” Some athletes do and fare very well, yet others fail miserably. A weekly program should provide a variety of exercises for the athlete, with no 2 days being identical.

Open kinetic chain exercises lend themselves well to the majority of skills used in athletics. The athletic trainer must study closely the demands of the sport, the skills needed to compete, and the stresses to be endured, in order to develop a sound, progressive program.

Creativity is key in challenging the athlete to develop skills of the sport and skills of self-protection to allow gradual return to team activities. The athletic trainer must be open-minded and insightful in developing a “bag of tricks” to fully achieve the goals of rehabilitation.