Mobility Training for the Young Athlete

Toby Brooks, PhD, ATC, CSCS[1] and Eric Cressey, MA, CSCS[2]
[1]Texas Tech University Health Sciences Center, Amarillo, Texas; and [2]Cressey Performance, Hudson, Massachusetts

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ABSTRACT

CONTEMPORARY CORRECTIVE EXERCISE TECHNIQUES EMPHASIZING THE IMPORTANCE OF ADEQUATE MOVEMENT ABILITY AND SOFT TISSUE EXTENSIBILITY ARE NOW RELATIVELY COMMON IN MOST STRENGTH AND CONDITIONING PROGRAMS. DESPITE DEMONSTRATED POTENTIAL FOR PERFORMANCE DEFICIT, PREACTIVITY FLEXIBILITY TRAINING HAS BEEN EMPLOYED AND CONTINUES TO BE USED BY MANY SPORT COACHES. PARTICULARLY, IN THE DEVELOPING ATHLETE, THE DIFFERENCES BETWEEN MOBILITY AND FLEXIBILITY TRAINING ARE SIGNIFICANT. THE PURPOSE OF THIS ARTICLE IS TO DEFINE MOBILITY AND DISCUSS THE PRACTICAL IMPLICATIONS OF INCORPORATING MOBILITY MOVEMENTS, DRILLS, AND EXERCISES INTO PROGRAMMING FOR YOUNG ATHLETES TO REDUCE THE RISK OF INJURY AND MAXIMIZE PERFORMANCE.

INTRODUCTION

In recent years, mobility training and corrective exercise techniques emphasizing the importance of adequate soft tissue extensibility have become increasingly popular in the field of strength and conditioning (3). More specifically, the application of mobility concepts to young athletes in the prevention and treatment of movement impairment syndromes has also grown increasingly popular. Many strength and conditioning professionals have recognized the importance of appropriate functional movement ability in athletic enhancement programming and have altered more traditional programming to accommodate the needs of their athletes.

Conversely, flexibility training has often been loosely defined in a variety of ways, including in reference to the actual length of muscle and soft tissue (i.e., "inflexible" hamstrings), the amount of movement possible at a joint or series of joints (i.e., inflexible ankles), or the position the athlete is capable of achieving during an athletic or conditioning movement (i.e., "too inflexible to perform a deep squat"). Most commonly, flexibility refers to the absolute range of motion possible within a joint or series of joints and may be either static or dynamic (2).

Although flexibility certainly influences systemic movement, the construct of flexibility does not sufficiently address all aspects of movement-specific functional activity. For example, flexibility is usually assessed in a non–weight-bearing position, whereas the majority of athletic movements occur with the athlete in standing or otherwise in an upright position. Because of the relatively isolated nature of flexibility examination, the influence of systemic restrictions such as fascia may not be readily apparent. As a result, flexibility is usually considered a clinical construct with respect to a joint-specific deficiency or excess in movement.

Conversely, mobility is considered a more functional construct describing the athlete's ability (or inability) to reach an intended posture or position. Although flexibility assessment generally involves only 1 or 2 joints at a time, mobility assessment is typically multijoint and as a result more systemic in nature. Mobility is more global in scope and includes the athlete's ability to function and reach desired positions during activity and is heavily dependent upon stability and proper coordination of multiple joints functioning simultaneously. Although mobility is relatively easy to assess in a general sense, follow-up screening is typically necessary to identify the source of any identified restriction or inhibition. Table 1 further depicts the principal differences between the constructs of flexibility and mobility.

In appreciating these differences, 3 critical distinctions emerge that should serve as the foundation for any effort toward mobility training in the adolescent and high school athlete. First, no single method of mobility training is effective for all athletes. The vast disparities and unique differences in young athletes make nonspecific programming impractical and largely ineffective. As such, programming must be tailored, at least to some degree, to be of maximum benefit to the developing athlete. Second, adolescent athletes in

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Table 1 Flexibility versus mobility		
	Flexibility	**Mobility**
Nature of the capacity	Clinical	Functional
Strength and power influence	Detrimental	Facilitative
Neuromuscular influence	Minimal	Significant
Articular involvement	1–2 joints	Multijoint
Influence of fascia	Minimal	Significant
Assessment	Clinical measurement (goniometry)	Functional, requires follow-up
Most appropriate time for training	After activity	Before or after activity

the midst of puberty and experiencing rapid changes in height and weight are essentially moving targets. Not only must programming be specific but also ever changing and varied so as to keep pace with the developing athlete. Otherwise, programming rapidly ages past the point of utility. Third, because of its systemic nature, mobility improvements are dependent upon other aspects of training such as strength and conditioning drills performed throughout the full range of motion as well as specifically targeted flexibility initiatives. Consequently, although mobility drills should be used as a general warm-up, simple cueing of appropriate postures and positioning throughout the session is critical in helping the young athlete reinforce the formation of appropriate movement patterns.

PERSISTENCE OF THE PRE-EXERCISE STATIC STRETCH

Despite evidence to the contrary, many sport coaches continue to ascribe to antiquated notions regarding the preactivity warm-up. Sport participation often begins with light jogging and static stretching with an eventual progression to sport-specific activities. However, such practice has been associated with performance reductions stemming from decreased isometric and dynamic muscle strength at different velocities (13,21,25,34,40). Whereas the former component obviously has dynamic stability implications (which also directly affects mobility), the latter component is most critical to performance. Several investigations have demonstrated that pre-exercise static stretching negatively impacts both slow speed high force movements (e.g., powerlifting) (3,8) and high-speed lower force movements (e.g., vertical jumps, sprints) (10,11,25).

Some investigations suggest that prolonged stretching makes the musculotendinous unit (MTU) excessively compliant. Because adequate MTU stiffness is an important component of force development, an increase in compliance reduces force and power output (10,17). This reduction in compliance not only decreases neural drive to the muscle but also impairs the proficiency of the stretch-shortening cycle. Simply stated, a compliant MTU does not store elastic energy as efficiently as a less compliant MTU (17,37). However, it should be noted that in many studies, examining the effects of static stretching on performance, the longer stretching duration and proximity to high-intensity exercise was not reflective of typical athletic warm-ups. Furthermore, such investigations have almost always been conducted on college-aged subjects. As such, their practical application to young athletes may be in question.

With these factors in mind, the inclusion of static stretching in a young athlete's training program is something that must be considered on an individual basis. Generally speaking, the need for specific flexibility work increases as the athlete physically matures. More specifically, the preadolescent typically requires an emphasis on neuromuscular development with a decreased emphasis on flexibility because of the fact that the musculoskeletal system is ever changing, likely negating any advantage of flexibility training employed at this stage of development. On the other hand, a more mature athlete will likely benefit from the inclusion of regular flexibility training because of its ability to modify the musculoskeletal system and accommodate improved neuromuscular efficiency. For example, a prepubescent 14-year-old high school freshman who has not yet gone through a growth spurt may not benefit from static stretching, whereas a more skeletally mature 18-year-old high school senior may benefit tremendously from its inclusion. Very simply, as the athlete matures skeletally and bone growth occurs, associated muscle and tendon changes may be dramatically facilitated through dedicated stretching initiatives. As a result, a young athlete's mobility training needs may change completely in a matter of just a few months.

Considering all these, one must appreciate the fact that the overwhelming majority of athletic injuries occur while athletes are moving and going through rapid changes in range of motion rather than while stationary and/or slowly taking tissues through a complete range of motion. Furthermore, injuries typically occur when multiple joints are moving simultaneously rather than one or two joints moving as would be the case during most static stretches. Moreover, injuries generally occur when athletes are in weight bearing rather than seated, supine, or prone (although a comprehensive mobility program appreciates that most upper-body movements are open chain in nature).

Accordingly, with few exceptions, an optimal pre-exercise warm-up should focus on weight-bearing multijoint movements that take athletes through full range of motion in a progressively more dynamic context. With the young athlete, such times are excellent opportunities for the acquisition and refinement of gross motor skills, as fatigue is not a factor and systemic movements should predominate. As a result, the warm-up can serve as the most opportune time to improve and ingrain mobility (18). When selected appropriately, mobility drills, frequently referred to as "dynamic flexibility" or "dynamic stretching," can be used to achieve all of these pre-exercise goals (10).

Mobility drills categorized as "general warm-up" effectively bridge the gap between the pre-exercise rest state and specific exercise by incorporating high-intensity movements through full range of motion. At the same time, adequate warm-up should progress from general to specific.

Research has shown that dynamic flexibility drills improve performance in a number of specific measures of performance including 20-m sprints (10), jumping tasks (43), and agility tests (11); increase dynamic range of motion (20); and reduce injury rates when compared with static stretching (20). Additionally, mobility drills can help to recruit or "activate" key muscles that may not contribute sufficiently as prime movers or stabilizers. For example, poor gluteus maximus function has repeatedly been associated with low back pain (14,16), whereas insufficient strength and motor control of the gluteus medius and lateral hip rotators has been associated with an increased risk of iliotibial band friction syndrome (27) and anterior knee pain (5,19). In the upper body, insufficient recruitment of the lower and middle trapezius (7) and serratus anterior (9) has been implicated in scapular dysfunction leading to shoulder pain.

Additionally, mobility training before exercise is an effective motor learning strategy for a young athlete. All too often, the athlete is instructed to complete rehabilitation and prehabilitation work as sessions separate from "normal" training and competition. This gap between corrective exercise and actual performance may impede the athlete's ability to integrate the more efficient strategies in performance. Incorporating this corrective work in the warm-up period may make it easier for the athlete to more quickly apply and ingrain the new movement strategies in higher intensity exercise.

Last, mobility training coupled with resistance training assists the athlete in developing functional stability. This is particularly important in the young athlete, where insufficient stability is oftentimes confused with inadequate "flexibility." By performing mobility drills before resistance training, the athlete first establishes range of motion and then subsequently applies stability within that range.

The need for supplemental static stretching is markedly reduced once appropriate mobility is established, and the athlete continues on a resistance training program through full range of motion with frequent variation in exercise selection and dynamic flexibility warm-ups. Simply stated, mobility maintenance is much easier than mobility creation. To that end, preparatory/warm-up, training, and flexibility sessions should be crafted with the goal of both maintaining and improving systemic mobility.

THE MODES OF MOBILITY IN YOUNG ATHLETES

Having established that the warm-up period is an opportune time at which to train mobility, it is crucial to select drills and other training stimuli that provide the most benefit in the least amount of time. Most athletes, particularly young athletes, often overlook the importance of an adequate warm-up. As a result, warm-up is often completed haphazardly and inattentively or simply skipped altogether. Accordingly, an appropriate warm-up should be engaging for the athlete and its importance consistently reinforced.

Some young athletes may need to dedicate extra time to some drills to effectively address identified limitations. Most frequently, athletes whose growth and maturation has outpaced their peers generally benefit the most from additional drills performed as separate sessions throughout the week. While increased height and weight may provide such athletes with a competitive advantage, it also likely increases the predisposition to injury because of intrinsic (e.g., insufficient eccentric control, higher center of gravity) and extrinsic (e.g., overuse) factors (29).

Potential modes of mobility training for young athletes vary considerably and may include ground-based or standing stimuli; open- or closed-chain movements; unilateral or bilateral patterns; upper-body, lower-body, or full-body movements; and isolated or integrated skills. Although fundamentally different, all modes still have one goal in common: to teach the young athlete to move more efficiently. When performing these drills, the point is not merely to increase core temperature and circulation, but also to develop and refine motor patterns that will be useful in the training session to follow. As a result, if a young athlete performs the prescribed drills with poor posture, then the same poor posture will most likely be evident once the training session (or competition) begins.

HIP FLEXION MOBILITY

It may seem counterintuitive to actively train hip flexion mobility (HFM) because so many young athletes spend countless hours sitting at desks at school and at computers in the home. However, in these seated positions, athletes rarely achieve the magnitude of hip flexion required during sprinting. Because this HFM is often lacking, lumbar flexion is commonly substituted as a means of attaining the required movement.

Effectively, in this compensated scenario, the athlete lacks sufficient lumbar stability to prevent motion from occurring at that region (35). Additionally, inadequate hip flexion strength has been correlated with both knee and low back pain (28,31).

Frequently, coaches often attempt to remedy this problem by simply stretching the muscles of the posterior hip to improve range of motion; however, such an approach ignores the strong case for added strengthening of the hip flexors in conjunction with an effective core stabilization program (and stretching of the posterior hip musculature). By adding full range-of-motion exercises for hip flexion coupled with core stabilization training, this frequently observed compensatory pattern may be combated.

HIP EXTENSION MOBILITY

Just as inadequate hip flexion can lead to inefficient and potentially injurious movement patterns, poor hip extension mobility (HEM) can be equally problematic, including a strong correlation between decreased HEM and both anterior knee pain (31) and low back pain (39). Exercises to address this deficiency and thereby prevent such pain target hip flexor length to create hip extension range. Concurrently, the addition of gluteal activation (GA) drills may be used to improve strength in hip extension and positively impact HEM.

HIP ABDUCTION MOBILITY

Hip abduction mobility (HAM), dependent upon length of the hip adductors and strength of the hip abductors, is an important yet commonly overlooked component of lower extremity function. Limited HAM has been associated with increased risk of groin strain (1). Whether the adductors are, in fact, hypomobile is only one issue of concern. The strength of the antagonist hip abductors is equally important, as athletes tend to overuse adductor magnus as a hip extensor to compensate for poor gluteus maximus and hamstring strength. Not surprisingly, abduction weakness is associated with patellofemoral pain and may result in increased likelihood of knee valgus collapse, a frequently observed mechanism of noncontact knee injury, especially among female athletes (15,31). In consideration of these factors, a comprehensive approach to HAM should include a focus on both adductor length and abductor strength.

HIP EXTERNAL ROTATION MOBILITY

Hip external rotation mobility (HERM) is intimately linked with hip extension and abduction as well as GA. Hip external rotation weakness has been linked to patellofemoral pain (31,33). While working to improve HERM, the athlete should work in both hip flexion and extension. For example, a cradle walk (Figure 1 and Video, Supplemental Digital Content 1, http://links.lww.com/SCJ/A105) can provide HERM in flexion, whereas a walking spiderman lunge provides HERM in extension (Figure 2 and Video, Supplemental Digital Content 2, http://links.lww.com/SCJ/A106).

GLUTEAL ACTIVATION

Gluteus maximus actions include abduction, external rotation, and extension. Although abduction and external rotation components of movement are important, GA drills that use the gluteal muscles in the sagittal plane to achieve terminal hip extension and some posterior pelvic tilt are frequently overlooked. Insufficient gluteus maximus function and hip extension strength has been frequently implicated in cases of low back and knee pain (14,16,31). The single leg supine bridge (Figure 3 and Video, Supplemental Digital Content 3, http://links.lww.com/SCJ/A107) and other similar exercises can be helpful in triggering GA.

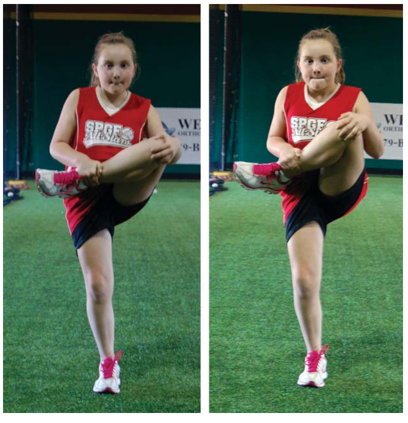

Figure 1. Cradle walk.

Figure 2. Walking spiderman lunge.

HIP ADDUCTION AND INTERNAL ROTATION MOBILITY

Deficits of hip adduction and internal rotation are often overlooked because

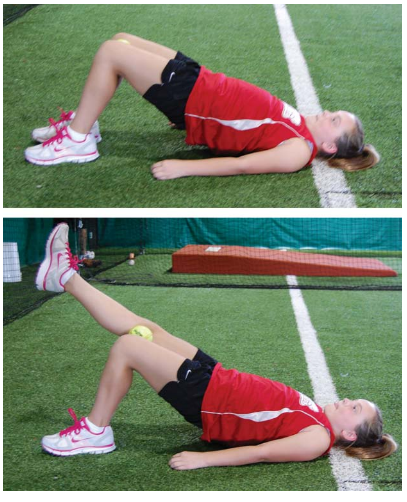

Figure 3. Single leg supine bridge.

of the tremendous focus on strengthening the hip abductors and external rotators to prevent or rehabilitate from injury. However, loss of hip adduction or internal rotation mobility (HIRM) is not uncommon and can lead to a host of other related issues if left unchecked. Such complications have been identified with far greater frequency in men than women (6). This typical increase in HIRM can subsequently predispose the female athlete to an increased risk of traumatic noncontact knee injury (most notably, anterior cruciate ligament and medial collateral ligament problems). Therefore, unless a female athlete has been specifically identified as lacking hip internal rotation and/or adduction, it is generally best to avoid exercises that increase mobility in these planes/directions.

ANKLE MOBILITY

Ankle mobility (AM), particularly dorsiflexion, is critical to normal gait. Athletes require substantially more dorsiflexion range for sprinting, squatting, lunging, jumping, throwing, and a host of other athletic activities. An athlete who lacks AM may substitute lumbar flexion to achieve adequate "depth," thereby putting the spine at risk. Specific to young athletes, limited AM contributes to the development of Osgood-Schlatter disease (33).

One simple way to progressively improve AM and develop strength and proprioception at the feet is to simply perform various exercises without shoes (4,26). Infants typically develop tremendous dexterity with the feet in the initial years of life, a time during which footwear is the exception rather than the rule. Years later, those individuals may develop planus feet, plantar fasciitis, and immobile ankles despite the use of modern athletic footwear (30). Barefoot training can help reactivate muscles long underused because of the added support and protection of shoes (26).

THORACIC SPINE MOBILITY

Although excessive mobility in the lumbar spine is generally considered problematic (core instability), adequate thoracic spine mobility (TSM) is imperative for both upper extremity and lumbar spine health. Limited TSM and shoulder impingement have been associated with chronic low back pain in obese individuals (23,41). While addressing TSM, chief concerns include thoracic extension and rotation, as the majority of the population uses far too much thoracic flexion in the course of daily living as a result of excessive sitting. With most drills in this mode, humeral horizontal abduction, external rotation, and flexion, all of which positively influence scapular positioning into posterior tilt and retraction, should be used extensively. For the young athlete, a drill such as the quadruped extension-rotation movement (Figure 4 and Video, Supplemental Digital Content 4, http://links.lww.com/SCJ/A108) can be beneficial in promoting stability through the hips while promoting TSM.

SCAPULAR STABILITY

Poor periscapular muscle function is a near-universal finding in those with shoulder pain (7,9). Typically, athletes present with poor recruitment of the middle and lower trapezius and serratus anterior, along with shortness and inflexibility of the pectoralis minor. Collectively, these deficits contribute to faulty posture, most notably, scapular protraction. This faulty positioning is usually apparent both statically and dynamically. Scapular protraction impairs ideal movement at the glenohumeral and acromioclavicular joints (32), and a simple drill such as the scapular wall slide (Figure 5 and Video, Supplemental Digital Content 5, http://links.lww.com/SCJ/A109) can be an effective means of promoting dynamic scapular retraction.

CERVICAL MOBILITY

Another commonly overlooked component of upper extremity health is cervical spine mobility, which is of tremendous importance. Forward head posture (FHP) is significantly greater in patients with overuse shoulder injuries compared with healthy controls (12). Likewise, FHP with concurrent rounded shoulders increases scapular protraction and anterior tilt during shoulder flexion (overhead reaching) independent of the presence of symptoms (38). Although it may be effective to integrate various "chin tuck" drills into the warm-up for those athletes who present with a pronounced FHP, successful interventions to correct FHP have often centered on addressing impairments further down the kinetic chain, including the glenohumeral joint, scapulae, and thoracic spine and simply

Figure 4. Quadruped extension-rotation.

Figure 5. Scapular wall slide.

cueing a neutral cervical spine posture during all training drills. In other words, athletes should look forward rather than up when squatting, deadlifting, or performing mobility drills.

SHOULDER INTERNAL ROTATION MOBILITY

Maintaining shoulder internal rotation mobility (SIRM) is an important component in the successful management of overhead athletes such as baseball players, swimmers, tennis players, and track and field throwers. Reinold et al. (32) noted that in response to the eccentric stress imposed during arm deceleration, pitchers tend to lose shoulder internal rotation after a pitching outing. Although this loss can be prevented with appropriate mobility efforts, if left unchecked over the course of multiple outings and competitive seasons, it can ultimately lead to a host of issues, including glenohumeral internal rotation deficit and global shoulder pain (24).

Overhead athletes often present with significantly more external rotation and less internal rotation in the dominant shoulder than the nondominant shoulder; however, if the arc of motion (internal rotation plus external rotation) is equal bilaterally, this asymmetry may be considered normal (42). Therefore, best practice for overhead athletes involves normalizing total motion bilaterally, even if the specific limits of motion are dissimilar. Performed correctly, the side-lying sleeper stretch for internal rotation (Figure 6 and Video, Supplemental Digital Content 6, http://links.lww.com/SCJ/A114) is a preferred means of gaining SIRM.

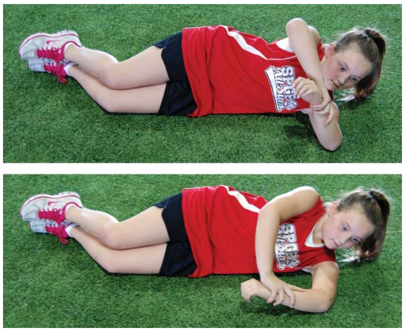

Figure 6. Side-lying sleeper stretch.

SHOULDER EXTERNAL ROTATION MOBILITY

Although shoulder external rotation mobility (SERM) is rarely a problem in overhead throwing athletes, it is a common deficit in athletes who spend long periods of time sitting and those who regularly perform numerous pressing movements (bench press, etc) with little or no pulling movements to ensure muscular balance. Not surprisingly, insufficient external rotation is associated with shoulder impingement, whereas improvement of external rotation mobility can reduce impingement symptoms (22,36). The "no money" drill (dynamic shoulder external rotation with the upper arms at the sides and the elbows flexed to 90°, movement into end range shoulder external rotation before movement back to the torso and repeating, alternating "top" hand position with each repetition) can be used either singly or with a lower extremity movement such as a skip to help promote SERM along with global motor control.

CONCLUSIONS

Although related, mobility and flexibility are unique constructs that are best approached as independent abilities to be addressed specifically. Developing mobility in the young athlete involves maximizing the effectiveness and efficiency of the warm-up through targeted dynamic flexibility drills and specific positioning cues. Additionally, this affords the strength and conditioning specialist an excellent opportunity to enhance motor learning in the developing athlete. In addition, developing a comprehensive and specific training program to improve strength, stability, and tissue quality to account for differences in gender, physical maturity, age, training experience, and sport participation is a critical skill. Although static stretching definitely has a place in many athletes' programs, its overall utility is largely specific to each individual athlete.

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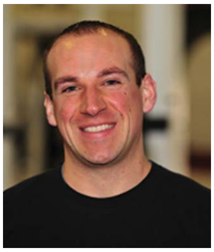
Toby Brooks *is an assistant professor in the Department of Rehabilitation Sciences, Texas Tech University Health Sciences Center, Lubbock. He also serves as director of Research and Education for the International Youth Conditioning Association.*



Eric Cressey *is the president and cofounder of Cressey Sports Performance in Hudson.*

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