The Importance of Flexibility for Functional Range of Motion

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The effectiveness of preexercise static stretching for performance enhancement and injury prevention has recently been questioned. The majority of relevant research has been focused on the short-term effects of static stretching[1] rather than its long-term effects on functional range of motion (FROM). For example, the impact of inadequate dorsiflexion FROM on subtalar mechanics and tibial rotation and their influence on patellofemoral motion are well documented.[2,3] The potential influence of joint hypomobility on dysfunction of the entire kinetic chain cannot be ignored. If one link of a kinetic chain is hypomobile, the proximal links must alter their function to preserve the overall "normal" function of the integrated kinetic chain.[4] This compensatory alteration of proximal joint function leads to long-term changes in the flexibility of associated soft tissues (muscle, tendon, ligament, and fascia), as well as changes in neuromuscular activation patterns, as each component of the kinetic chain seeks the path of least resistance during performance of functional-movement patterns.[5] This article presents a framework assessing FROM of the lower extremity and reviews contemporary techniques for restoring restricted FROM.

Key Points

- Loss of functional range of motion can alter the function of the various components of the kinetic chain, thereby increasing injury susceptibility.
- Both the athlete and the athletic trainer or therapist must understand that time and effort are required to restore normal functional motion.
- Loss of functional range of motion is readily identifiable by an athletic trainer or therapist.
- Regular performance of stretching exercises, combined with self-mobilization of soft tissue, can facilitate restoration of normal functional motion.
- Key Words: kinetic chain, stretching, self-mobilization of soft tissue

The Kinetic Chain

Gross movement of a multisegmental system (e.g., the spine or an extremity) is the result of numerous interdependent motions within each of the joints that make up the kinetic chain. For example, each spinal segment produces relatively little motion. The amount of forward flexion occurring between the first and second lumbar vertebrae is relatively small, but summation of the forward flexion occurring between all lumbar, thoracic, and cervical vertebrae can produce a large amplitude of overall spine flexion. An anatomic leg-length discrepancy will create pelvic obliquity in the frontal plane (i.e., the pelvis will be lower on the side of the shorter extremity), which induces lateral flexion of the lumbar spine toward the opposite side. A functional leg-length discrepancy, which is produced by excessive subtalar pronation during the stance phase of the gait cycle, is associated with a drop of both the navicular and the head of the talus and internal rotation of the tibia in relation to the foot. As internal-rotation torque is transferred through the knee joint, the tibia internally rotates in relation to the femur, which induces a valgus alignment of the lower extremity. Farther up the kinetic chain, the pelvis will also drop, which induces the same effect on the spine as an anatomic leg-length discrepancy.

Clinicians should always assess movement of the entire kinetic chain when evaluating injuries. A goniometric measurement of straight-leg hip flexion to assess hamstring flexibility is certainly useful, but it is not the only means by which flexibility should be evaluated. A tight hamstring in a supine athlete does not necessarily limit FROM. Using inductive reasoning (i.e., a specific observation used as the basis for a generalized explanation), clinicians often assume that there is a relationship between hamstring tightness and lumbar pain. Although this assumption is widely accepted, it would seem to make more sense for the clinician to assess the athlete's flexibility while the athlete performs a controlled functional motion. This type of assessment will enable the clinician to see where the limitations in motion occur and where compensatory movement strategies are employed during the functional motion. The clinician can use deductive reasoning (i.e., a general observation used as the basis for identification of a specific problem) to relate FROM restrictions to alterations in the normal function of the components of the kinetic chain, thereby focusing attention on specific component motions that must be restored for resolution of symptoms.

Assessment Framework

For the kinetic chain to function optimally, each component of the chain must make specific motion contributions that are coordinated with those of the other components. Inadequate flexibility can adversely affect the component motions of the kinetic chain, which can contribute to injury susceptibility. If there is not an optimal length–tension relationship in the musculotendinous units crossing any of the component joints of the kinetic chain, compensatory motion at other joints must occur. Muscle weakness, antagonist strength imbalances, altered neuromuscular control, and excessive loading of tissues can result.[5] A functional-movement screen (FMS) might identify compensatory joint motions during performance of general functional-movement patterns (e.g., walking gait, overhead-squat test, single-leg-squat test) or sport-specific movement patterns.[5,6]

One of the most commonly used procedures for assessing lower extremity FROM is the overhead double-leg squat (ODLS). The ODLS is a multijoint and multiplane exercise that involves large and small muscle groups. The procedure for assessing lower extremity FROM with the ODLS is outlined in Table 1. It is imperative for the clinician to ensure the athlete's safety during performance of the functional-movement pattern. The ODLS should only be performed when an athlete is capable of full weight bearing in both extremities.

An athlete with a unilaterally tight gastrocnemius-soleus complex that limits dorsiflexion of the left ankle might exhibit a variety of alterations in the kinetic-chain movement pattern while performing the ODLS (Figures 1–3). From an anterior viewpoint, pronation of the subtalar joint might be observed, which is associated with navicular drop and internal rotation of the tibia in relation to the foot. Farther up the kinetic chain, the pelvis might be observed to descend to a greater extent on the involved side. From a lateral viewpoint, the athlete's heel might lift off the floor during the movement, which will be associated with a rate of hip descent faster than the rate of knee descent. Ideally, the athletic trainer or therapist would videotape the performance of 5–10 repetitions of each exercise, and check for *repeated* compensatory motions or apparent motion restrictions. Figure 1 illustrates the starting position for the ODLS, and the final position is illustrated in Figure 2 (lateral viewpoint) and Figure 3 (anterior viewpoint). Lacking normal dorsiflexion of the left ankle, the athlete exhibits abduction of the long axis of the left foot (Figure 3[a]) and lateral movement of the left knee (Figure 3[b]). Hamstring tightness and iliopsoas weakness are made evident by flexion of the lumbar spine, which is caused by a combination of hamstring tension acting on the ischial tuberosity and failure of the iliopsoas to generate downward rotation of the pelvis (Figure 2[b]). Tightness of the contralateral latissimus dorsi is indicated by asymmetrical elevation of the arms (Figure 3[c]). The athlete whose ODLS performance is illustrated had difficulty in repetitively performing this functional-movement pattern. His ODLS findings were consistent with the results of an orthopedic clinical assessment and his chief complaints. The FMS findings also provide the basis for the rehabilitation plan: to increase ankle dorsiflexion, increase hamstring flexibility, and increase iliotibial-band flexibility.

The FMS procedures focus on soft-tissue restrictions affecting FROM, which are difficult to quantify and are not indicated by empirical evidence. The loss