Biomechanical and Neuromuscular Effects of Ankle Taping and Bracing

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Objective: An extensive review of clinically relevant research is provided to assist clinicians in understanding the underlying mechanisms by which various ankle-support systems may provide beneficial effects. Strategies for management of different types of ankle ligament conditions are also discussed.

Background: Much of the literature pertaining to ankle instability and external support has focused on assessment of inward displacement of the hindfoot within the frontal plane. Some researchers have emphasized the importance of (1) pathologic rotary displacement of the talus within the transverse plane, (2) the frequent presence of subtalar joint ligament lesions, and (3) the interrelated effects of ankle support on deceleration of inversion velocity and facilitation of neuromuscular response.

Description: The traditional method for application of adhesive tape to the ankle primarily restricts inward displacement of the hindfoot within the frontal plane. The biomechanical rationale for a method of ankle taping that restricts lower leg rotation and triplanar displacement of the foot associated with subtalar motion is presented.

Clinical Advantages: The lateral subtalar-sling taping procedure may limit strain on the anterior talofibular ligament associated with subtalar inversion, restrain anterolateral rotary subluxation of the talus in the presence of ligament laxity, and protect the subtalar ligaments from excessive loading. The medial subtalar sling may reduce strain on the anterior-inferior tibiofibular syndesmosis and enhance hindfoot-to-forefoot force transfer during the push-off phase of the gait cycle.

Key Words: ankle instability, subtalar joint injury, ankle dysfunction

For more than a century, ankle taping has been advocated as a means to protect the ankle ligaments from excessive strain. Widespread belief in the effectiveness of ankle taping and the extremely high incidence of lateral ankle sprains among athletes resulted in ubiquitous use of the procedure within scholastic and professional athletic organizations for many years. The skillful application of adhesive tape to the ankles of athletes remains strongly associated with the role of the athletic trainer today. One prospective study has documented the effectiveness of ankle taping in reducing sprain incidence, and numerous researchers have evaluated the extent to which tape provides a mechanical restraint to excessive ankle motion. Literature on the subject also contains descriptions of various tape-application procedures for the ankle and critical analyses of the benefits that may be derived from ankle taping. Some researchers have emphasized that ankle taping rapidly loses its initial level of resistance to motion during exercise, but most studies on the mechanical effect of taping have demonstrated some level of motion restriction after exercise. Although tape clearly loosens significantly during exercise, its restraining effect on extreme ankle motion is not eliminated by prolonged athletic activity.

In recent years, a variety of ankle braces have become commercially available as alternatives to ankle taping. Some investigators have studied the mechanical effect of various brace designs on restraint of ankle motion, and many such studies have compared the mechanical effects of bracing and taping. Some researchers have found comparable levels of postexercise motion restraint for taping and bracing, whereas others have concluded that ankle bracing is superior to taping on the basis of less exercise-induced increase in ankle motion with bracing. In a recent meta-analysis of 19 studies of the effects of different types of ankle support on ankle motion before and after activity, significantly greater frontal-plane ankle-motion restriction after exercise was found for a semirigid stirrup brace design than for taping or a lace-up type brace. Several prospective studies have documented a beneficial effect of semirigid ankle bracing on sprain incidence, and 2 retrospective studies comparing the effects of taping and a lace-up brace on sprain incidence supported the superiority of bracing for injury prevention. Despite these findings, some sports medicine clinicians and athletes believe that taping provides superior benefits related to comfort, perception of greater support, and less interference with normal ankle function.

EFFECTS ON PERFORMANCE CAPABILITIES

A number of authors have evaluated the effects of ankle taping and bracing on the functional performance capabilities of normal and injured subjects. Findings regarding the extent to which ankle support may interfere with normal function have been inconsistent, and no clear conclusions can
be drawn concerning the relative effects of different brace designs (eg, semirigid versus lace up). For example, some researchers found that various forms of ankle support decreased vertical jump height by 3% to 5%6,56,69,77,82,83 whereas others did not observe a significant effect.50,68,74–76,80,81,84,85 Some investigators observed significantly decreased performance on multidirectional agility tests for uninjured subjects wearing ankle support,6,56,69 whereas others did not find a difference between supported and unsupported conditions.97,68,75,80,81,83,85 Most of the studies comparing the effects of taping and bracing on performance have not demonstrated significant differences between taping and various types of braces.50,56,67,79,83,85 One group of researchers has suggested that stirrup-type braces are superior to taping and lace-up braces on the basis of a less adverse effect on sagittal-plane isokinetic strength and range of motion.73

Surprisingly, relatively few authors have evaluated the extent to which ankle support may improve the functional capabilities of subjects with ankle dysfunction.72,74,76 None have evaluated different ankle-taping methods or different brace designs, as all 3 of the cited studies evaluated the effect of the same semirigid, stirrup-type brace. Gross et al74 found no significant beneficial effect on agility test performance for subjects with a history of recurrent ankle sprains, whereas Hals et al76 reported significantly improved agility test performance for subjects with a postacute sprain when wearing the brace. Fridén et al72 observed significant improvement in unilateral postural balance in subjects with a postacute sprain wearing the stirrup-type brace.

Although research evidence supports protected functional use as the most appropriate management of an acute lateral ankle sprain of any degree of severity,86–88 relatively little scientific information pertains to the influence of ankle-support characteristics on recovery of optimal ankle function. Athletic trainers have long used the open-basketweave ankle-taping procedure to restrict ankle motion and control edema,22,24,25,29,31 and stirrup-type ankle braces have been designed to provide the same therapeutic benefits.89,90 Two studies of the effects of different brace designs on edema control and the rate of restoration of functional capabilities produced conflicting results.91,92 A potentially important area of research that has not been thoroughly investigated is the relationship between specific structural characteristics of various ankle supports and their suitability for achieving different beneficial effects, such as restricting frontal-plane motion and transverse-plane motion, reducing ankle-displacement velocity, controlling edema, reducing load on specific ligaments, and enhancing proprioceptively mediated joint stabilization.

**ALTERNATIVE MECHANISMS OF BENEFICIAL EFFECT**

A number of investigators have provided information about alternative mechanisms by which ankle support may offer protection during a potentially injurious event. The effects of ankle taping and bracing on proprioceptive input to the central nervous system,71,93–95 peroneal muscle activity,3,6,10,96,97 and deceleration of ankle motion6,15,18,47 may be as important as restriction of the range of ankle inversion for sprain prevention.

Feuerbach and Grabiner71 found that both anteroposterior and mediolateral postural sway were decreased in normal subjects when a semirigid, stirrup-type brace was worn. The possibility that the improvement was due to enhanced proprioceptive input to the central nervous system was evaluated in a subsequent study of the effect of the brace on joint position sense, both with and without ankle-joint anesthesia.95 Because the presence of the brace improved the accuracy of active replication of reference ankle positions in each of 3 planes, even in the anesthetized condition, the authors concluded that the stirrup-type brace enhanced proprioception from cutaneous mechanoreceptors.

Simoneau et al95 found that tape straps adhered to the skin significantly improved joint position sense in nonweight-bearing plantar flexion. Heit et al94 noted that taping and a lace-up brace both significantly improved the ability of subjects to actively reproduce a specific plantar-flexion joint angle. Because taping also significantly enhanced inversion position sense, they suggested that taping may be more effective than bracing for improving ankle joint proprioception. Awareness of ankle-joint position is clearly most important immediately before ground contact in order to avoid landing in an inverted position, whereas peroneal muscle activation is essential to counteract a potentially injurious force after landing.

Glick et al96 were the first to present evidence of a relationship between peroneal muscle activity and the presence of tape on the ankle. Using electromyography (EMG) and cinematography, they found that the peroneus brevis muscle was active for a longer period of time at the end of the swing phase, just before footstrike, when the ankle was taped. Springings et al97 also used EMG to assess the effect of taping on peroneal activation, expecting that the tape would relieve strain on the lateral anatomical structures of the ankle and decrease evertor muscle activation during a step-down maneuver and a simulated weight-bearing inversion-sprint motion. Contrary to this expectation, which was derived from the concern that long-term taping might ultimately produce peroneal weakness, taping did not prevent the evertor musculature from being vigorously activated.

Karlsson and Andréasson6 used EMG to assess the effect of taping on the speed of peroneal response to sudden weight-bearing inversion in subjects with normal and mechanically unstable ankles. Tape on mechanically unstable ankles decreased the response latency of both the peroneus brevis and peroneus longus muscles by 8% (75.2 versus 81.6 milliseconds) and 13% (73.4 versus 84.5 milliseconds), respectively; the greatest improvement in response speed was in ankles with the greatest degree of instability.

Lohrer et al10 analyzed the effects of taping on both peroneal EMG activity and restraint of weight-bearing lateral ankle displacement. They concluded that reduction in the angular velocity of displacement with tape, combined with restricted displacement amplitude, permitted relatively greater peroneal activation per degree of motion than the untaped condition. The “proprioceptive amplification ratio,” calculated as the integrated peroneal EMG activity divided by the maximum inversion amplitude, was presented as a means of quantifying the interrelated neuromuscular stimulation and motion-restriction effects of taping. Further evidence supporting this concept was presented by Alt et al,3 who used identical methods to evaluate the effects of ankle taping before and after 30 minutes of exercise. Compared with the untaped condition, ankle taping reduced the postexercise inversion amplitude by 38% and the postexercise integrated EMG activity by only 20%. Thus, taping produced relatively greater integrated peroneal EMG activity within the restricted range of inversion than that ob-
served for the corresponding portion of the range of unrestrained inversion.

Vaes et al\textsuperscript{47} used radiographic cinematography to assess the effect of ankle bracing on inversion velocity during a weight-bearing sprain simulation that induced 50° of inversion displacement. A stirrup-type brace decreased the distance that stable and mechanically unstable ankles were displaced during a 40-millisecond high-velocity phase of the sprain simulation by approximately 15% to 20%. Approximately 40% of the 50°-inversion displacement of the unbraced ankles occurred during this high-velocity phase, which occurred within the 40- and 80-millisecond intervals after inversion displacement began. Conversion of their reported ankle-displacement data from pixels to degrees of motion yields an estimated velocity of approximately 400\textsuperscript{°}/s\textsuperscript{−1} to 450\textsuperscript{°}/s\textsuperscript{−1} for the unbraced ankles, which is consistent with the 400\textsuperscript{°}/s\textsuperscript{−1} injury velocity estimate of Alt et al\textsuperscript{3} and the maximum inversion velocity value of 460\textsuperscript{°}/s\textsuperscript{−1} reported by Pederson et al\textsuperscript{15} for untaped ankles.

Ricard et al\textsuperscript{18} reported a maximum inversion velocity of 740\textsuperscript{°}/s\textsuperscript{−1} for untaped ankles and a corresponding average inversion velocity of about 370\textsuperscript{°}/s\textsuperscript{−1} for a 37° range of displacement. Taping decreased both the maximum and average post-exercise inversion velocity by 31% to velocities of 511\textsuperscript{°}/s\textsuperscript{−1} and 254\textsuperscript{°}/s\textsuperscript{−1}, respectively. Clarke et al\textsuperscript{8} and DeClerq\textsuperscript{10} reported almost identical maximum velocity values of 532\textsuperscript{°}/s\textsuperscript{−1} and 533\textsuperscript{°}/s\textsuperscript{−1} for subtalar eversion during running. Although the values for inversion velocity derived from trapdoor platforms are relatively similar to those observed for subtalar eversion during running, the velocity of ankle displacement associated with jump landing may exceed 1000\textsuperscript{°}/s\textsuperscript{−1}. Ricard et al\textsuperscript{99} suggested that most ankle injuries occur between 30 and 50 milliseconds after ground contact. Vaes et al\textsuperscript{47} demonstrated that 50° of weight-bearing inversion displacement did not produce harm or discomfort, which suggests that some greater amount of displacement is necessary for lateral ankle-ligament injury. Thus, inversion velocity must be greater than 1000\textsuperscript{°}/s\textsuperscript{−1} to produce ankle displacement beyond 50° in less than 50 milliseconds.

Konradse et al\textsuperscript{100} and Alt et al\textsuperscript{3} reported a 50- to 65-millisecond delay between the initiation of sudden inversion and the onset of peroneal EMG activity and a total time of at least 120 milliseconds required for generation of an effective muscle force to resist the inversion displacement. The findings of Glick et al\textsuperscript{26} concerning the facilitatory effect of tape on peroneal activation before footstrike and those of Karlsson and Andréasson\textsuperscript{9} concerning the facilitatory effect of taping on the speed of peroneal response to sudden weight-bearing inversion suggest that the peroneal muscles may generate an effective restraining force against inversion displacement in less than 120 milliseconds when the ankle is taped.

Assuming that the peroneal muscles are completely relaxed at the start of inversion, a velocity of approximately 300\textsuperscript{°}/s\textsuperscript{−1} or less would allow for generation of a resisting eversion force before the ankle is displaced beyond 40° of inversion. Ricard et al\textsuperscript{18} reported that the postexercise average inversion velocity for taped ankles was approximately 250\textsuperscript{°}/s\textsuperscript{−1}. They also presented evidence that high-velocity weight-bearing inversion demonstrated smaller amounts of postexercise support loss in taped ankles than very low-velocity open-chain inversion. This suggests that both the deceleration and motion-restriction effects of taping are rate dependent and are relatively more effective at high velocities of ankle displacement.

The contradictory findings of past research on the relative effects of ankle taping and bracing may be explained by variations in tape-application procedures, variations in the properties of tape and other materials used in the application process, methodologic limitations imposed by the risk of injury to subjects, and the exceedingly complex nature of the integrated biomechanical function of the joints of the foot and ankle. Discussion of the effects of an external ankle-support system necessitates a review of the normal biomechanical function of the foot and ankle, and clear distinctions need to be made among various terms used to describe foot and ankle motion.\textsuperscript{101,102}

PATHOMECHANICAL CONSIDERATIONS

Many authors and clinicians use the coupled terms \textit{eversion-inversion} to define motion confined to the frontal plane, and the coupled terms \textit{pronation-supination} to define triplanar motion that occurs around the functional axis of the subtalar joint. Others make the distinction between uniplanar and triplanar motion in an opposite manner, and some use the 2 sets of terms interchangeably. Further complicating the matter, pronation-supination is commonly used to describe triplanar displacement associated with normal gait, and eversion-inversion is commonly used to describe triplanar displacement associated with ankle-injury mechanisms. Regardless of whether the research methods employed to study the effects of ankle support have analyzed isolated frontal-plane motion or triplanar motion, researchers have almost exclusively used the term \textit{inversion} to define either type of inward displacement of the plantar aspect of the foot. Because this discussion relates to the pathomechanics of ankle injury, the terms \textit{frontal-plane inversion} and \textit{subtalar inversion} will be used to differentiate the uniplanar component of the injury-producing motion from the more complex triplanar motion that occurs between the leg and the foot.

INVERSION-EVERSION MECHANICS

The talus is the key structure of the ankle, linking the leg and the foot in a manner similar to a universal joint.\textsuperscript{103} The leg is hinged to the talus in 1 plane at the talocrural joint; the foot is hinged to the talus in a different plane at the subtalar joint. The function of the subtalar joint is highly integrated with that of the talocrural joint proximally, as well as that of the transverse tarsal and lateral tarsometatarsal joints distally. The configuration of the articular surfaces between the talus and the calcaneus is the primary determinant of the pattern of foot displacement that results from subtalar motion. Because the functional axis of the subtalar joint approximates a 45° orientation in relation to the long axis of the foot in the sagittal plane (Figure 1), it has been compared with a mitered hinge that produces opposite and equal amounts of rotation of the proximal and distal hinged segments.\textsuperscript{104} Under weight-bearing conditions, the coupling mechanism created by the integrated function of the talocrural, subtalar, and transverse tarsal joints acts like a torque converter between the leg and the foot. Rotation of either segment is associated with rotation of the other segment in the opposite direction. The relative amounts of foot displacement and axial leg rotation associated with subtalar motion vary considerably among individuals and are related to the structure, alignment, and ligamentous integrity of the ankle and foot joints.\textsuperscript{105}

Although subtalar inversion causes the talus to rotate exter-
nally with respect to the calcaneus in the transverse plane, the
transfer of inversion torque between the talocrural joint and
the lower leg is associated with external rotation of the lower
leg in relation to the talus after the subtalar joint has reached
the limit of its range of motion. If the lateral border of the
foot inverts, the lateral tarsometatarsal joints, the transverse
tarsal joint, and the subtalar joint each lock when the maxi-
mum range of inversion is reached, and the entire foot acts as
a rigid lever that rotates inwardly around the subtalar axis
while the lower leg rotates externally (Figure 2). If the anterior
talofibular ligament (ATFL) is disrupted, the composite axis
of talocrural-subtalar motion is no longer fixed, and the an-
terolateral portion of the talus is free to rotate out from beneath
the tibiofibular mortise. The term anterolateral ro-
tary instability refers to anterior and internal rotary displace-
ment of the lateral border of the talus in relation to the lower
leg. Anterolateral rotary instability refers to anterior and internal rotary displacement of the lateral border of the talus in relation to the lower leg.109,113–115

CLINICAL EVALUATION AND MANAGEMENT OF
ANKLE INSTABILITY

To evaluate the integrity of the ATFL, stress radiography
has been used to quantify anterior translation of the talus in
relation to the calcaneus within the sagittal plane and varus tilt
of the talus in relation to the tibia within the frontal plane.
The lack of a consistent relationship between radiographic ev-
dence of talocrural joint instability and symptoms of chronic
ankle dysfunction after an inversion sprain is largely respon-
sible for widespread acceptance of the idea that mechanical
instability and functional instability are distinctly different
conditions. Many believe that a deficiency in joint propriocep-
tion is responsible for symptoms of functional instability in
the absence of mechanical instability, but some authors have
suggested that traditional methods of clinical evaluation are
inadequate for identification of rotary mechanical instability
within the transverse plane.103,106,110,111,113,115

Because severe damage to the lateral ankle ligaments has
been associated with increased talar tilt, prevention of frontal-
plane displacement of the calcaneus and talus has been a pri-
mary goal guiding the design of ankle-support systems. The
notion that talar tilt is the primary component of the mecha-
nism responsible for disruption of the lateral ankle ligaments
is refuted by research findings derived from axially loaded
cadaver specimens. Cass and Settles106 found that isolated re-
lease of the ATFL was not associated with talar tilt when an
axial load was applied to an inverted hindfoot. Unlike other
cadaver studies of pathologic ankle displacement, axial rota-
tion of the leg was not constrained. These researchers106 and
others101,110–113,116–118 have emphasized the role of the ATFL
in restraining external rotation of the leg upon the talus. Much
of the research that has evaluated the mechanical effects of
ankle support has involved assessment of isolated frontal-plane
motion of the foot in relation to the leg, and no study has
assessed the effect of ankle taping or bracing on leg rotation.

In recent years, magnetic resonance imaging (MRI) has
clearly demonstrated that ligamentous damage can be more
severe than associated physical signs and symptoms might
suggest.119,120 Magnetic resonance imaging has also dramati-
cally increased awareness of various types of soft tissue con-
ditions that were previously unrecognized. Frey et al120 com-
pared ankle-sprain severity diagnoses made by orthopaedic
surgeons with MRI results and concluded that clinicians often
underestimate the severity of ligamentous damage in the ab-

Figure 1. Approximate orientation of functional axis of the subtalar joint in the sagittal plane for most individuals.

Figure 2. Development of tension within the anterior talofibular ligament as the leg externally rotates in relation to the foot, which resists rotary subluxation of the talus.
Rationale for Subtalar Taping Procedure

Although numerous combinations of tape-strip orientations and wrapping patterns have been advocated as superior ankle-taping procedures, the basic components of the application procedure described by Gibney\(^1\) in 1895 are included in almost every contemporary ankle-taping procedure. The Gibney basketweave procedure consists of an interwoven application of stirrup strips, which cover the plantar surface of the hindfoot and extend proximally on both the medial and lateral aspects of the leg, and horseshoe strips, which are applied perpendicular to the stirrup strips on the hindfoot.\(^{29,51}\) Most athletic trainers use an ankle-taping procedure that incorporates some variation of the Gibney basketweave in combination with the Louisiana heel-lock and figure-8 wrapping patterns.

Although inward displacement of the hindfoot is generally associated with triplanar rotation around the functional axis of the subtalar joint, external forces can impose a nonfunctional rotation around the long axis of the foot when it is in a neutral or dorsiflexed position. The force vector created by tension within the longitudinal fibers of stirrup strips is perpendicular to an anteroposterior axis of isolated frontal-plane inversion when the talocrural joint is in a neutral position (Figure 3). Thus, stirrup strips are well positioned to provide maximum restraint to inward displacement of the hindfoot within the frontal plane (ie, varus displacement of the calcaneus and lateral tilting of the talus within the talocrural mortise). The application of heel-lock and figure-8 components further encases the hindfoot, which probably provides additional resistance to lateral distraction of the talocrural and subtalar joints within the frontal plane.

Because torque is transferred through the kinetic chain from the forefoot to the leg and vice versa, efforts to stabilize the talocrural joint should not be limited to restricting inward hindfoot motion within the frontal plane. The subtalar sling consists of 1 or more strips of high-strength, semielastic tape that spans all of the joints between the forefoot and leg (ie, tarsometatarsal, transverse tarsal, subtalar, and talocrural). The subtalar-sling component is applied after the stirrup and horseshoe strips and before the heel-lock configuration to the hindfoot and overlapping circumferential closure strips on the foot and leg. To resist subtalar inversion, the tape strips are anchored on the plantar aspect of the forefoot, wrapped around the lateral border of the foot, and wrapped around the leg above the malleoli. When viewed in the sagittal plane, the midportion subtalar sling has a 45° orientation that is approximately perpendicular to the orientation of the functional axis of the subtalar joint (Figure 4). The semielastic tape strips are applied with sufficient tension to create a lateral “bowstring effect” when anchored to the leg. Excessive tension may cause discomfort to develop along the lateral border of the foot during activity, whereas insufficient tension fails to restrict the end range of subtalar inversion after exercise-induced loosening. Nonelastic tape covers and secures the subtalar-sling attachment to the plantar aspect of the forefoot, and the lateral bowstringing portion is pulled against the surface of the midfoot through the application of a heel-lock tape configuration.

The incorporation of the lateral subtalar sling with other components of a traditional hindfoot-taping procedure increased residual subtalar inversion restriction after 2 to 3 hours of physical activity by 94% compared with the traditional procedure without the additional component.\(^{21}\) Compared with the unrestricted range of inversion, the taping procedure that incorporated the lateral subtalar sling provided a residual restriction of 16.5° (41% of 40° unrestricted range), whereas the taping procedure without the subtalar sling provided a residual restriction of 8.5° (21% of 40° unrestricted range).

The vector created by tension within the lateral subtalar sling has a vertical component that resists varus displacement of the forefoot in the frontal plane and an anteroposterior component that resists anterior translation of the talus in the sagittal plane (Figure 5). Probably more important is its effect on torque transmission between the forefoot and leg and restraint of rotary subluxation of the talus in the transverse plane (Figure 6). External rotation of the leg increases tension within the...
Figure 4. Lateral subtalar sling. A, Orientation of lateral subtalar sling applied over stirrup strips on the hindfoot. B, Optional second lateral subtalar sling wraps around the lateral aspect of the foot at a more distal position.

Figure 5. Vertical and anteroposterior components of the vector created by tension within the lateral subtalar sling.

Figure 6. Restraint of anterolateral rotary subluxation of talus provided by the lateral subtalar sling as tape tension develops with external rotation of the leg.

tape strips forming the lateral subtalar sling, which tends to lift the lateral border of the foot, thereby reversing the normal effect of external leg rotation on the forefoot and protecting the ATFL from tensile loading.

The point at which the lateral subtalar sling wraps around the border of the foot affects the degree of discomfort experienced by some athletes and is a major factor determining the extent to which the sling achieves the desired effect. The more anterior on the foot the sling is applied, the longer the moment arm is between the functional axis of the subtalar joint and the sling fixation point on the lateral border of the foot. A more posterior position may be more comfortable for the athlete but lacks the mechanical advantage of the more anterior position (Figure 7). Although discomfort is sometimes experienced by athletes who are unaccustomed to the pressure exerted by the tape on the lateral border of the forefoot, those who complain
generally become more tolerant of the procedure after several applications.\textsuperscript{51}

The subtalar sling can also be applied to the medial aspect of the foot to support the medial longitudinal arch and to control subtalar eversion (Figure 8). Although the mechanism is unclear, MRI evidence of damage to the deltoid ligament and the posterior tibialis tendon has been associated with a history of an inversion ankle sprain and concomitant damage to the lateral structures.\textsuperscript{120,122} Several investigators have reported a relationship between lateral ankle-ligament injury and a deficiency in the isokinetic performance of the ankle invertors.\textsuperscript{125–128} This phenomenon is believed to be caused by neural inhibition of the muscles that produce the motion associated with the injury mechanism,\textsuperscript{129} and the degree of inhibition after an acute lateral sprain appears to be related to the amount of traumatic edema associated with the injury.\textsuperscript{130} Stabilization of the talonavicular joint by the posterior tibialis muscle is essential for transfer of the force generated by the gastrocnemius-soleus muscles at their insertion on the calcaneus to the forefoot at push-off. Use of the medial subtalar sling may compensate for deficient posterior tibialis function, thereby facilitating the hindfoot-to-forefoot force transfer that occurs between the midstance and push-off phases of the gait cycle.

Another potentially important clinical application for the medial subtalar sling is the prevention of anterior-inferior tibiotalar syndesmosis sprain. The mechanism of injury associated with the syndesmotic ankle sprain involves external rotation of the foot and internal rotation of the lower leg.\textsuperscript{131–134} Restriction of subtalar eversion, which is associated with foot and leg rotation in opposite directions, can reduce the amount of stress imposed on the syndesmosis by functional activities. Because susceptibility to an inversion sprain is always a concern, a taping procedure that incorporates the medial subtalar sling should always include application of the lateral subtalar sling.

CONCLUSIONS

Although the relative effectiveness of taping versus bracing for restraint of excessive inversion has not been clearly established, both types of ankle support clearly provide beneficial protective effects. During the acute phase of ankle-sprain management, bracing offers advantages related to ease of repetitive removal and reapplication, adjustability of strap or lace tension, and structural features that may facilitate edema resolution. Research findings suggest that taping may provide superior benefits with regard to deceleration of inversion velocity and facilitation of dynamic neuromuscular protective mechanisms. Furthermore, taping offers a means to address the complex interrelated biomechanical factors that are responsible for subtalar joint injury and rotary instability of the talocrural joint. Future research on the effectiveness of various braces and taping procedures should use methods that assess rotary displacements of both the foot and lower leg within the transverse plane.
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