Journal of Athletic Training 2008;43(2):164–171

www.nata.org/jat

Ankle Bracing, Fatigue, and Time to Stabilization in Collegiate Volleyball Athletes

Megan Y. Shaw, MS, ATC*; Phillip A. Gribble, PhD, ATC†; Jamie L. Frye, PhD, ATC†

*Miami University, Oxford, OH; †University of Toledo, Toledo, OH; ‡James Madison University, Harrisonburg, VA

Context: Fatigue has been shown to disrupt dynamic stability in healthy volunteers. It is not known if wearing prophylactic ankle supports can improve dynamic stability in fatigued athletes.

Objective: To determine the type of ankle brace that may be more effective at providing dynamic stability after a jump-landing task during normal and fatigued conditions.

Design: Two separate repeated-measures analyses of variance with 2 within-subjects factors (condition and time) were performed for each dependent variable.

Setting: Research laboratory.

Patients or Other Participants: Ten healthy female collegiate volleyball athletes participated (age = 19.5 ± 1.27 years, height = 179.07 ± 7.6 cm, mass = 69.86 ± 5.42 kg).

Intervention(s): Athletes participated in 3 separate testing sessions, applying a different bracing condition at each session: no brace (NB), Swede-O Universal lace-up ankle brace (AB), and Active Ankle brace (AA). Three trials of a jump-landing task were performed under each condition before and after induced functional fatigue. The jump-landing task consisted of a single-leg landing onto a force plate from a height equivalent to 50% of each participant's maximal jump height and from a starting position 70 cm from the center of the force plate.

Main Outcome Measure(s): Time to stabilization in the anterior-posterior (APTTS) and medial-lateral (MLTTS) directions.

Results: For APTTS, a condition-by-time interaction existed ($F_{2,18} = 5.55$, $P = .013$). For the AA condition, Tukey post hoc testing revealed faster pretest (2.734 ± 0.331 seconds) APTTS than posttest (3.817 ± 0.263 seconds). Post hoc testing also revealed that the AB condition provided faster APTTS (2.492 ± 0.271 seconds) than AA (3.817 ± 0.263 seconds) and NB (3.341 ± 0.339 seconds) conditions during posttesting. No statistically significant findings were associated with MLTTS.

Conclusions: Fatigue increased APTTS for the AA condition. Because the AB condition was more effective than the other 2 conditions during the posttesting, the AB appears to be the best option for providing dynamic stability in the anterior-posterior direction during a landing task.

Key Words: dynamic stability, postural control

Key Points

- With fatigue, anterior-posterior time to stabilization increased in the no-brace and Active Ankle brace conditions but not in the Swede-O Universal lace-up ankle brace condition.
- Medial-lateral time to stabilization was consistent from prefatigue to postfatigue for all conditions.
- In volleyball players, the Swede-O Universal lace-up ankle brace appeared to provide the most efficient dynamic stability.

Accounting for 85% of all sprains, lateral ankle sprains are the most common sport-related injury today.[1–3] In basketball and volleyball, ankle sprains frequently occur because these sports involve jumping and landing with high ground reaction forces, resulting in lateral ankle sprain rates of 79% and 87%, respectively.[2] Ankle braces are commonly used to help reduce the occurrence and severity of ankle sprains. Sitler et al[4] compared the use of an ankle stirrup with no bracing in 1601 basketball athletes during a 2-year period. The rate of ankle injury in players who did not use ankle braces was 3 times the rate of injury in players who wore ankle braces. Tropp et al[5] studied 450 soccer athletes during a 6-month period and compared a group of athletes using ankle braces with a group involved in a proprioceptive injury prevention program and with a control group. For players with no previous ankle injuries, the incidence of ankle injury was 3% for the brace group, 5% for the proprioception training group, and 11% for the control group. Players with previous ankle injuries had an injury frequency of 2% in the brace group, 5% in the proprioception training group, and 25% in the control group. The authors[5] found that athletes with previous sprains were at a greater risk for reinjury. Additionally, they found that the use of ankle bracing or proprioception training programs effectively prevented ankle sprains.

The most common mechanism for ankle injury in jumping sports is landing, which accounts for 58% of basketball injuries and 63% of volleyball injuries.[3,6,7] Many factors, including muscle fatigue, may affect landing patterns and ankle control during landing. Fatigue negatively affects muscle spindles through the activation of nociceptors and inflammatory by-products, which in turn change and decrease the discharge pattern of muscle spindles.[8]

As the body's innate protection from injury, neuromuscular control also plays a leading role in dynamic joint stability. Specifically, neuromuscular control can be defined as the unconscious activation of dynamic restraints in preparation for, and in response to, joint motion and joint loading to maintain and restore functional joint stability.[9,10] During athletic competition, fatigue may alter neuromuscular control and may decrease the body's ability to maintain stability.[8,11] Gribble et al[12] demonstrated that chronic ankle instability amplified deficits in dynamic postural control associated with fatigue. However, the postural control measure used in that study (the Star Excursion Balance Test) is not as functional and dynamic as a jump-landing task.

Time to stabilization (TTS) is a measure of neuromuscular control that uses force plate measures to evaluate dynamic postural stability during jump landing.[13–15] It is different from other jump-landing assessments. To quantify TTS, participants completed a single-leg landing from a height equal to 50% of his or her maximal jumping height and gained stability on this limb as quickly as possible. This measure is a more functional test compared with the traditional postural control measures because it simulates a movement produced during jumping sports, thus providing a functional method for assessing the effects of fatigue on neuromuscular control and dynamic stability.[16] Wikstrom et al[17] demonstrated that the application of prophylactic ankle bracing in participants with functionally unstable ankles did not improve this measure of dynamic stability. However, it is not known if enhancing stability at the ankle with ankle bracing can improve dynamic stability, as measured through TTS, when the participant is fatigued.

Athletes involved in jumping sports often wear protective equipment, such as lace-up ankle braces and semirigid orthoses. These devices are used not only after an injury has occurred but also for injury prevention.[18,19] The effectiveness of lace-up and semirigid ankle braces on jump height, running speed, and agility does not appear to differ significantly,[2,18,20] but evidence indicates that various ankle braces, specifically the Swede-O Universal brace (AB; Swede-O, Inc, North Branch, MN) and the Active Ankle brace (AA; Active Ankle Systems, Inc, Louisville, KY), contribute to dynamic stability.[17] Therefore, the purpose of our study was to compare the ability of the AB and the AA to improve an athlete's dynamic stability by measuring the TTS after a jump-landing task during normal and fatigued conditions. Determining which ankle brace is associated with shorter TTS postfatigue is important because this relationship can negatively affect an athlete's ability to land properly from a jump.

METHODS

Participants

Ten female volleyball athletes (age = 19.5 ± 1.27 years, height = 179.07 ± 7.6 cm, mass = 69.86 ± 5.42 kg; 7 hitters or front-row players, 1 setter, 2 defensive players) at a National Collegiate Athletic Association Division I college volunteered to participate in this study. All participants were healthy with no ankle or knee injuries in the past 12 months and no history of lower extremity surgery or fracture. Additionally, participants did not have chronic lower extremity disorders (ie, chronic ankle instability or patellofemoral pain syndrome). All participants were using the AA during team practice and competition. Before participating in the study, all participants read and signed an informed consent form. The study was approved by the University of Toledo Institutional Review Board. Based on data from a pilot project involving 6 volunteers who completed the protocol described in this study and using an online statistical calculator[21] (University of California, Los Angeles, Los Angeles, CA) with the normal distribution 1-sample option, a sample size of 10 was associated with a power level of .90.

Instrumentation

We used a force plate (model 4060NC; Bertec Inc, Columbus, OH) integrated with MotionMonitor software (version 6.0; Innovative Sports Technologies Inc, Chicago, IL) to collect ground reaction forces during the jump-landing task. Ground reaction force data were sampled at 180 Hz.[13,15,17] A metronome (model DM50L; Seiko Corp, Mahwah, NJ) was used to standardize lunge cycles.

Procedures

Each participant reported to the research laboratory on 4 separate occasions, which were 7 days apart. At the initial session, an assessment of each participant's maximal vertical jump height ($Vert_{max}$) was determined. First, the standing height of the participant was measured by having her stand under a Vertec jump training system (Sports Imports, Columbus, OH) and reach up to touch the highest point possible while maintaining both feet flat on the ground. Second, participants performed a 2-footed maximal vertical jump reaching to the highest point possible on the Vertec. Each participant was given 3 jump trials, and we recorded the greatest height achieved. The $Vert_{max}$ was determined by subtracting the standing-reach height from the largest jump height.

Next, we determined the testing limb as the leg on which the participant would choose to stand while kicking a ball. This limb received the brace conditions and served as the landing limb during the testing protocol. We measured and recorded the length of each participant's testing limb from the anterior superior iliac spine to the distal portion of the medial malleolus. This length was used to determine the reach distance of the lunging task that was part of the functional fatigue protocol.

Finally, the functional fatigue protocol was explained and demonstrated to the participants during the initial session. Each athlete was allowed to practice the protocol once to establish a baseline time and perform the protocol a second time while being timed. Five minutes of rest were provided between these 2 trials. The timed trial was used for the other 3 testing sessions to establish the point of fatigue.

The functional fatigue protocol comprised 3 stations: Modified Southeast Missouri (SEMO) agility drill, stationary lunges, and quick jumps.

Modified Southeast Missouri Agility Drill. The SEMO agility drill is a series of forward sprints, diagonal backpedaling, and side shuffling.[16] We used a modification of the SEMO that was completed in a rectangle of 12 × 19 ft (3.6 × 5.7 m) (Figure 1). At the completion of this station, participants immediately began the stationary lunges station.

Stationary Lunges. Activities at this station occurred at the finishing position of the SEMO agility drill (Figure 2). Using an alternating leg pattern, the participant lunged forward with each leg 5 times to a distance equal to the recorded leg length. Pieces of tape on the floor served as the point of origin and the target reaching distance. With a metronome to establish the rate of performance, the participant performed lunges at a rate of 1 lunge per

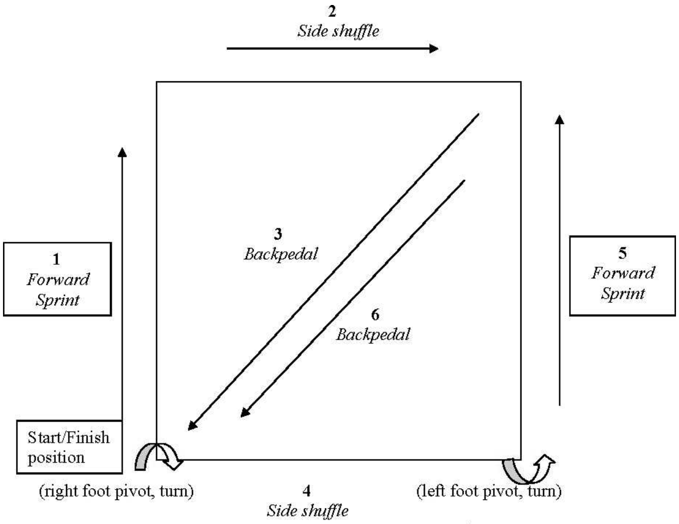

Figure 1. Modified Southeast Missouri agility drill.

2 seconds. A lunge cycle was defined as reaching to the target, achieving approximately 90° of hip and knee flexion in the lunging leg while maintaining an upright trunk, and returning the reaching leg to the point of origin. At the completion of the lunges, the participant immediately began the quick jumps station.

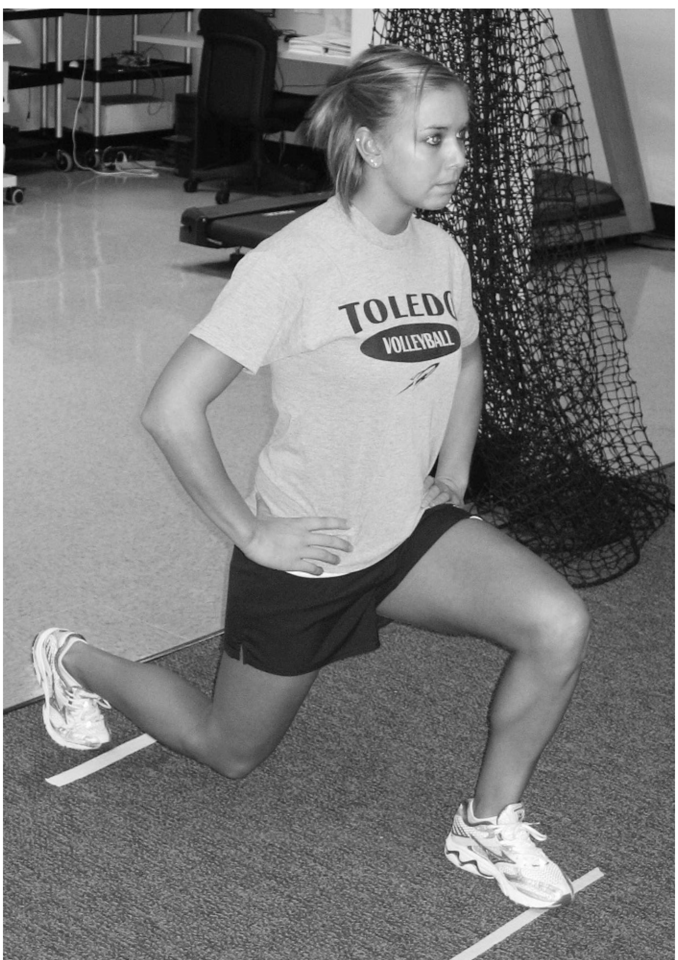

Figure 2. Lunging task.

Figure 3. Quick jumps. A, Starting position. B, Jumping to target (50% $Vert_{max}$).

Quick Jumps. Quick jumps were accomplished near a wall and consisted of 10 quick, 2-footed jumps with both arms above the head reaching for a mark on the wall equal to 50% of the previously measured $Vert_{max}$ (Figure 3).

The participants continued to run through each station until the time to finish the stations increased by 50% compared with their baseline timed runs.[16,22] Athletes were given verbal encouragement throughout the protocol. As soon as fatigue was achieved, participants immediately moved to the testing area and began the posttesting jump-landing trials within 5 seconds.

During each of the 3 subsequent testing sessions, participants performed the jump-landing task before and after the functional fatigue protocol. The jump-landing task consisted of a single-leg landing from a jump height equivalent to 50% of the $Vert_{max}$.[15] To begin the task, each athlete stood 140 cm from the center of the force plate (Figure 4A). Participants took a step with the testing limb to a mark 70 cm in front of the force plate (Figure 4B). Next, they brought the nontesting leg forward to the same mark; jumped with both feet toward the force plate; reached up to touch an indicated marker (50% $Vert_{max}$) on the Vertec positioned above the force plate (Figure 4C); and landed on the testing foot on the force plate, completing a jump distance of 70 cm (Figure 4D).[15] We instructed each athlete to stabilize as quickly as possible on the single testing leg and put both hands on her hips while facing forward. Participants were allowed to practice this task until comfortable

Figure 4. Jump-landing procedure. A, Starting position. B, Step forward with testing leg. C, Jumping to target (50% $Vert_{max}$). D, Landing and maintaining dynamic stability on testing leg.

and consistent with the landings at the beginning of each testing session. Data were collected for 3 trials of the jump-landing task before and after fatigue. If a participant touched the ground with the nonstance leg or demonstrated an additional hop upon landing, the trial was discarded and repeated until 3 acceptable trials were obtained.

Participants wore the team practice shoes (Mizuno Wave Spike 8; Mizuno USA Inc, Norcross, GA) and athletic

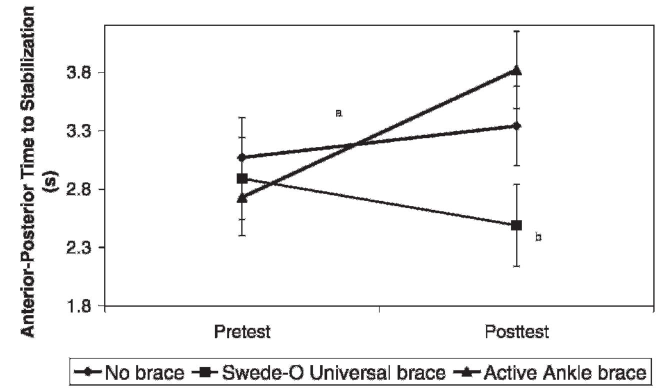

Figure 5. Anterior-posterior time-to-stabilization condition-by-time interaction. [a] For the Active Ankle brace condition, anterior-posterior time to stabilization was significantly slower from pretesting to posttesting. [b] At posttesting, the Swede-O Universal lace-up ankle brace condition provided significantly faster anterior-posterior time to stabilization compared with the Active Ankle brace and no-brace conditions.

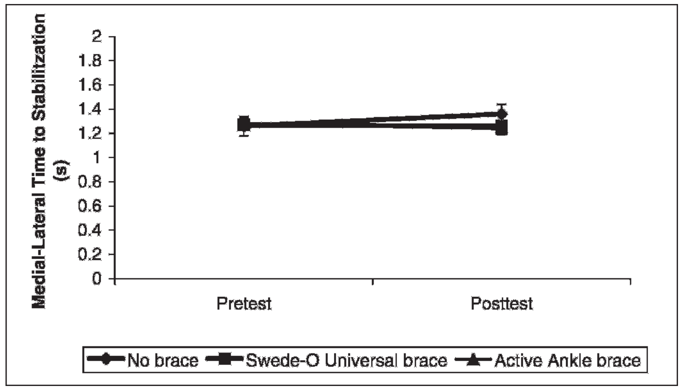

Figure 6. Medial-lateral time to stabilization condition-by-time interaction. Ankle bracing and fatigue had no influence on medial-lateral time to stabilization.

apparel at all testing sessions. The brace conditions were counterbalanced and applied to the foot of the testing limb of each athlete: no brace (NB), AA, and AB. The AA brace consists of 2 molded plastic sides padded with neoprene and connected to a heel piece by a hinge joint that enables dorsiflexion and plantar flexion of the ankle and restricts inversion and eversion.[23] The AB is made of canvas and encompasses the talocrural joint with medial and lateral supports to restrict motion in all 4 cardinal planes.[23,24] During testing sessions for the brace conditions, participants wore the appropriate brace during pretest jump-landing tasks, the fatigue protocol, and posttest jump-landing tasks. For the NB condition, participants only wore shoes and socks for all procedures.

Data Reduction

The TTS values in the anterior-posterior (APTTS) and medial-lateral (MLTTS) directions were calculated through the sequential estimation method, using an algorithm to calculate a cumulative average of all the ground reaction force data points from the jump-landing trials in a series by successively adding one data point at a time.[14,25] Next, we compared the cumulative average of trial data with the overall series mean of the ground reaction force. The series consisted of ground reaction force data collected during the 5-second period after landing and contacting the force plate. The position of stability was determined when the cumulative, or sequential, average of the series mean was within ± 0.25 SDs of the overall series mean. The point when the position of stability was achieved was designated as the TTS. All TTS analyses were performed using Excel 2000 (Microsoft Corp, Redmond, WA).

Statistical Analysis

The means and SEs of the 3 jump trials during each prefatigue and postfatigue session were used for statistical comparisons. Two separate repeated-measures analyses of variance with 2 within-subjects factors (condition and time) were performed for the dependent variables of APTTS and MLTTS. Post hoc Tukey tests were applied in the event of a statistically significant interaction. Significance was set a priori at .05. All statistical analyses were performed using SPSS (version 12.0; SPSS Inc, Chicago, IL).

RESULTS

Anterior-Posterior Time to Stabilization

For APTTS, a condition-by-time interaction existed ($F_{2,18} = 5.55$, $P = .013$, effect size = 0.381, observed power = 0.787). Post hoc Tukey testing revealed that in the AA condition, APTTS was slower from pretesting (2.734 ± 0.331 seconds) to posttesting (3.817 ± 0.263 seconds) (Figure 5). Additionally, at posttesting, the AB condition provided faster APTTS (2.492 ± 0.271 seconds) compared with the AA (3.817 ± 0.263 seconds) and NB (3.341 ± 0.339 seconds) conditions.

Medial-Lateral Time to Stabilization

The condition-by-time interaction for MLTTS was not statistically significant ($F_{2,18} = 1.816$, $P = .191$, effect size = 0.161, observed power = 0.329) (Figure 6). For the NB condition, prefatigue MLTTS was 1.256 ± 0.008 seconds, and postfatigue MLTTS was 1.360 ± 0.077 seconds. Prefatigue MLTTS for the AB condition was 1.268 ± 0.030 seconds, and postfatigue MLTTS was 1.257 ± 0.016 seconds. For the AA condition, prefatigue MLTTS was 1.275 ± 0.019 seconds, and postfatigue MLTTS was 1.241 ± 0.51 seconds.

DISCUSSION

In both AP and ML directions, all 3 conditions produced similar prefatigue TTS scores. These findings indicated that without fatigue, the use of prophylactic ankle braces did not improve dynamic stability among this group of skilled volleyball athletes. In the presence of fatigue, however, APTTS increased in 2 of 3 conditions and MLTTS remained consistent. We studied healthy, elite jumping athletes, so these findings cannot be assumed for the general population.

As evidenced by a faster TTS, the AB condition provided an improvement in the participant's dynamic stability in the AP direction postfatigue compared with the NB and AA conditions. In contrast, participants wearing the AA had an increased APTTS after the fatigue protocol, indicating they took longer to stabilize their ankles after the jumping task. While not statistically significant, the AB condition actually provided slightly better dynamic stability postfatigue (2.492 ± 0.271 seconds) than prefatigue (2.893 ± 0.348 seconds). These findings suggest that the AB condition may be more efficient than AA or NB at providing dynamic stability in the AP direction during functional fatiguing conditions.

The mechanism of an inversion ankle sprain is a combination of forced inversion and plantar flexion.[26,27] As noted, the AB is made with a canvas support that encompasses the talocrural and midtarsal joints and has plastic supports on each side. It is designed to restrict movement in 4 motions of the ankle complex: inversion, eversion, plantar flexion, and dorsiflexion.[23,24] The AA is made of 2 molded plastic sides with hinges that enable dorsiflexion and plantar flexion and restrict inversion and eversion.[23] One could assume that, based on its design, the AB would prevent ankle sprains and reduce AP translation better than the AA or NB. The results of our study most likely are related to the design and purpose of each type of ankle brace and to the cutaneous input that braces provide to the muscles surrounding the ankle.[28,29]

The increase in APTTS between the prefatigue and postfatigue AA conditions was significant, meaning that the AA condition was associated with a longer time to create a stable stance postfatigue than prefatigue. Interestingly, although not statistically different, the NB condition was associated with slightly faster APTTS compared with the AA condition postfatigue, suggesting that the AA condition may slightly hinder the ability to find a stable state postfatigue compared with the AB and the NB conditions. Therefore, these results suggest that wearing the AB improves TTS capabilities after a fatiguing protocol. However, wearing the AA has TTS capabilities that are similar to, or perhaps even less effective than, wearing no ankle brace. Providing improved capabilities to stabilize the ankle in both the AP and ML directions may contribute to the prevention of the mechanisms of injury that are associated with chronic ankle instability.

The peroneous longus muscle is a primary dynamic defense mechanism against inversion moments. The reaction time of the muscle and the magnitude of its response are thought to have important roles in preventing inversion forces at the ankle and helping to maintain balance.[29] Some authors[28] have suggested that the application of an ankle brace increases peroneal motoneuron excitability, which in theory elicits a greater muscular response resulting from the brace-stimulated mechanoreceptors in the skin. This theory is consistent with that of Cordova and Ingersoll,[29] who studied the peroneous longus stretch reflex amplitude after the application of an ankle brace. Studying 2 different ankle brace groups and a control group, they examined the short-term and long-term effects of wearing ankle braces during an induced inversion moment at the ankle. Initially, the lace-up ankle brace group had higher stretch reflex amplitude compared with the semirigid ankle brace and control groups, and no difference was found between the latter 2 conditions. After 8 weeks of use, the stretch reflex amplitude increased in the semirigid ankle brace group but not in the lace-up brace or control groups. No difference was noted between the lace-up and control groups after 8 weeks of use. The results of the initial brace condition were similar to the results of our study, which showed that the AB was more effective than the AA and NB conditions after 1 use. The effectiveness of the AB may be due to increased afferent signals being sent to the central nervous system primarily by cutaneous mechanoreceptors. Because the AB covers more surface area than the AA, it may stimulate more mechanoreceptors, leading to increased afferent signals and a stronger peroneal reaction.[29] This does not explain why the AA condition was not more effective than the control condition, however. It can be speculated that because the AA does not lie as flush to the skin as the AB, mechanoreceptors do not respond as well to the application of the AA and, therefore, do not elicit as great a response.

Fatigue has a negative effect on dynamic stability because it potentially desensitizes muscle spindles and the afferent pathways to the central nervous system, leading to an increased likelihood of injury.[30,31] Under normal conditions, the firing rates of muscle contractions are rapid and an appropriate number of motor units is recruited. After a muscle contracts, fewer motor units are needed to maintain contraction. However, firing rates are slowed with fatigue and fewer motor units are stimulated, leading to a diminished muscle contraction.[31] Based on evidence that the application of ankle braces helps recruit motor units[28] and based on the results of our study, the clinician can hypothesize that ankle braces may be able to recruit mechanoreceptors. In turn, these mechanoreceptors may be able to stimulate motor units even under fatigued conditions, leading to improved dynamic stability.

We found no differences in MLTTS between condition and time. The design of both braces protects against ML translation with rigid supports on either side,[23] which could account for the findings. Additionally, the functional fatigue protocol may not have been demanding enough to affect dynamic stability in the ML direction. To our knowledge, our functional fatigue protocol has not been used previously, although all 3 parts of it have been used separately. However, this protocol may not have fatigued the muscles that aid ML support to the same extent as muscles that aid AP support because the protocol consists mostly of exercises in the AP direction (sprints, lunges, and jumps). This may explain why differences were found in the AP direction but not the ML direction and could indicate that participants were able to withstand inversion and eversion moments better postfatigue compared with plantar-flexion and dorsiflexion moments. Perhaps this is also why the control condition was not associated with significantly increased MLTTS postfatigue.

Our findings may have been influenced by the direction of the jump-landing task, which provided greater AP momentum than ML momentum when jumping toward the force plate. We did not control for acceleration during the jump, which could have caused differences in APTTS and MLTTS findings. In an effort to simulate the volleyball spike approach, the players performed a forward step before the 2-footed take-off. Compared with participants in previous studies that incorporated the jumping protocol of 70 cm,[13,15,16,25,32] they essentially doubled the distance covered between the point of movement initiation and landing. Therefore, although the ranges of TTS were similar between our study and previous studies, we recommend caution in making direct comparisons of results because our participants covered more distance before take-off than participants in these other studies. Additionally, the collegiate volleyball players in our study were accustomed to wearing the AA, so they may have jumped forward with greater acceleration in that condition than in the other 2 conditions, resulting in higher APTTS values after fatigue. Finally, the combination of fatigue to AP muscle groups and larger momentum in the AP plane may have created a greater challenge to maintaining dynamic stability. The AB appears to be superior to the AA and NB conditions at reducing these deficits during this task.

Contrary to previous findings,[16,22] we found no differences in the NB condition from prefatigue to postfatigue for APTTS. Shills et al[22] found that TTS increased after fatigue in participants with and without functional ankle instability, and Wikstrom et al[16] showed slightly faster postfatigue TTS in healthy volunteers after they employed 2 fatigue protocols. The fatigue protocols used in these 2 studies differed from each other; however, all of the fatigue protocols employed running, cutting, and jumping maneuvers. The participants in our study were healthy, elite volleyball athletes who were used to jumping and landing with and without fatigue, which may have given them better dynamic stability and influenced our results.

Bocchinfuso et al[33] and MacKean et al[23] studied healthy participants to test the effects of various types of ankle braces on vertical jump, speed, and agility. The authors of both studies found that the AA had no negative effect on these factors. Additionally, MacKean et al[23] found that participants with uninjured ankles and with no applied ankle support had the highest level of functional performance. In our study, athletes performed a series of running, cutting, and jumping maneuvers, similar to that of Bocchinfuso et al[33] and MacKean et al,[23] to the point of fatigue. Our results demonstrated that the difference in dynamic stability between the AA and NB conditions was not statistically significant. This may reflect the design of the AA, which enables dorsiflexion and plantar-flexion motions at the ankle.[23] Not wearing an ankle brace also enables this freedom of movement, which may account for the similar results between the AA and NB conditions and indicate that the AA is best suited for sports that do not require great stability in the AP direction.

In our study, the mean prefatigue APTTS (2.90 seconds) was slower than the range (1.35–2.38 seconds) reported by other researchers,[15,16,25] although the mean prefatigue MLTTS (1.27 seconds) was faster (range: 1.56–1.95 seconds).[15,16,25] It should be noted that Ross and Guskiewicz[15] used a different method of calculating TTS than Wikstrom et al[16,25] and we used. Our mean postfatigue APTTS (3.22 seconds) was much slower than the 1.35 seconds reported by Wikstrom et al,[16] but our postfatigue mean MLTTS of 1.29 seconds was faster than the time reported by Wikstrom et al[16] (1.53 seconds). Our TTS values may have been lower than the values reported in other studies because of the jumping task that we used. This jump-landing protocol included an additional forward step before jumping, which was designed to simulate a multiple-step approach for a volleyball spike. This additional step, which has not been included in previous studies, may have contributed to increased momentum in the AP direction and led to increased time to achieve stability.

Limitations

We do not know if the same level of fatigue was achieved by each participant during each session because of the lack of electromyographic and physiologic assessment. This is a concern any time a functional fatigue protocol is used because of the difficulty in determining fatigue in real time. However, our protocol and level of determination of fatigue were similar to those of previous studies in which the authors examined the influence of functional fatigue on measures of TTS.[16,34] Another limitation of this study was that the participants were part of a specific population: uninjured female collegiate volleyball athletes. Therefore, the results may only be applied to that group of individuals. Additionally, only the dominant foot of each athlete was tested, so we do not know if differences in performance between the dominant and nondominant foot existed when the braces were applied. Finally, we only examined how a short-lasting fatigue protocol affects a short-term brace application. How effective these braces may be in preventing ankle sprains over the course of a volleyball match or even an entire season is a question for future researchers.

CONCLUSIONS

We attempted to determine which ankle brace is the most appropriate for volleyball athletes to use during competition to provide dynamic stability. Our results under controlled testing conditions suggest that the AB may be the best option. More researchers should examine the effects of long-term ankle bracing on TTS before definitive determinations are made about the AA and AB braces. Our study is a stepping stone in studying the relationship of ankle braces and fatigue on TTS. Future researchers should examine injured and uninjured participants tested under these conditions to determine if these results are useful in selecting appropriate prophylactic bracing that can treat or prevent injury to the ankle during functional activities.

ACKNOWLEDGMENTS

We thank the National Athletic Trainers' Association Research & Education Foundation (Dallas, TX) for providing funds for this study through its Osternig Master's Grant Program. We also thank Swede-O, Inc (North Branch, MN), and Active Ankle Systems, Inc (Louisville, KY), for donating the braces used during this study.

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Megan Y. Shaw, MS, ATC; Phillip A. Gribble, PhD, ATC; and Jamie L. Frye, PhD, ATC, contributed to conception and design; acquisition and analysis and interpretation of the data; and drafting, critical revision, and final approval of the article.

Address correspondence to Phillip A. Gribble, PhD, ATC, Mailstop #119, University of Toledo, Toledo, OH 43606. Address e-mail to phillip.gribble@utoledo.edu.