Journal of Athletic Training 1999;34(3):239-245

www.nata.org/jat

Eversion Strength Analysis of Uninjured and Functionally Unstable Ankles

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Objective: Functional ankle instability (FAI) afflicts many athletes. Several causes of FAI have been implicated, including peroneal muscle weakness. Traditional musculoskeletal rehabilitation programs have focused on concentric muscle strength. The purpose of our study was to compare concentric and eccentric isokinetic and isometric eversion ankle strength measurements between subjects identified as having unilateral FAI and subjects having no history of inversion ankle sprain.

Design and Setting: Employing a matched-pairs technique, subjects with no history of ankle injury were compared with subjects with unilateral FAI using isokinetic and isometric measures of eversion ankle strength. Strength testing was performed in a sports medicine clinic setting.

Subjects: Forty-two subjects volunteered for this study: 21 subjects suffered from unilateral FAI (age = 19.3 ± 1.1 years, wt = 84.0 ± 9.5 kg, ht = 181.5 ± 9.2 cm), while 21 subjects served as matched-paired controls (age = 19.5 ± 1.2 years, wt = 82.5 ± 10.9 kg, ht = 179.5 ± 7.9 cm).

Measurements: Ankle eversion concentric and eccentric strength (peak torque) was assessed at 0°/s, 30°/s, 60°/s, 90°/s, 120°/s, 150°/s, and 180°/s using an isokinetic dynamometer.

Results: We found no significant differences in concentric, eccentric, or isometric eversion ankle strength between the 2 groups of subjects.

Conclusions: The exact cause of FAI remains elusive. Based on our results, those who suffer from unilateral FAI do not appear to have eversion strength deficits. Unless clear evidence of weakness exists, clinicians may find that eversion strength training exercises are unnecessary. Future research should examine other causes of FAI, including reciprocal muscle group strength ratios and proprioception deficits.

Key Words: isokinetic, peak torque, eccentric, concentric

Ankle injuries, specifically lateral ligament sprains, are a common sport-related problem.[1–5] These injuries result in more time loss than any other single injury in athletics.[4] The high-intensity nature of sporting activities requires optimal neuromuscular development and control of the lower extremity. Prevention and treatment programs for ankle injuries can be time consuming and costly. Despite efforts to rehabilitate these ligamentous injuries, repeated episodes of ankle injury (sprain) often occur. Freeman[6] first introduced the concept of functional ankle instability (FAI) to describe the feeling of "giving way," which was a symptom many of his patients experienced after an initial ankle sprain. O'Donoghue[7] later categorized this as "once a sprain, always a sprain." Previous research has demonstrated that this entity may be prevalent in as many as 40% of the patients suffering from an acute lateral ligament injury to the ankle.[8,9]

Several causes of FAI have been implicated in the literature. Decreased range of motion was described by Cahill[10] as a potential cause of chronic ankle instability. Several studies[6,9,11–16] have suggested that a decrease in ankle joint proprioception after an initial ankle sprain leads to chronic ankle instability. Mechanical instability has also been mentioned as a factor contributing to FAI.[17] However, as Freeman[6] postulated and others have supported,[13,18,19] the pathologic processes to which FAI is usually attributed (ie, mechanical instability) are rarely, if ever, responsible for initiating the disability. Perhaps the most questionable factor contributing to chronic FAI is peroneal muscle weakness. The potential role of peroneal weakness as a cause of ankle instability has been given little attention in the literature. Previous research[8,11,14,20–23] has indicated that decreases in ankle eversion muscle strength were present in those with FAI. However, several recent reports contradict these findings,[15,24–28] showing no deficit in eversion strength in those with functionally unstable ankles. These discrepancies in the role of eversion strength in ankle instability suggest the need for additional research.

Programs for follow-up therapy and rehabilitation of the functionally unstable ankle vary according to the athletic trainer's or therapist's background, philosophy, and physician familiarity. Until recently, the accepted standard for rehabilitation of the strength component after ankle injury was to rely solely on the concentric action of the muscle. Our own approach to ankle injury rehabilitation has focused on both the

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concentric and eccentric actions of normal muscle physiology. Isokinetic dynamometers are often used to examine the progress of rehabilitation and to assess levels of muscle performance. These devices have enabled both the clinician and researcher to quantify concentric, eccentric, and isometric force production about a body joint. A potential problem with the use of these devices as rehabilitative and assessment tools has been the clinicians' reluctance to rely solely on the concentric (shortening) phase of muscle action. Typical lower extremity function requires both the concentric and eccentric (lengthening) components of muscle activity.

Providing quantitative data on the concentric activity of muscles surrounding the joint provides only partial information on a muscle's total performance capacity, particularly with respect to the ankle joint. This holds true because a significant proportion of normal gait involves eccentric muscle control. Those individuals lacking adequate eccentric muscle control and those unable to develop adequate contraction velocity either concentrically or eccentrically may be predisposed to initial ankle injury or find themselves functionally unstable.[14,25,29] Newer active isokinetic dynamometers are capable of assessing both the concentric and eccentric action of muscle. The ability to assess muscle strength is particularly important to the clinician in the evaluation and rehabilitation of individuals with musculoskeletal disorders.

The purpose of our study was to compare concentric and eccentric isokinetic and isometric eversion ankle strength between subjects identified as having unilateral FAI and subjects having no history of inversion ankle sprain.

METHODS

The ankles of 42 college-aged male subjects were tested in this study. Subjects were recruited for participation from the student population at a small midwestern college. Twenty-one subjects (age = 19.3 ± 1.1 years, wt = 84.0 ± 9.5 kg, ht = 181.5 ± 9.2 cm) experienced unilateral chronic FAI at the time of the study. To be characterized as functionally unstable, the subjects satisfied the following criteria: (1) experienced at least 1 significant lateral (inversion) ankle sprain of either the right or left ankle, but not both, in which the subject was unable to bear weight or was placed on crutches, within the last year, (2) no reported history of fracture to either ankle, (3) sustained at least 1 repeated injury or the experience of feelings of ankle instability or "giving way" in either the right or left ankle, but not both, (4) not undergoing any formal or informal rehabilitation of the unstable ankle, and (5) have no evidence of mechanical instability as assessed by a physician using an anterior drawer test. Subjects were pain free and full weight-bearing, without a limp, at the time of the study. The average time period since their last episode of instability was 6 weeks.

The other 21 subjects (age = 19.5 ± 1.2 years, wt = 82.5 ± 10.9 kg, ht = 179.5 ± 7.9 cm) served as controls. These subjects were match paired with the subjects suffering from unilateral chronic FAI. The side of unilateral FAI was matched with the same uninjured side on the control subjects. In addition, height, weight, age, body type, and activity level were used to match the subjects between groups. For the entire group of matched pairs, the average weight difference was 5.1 ± 4.8 kg and the average height difference was 3.4 ± 3.1 cm.

Subjects were briefed on all testing procedures and asked to read and sign a consent form approved by a university committee for the protection of human subjects.

Instrumentation

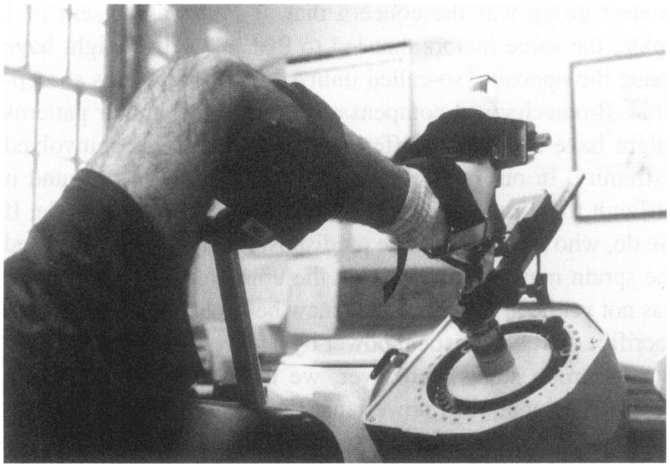
The Kin Com 125 AP (Chattanooga Group, Inc, Hixson, TN) isokinetic dynamometer was used to assess peak torque (PT) for the motion of ankle eversion. The Kin Com is an isokinetic strength testing device, integrated with a computer and the appropriate software to provide precise strength measurements from both concentric and eccentric muscle actions. In addition, the dynamometer can be used to assess isometric strength. Kin Com dynamometers allow for precise and reliable measurement and storage of data from isokinetic, isotonic, and isometric muscular actions.[30,31]

Test Procedures

Subjects reported to an isokinetic testing laboratory on one occasion. Subjects were acquainted with the isokinetic dynamometer and the test environment. Height and weight measurements were recorded with the subjects barefooted and in shorts. Subjects rode a stationary bicycle for a 5-minute warm-up and performed several general lower body flexibility exercises. Testing of the ankle occurred at 7 predetermined velocities, ranging from 0° to 180° per second. The presentation of velocities was counterbalanced using a 7-by-7 latin square.[32]

Eversion ankle motion was tested with the subject seated on the dynamometer chair. All tests were performed with the subject wearing socks. The subject was stabilized in the chair according to manufacturer's guidelines, with straps securing the chest and waist. The isokinetic dynamometer was moved to the appropriate position and height for eversion strength testing using the automatic positioning function of the dynamometer. A universal stabilizer was used to position and hold the lower leg and to help prevent any unwanted muscle substitution (Figure). The foot was securely fastened into the ankle inversion-eversion footplate attachment using hook-and-loop closures. With the foot securely fastened into the footplate, the subject's active ankle eversion range of motion was determined. A procedure described by Donatelli[33] was used to find the position of subtalar joint neutral, which became the start position (0°). The start and stop angles for eversion motion were set at 0° and 25°, respectively.

Isokinetic tests of the ankle evertors (peroneals) were performed at 30°, 60°, 90°, 120°, 150°, and 180° per second. To become familiar with the isokinetic exercise concept and especially the eccentric mode, each subject was allowed 3



Subject positioned on the Kin Com 125 AP isokinetic dynamometer for eversion strength testing.

submaximal (50% capacity) and 3 maximal (100%) warm-up repetitions at 105°/s in a continuous manner. A 2-minute rest was provided at the end of the practice session. According to Cress et al,[34] 105°/s allows subjects to become familiar with the eccentric mode without letting them get additional practice at one of the test velocities. The order of test velocity presentation was counterbalanced to minimize any potential learning effects. Each subject in the matched-pairs control group performed the test sequence in the same order as the FAI counterpart. For each test velocity, 3 maximal eccentric and concentric test repetitions were completed through the 25° of eversion range of motion. Using the interrupted sequence protocol of the Kin Com software package, each of these repetitions was completed individually with a 15-second pause between repetitions. Subjects were instructed to provide maximal effort throughout the entire repetition. A 1-minute rest period was given between each of the 7 test velocities.

One isometric (0°/s) test was included in the 7 test velocities. This test was performed with the foot in the subtalar joint neutral position, corresponding with the start angle (0°) previously entered into the Kin Com computer. Each isometric contraction lasted 5 seconds, with a 30-second rest between contractions. A total of 3 maximal isometric contractions were completed.

Both ankles of subjects in the FAI group and control group were tested using the same procedure. The highest PT value recorded from the 3 maximal test repetitions at each of the 7 test velocities was used for further statistical analysis. PT values for the functionally unstable ankle were matched against the control counterpart for analysis.

Statistical Analysis

A separate mixed-model analysis of variance (ANOVA) statistical procedure was conducted on each of the concentric and eccentric data sets. Isometric data were included in both analyses. The SPSS for Macintosh Release 6.1.1 (SPSS Inc, Chicago, IL) was used to assist in the statistical analysis. PT values were the dependent measure. This analysis, to determine differences between normal and functionally unstable ankles, used one within-subjects variable (velocity [0°, 30°, 60°, 90°, 120°, 150°, and 180° per second]) and one between-subjects variable (ankle stability status [functional instability versus control]). Mean comparisons within the analysis were conducted using a Tukey honestly significant difference post hoc analysis. An a priori α level of significance was set at $P < .05$ for all comparisons. An a priori power analysis was conducted to determine the power of the statistical design to detect significant differences. Using our proposed sample size of 21 subjects, the analysis resulted in a power of 0.94.

RESULTS

Concentric PT Data

The descriptive statistics for concentric PT and PT/body weight (BW) ratios, including the isometric data, are presented in Table 1. The results of the ANOVA showed no significant interactions involving the between-subjects factor of group ($F_{6,240} = 0.71$, $P = .644$). There was no significant difference between the groups ($F_{1,40} = 1.13$, $P = .294$). As expected, the ANOVA revealed a main effect for velocity ($F_{6,240} = 99.39$, $P < .001$). PT production decreased as the velocity of movement increased.

Eccentric PT Data

The descriptive statistics for eccentric PT and PT/BW ratios, including the isometric data, are presented in Table 2. The results showed no significant interactions involving the between-subjects factor of group ($F_{6,240} = 0.94$, $P = .466$). There were no significant differences between the groups ($F_{1,40} = 0.10$, $P = .753$). A main effect for velocity ($F_{6,240} = 5.95$, $P < .001$) was evident when the eccentric ANOVA was analyzed. Eccentric PT values appeared to show very little variation between velocities. However, significant differences were present when comparing the PT values between 90°/s and 30°/s and 90°/s and 0°/s. In addition, significant differences existed between 180°/s and the eccentric velocities of 60°, 90°, 120°, and 150° per second.

Table 1. Concentric and Isometric Peak Torque (Nm) and PT/BW* Ratio Mean Values (± SD) for Ankle Eversion in Control (Uninjured) and Experimental (Functional Instability) Groups

Velocity (°/s)	Control (PT)	Control (PT/BW)	Experimental (PT)	Experimental (PT/BW)
0	30.14 ± 5.11	.37 ± .06	29.71 ± 7.63	.36 ± .06
30	25.81 ± 4.26	.33 ± .06	24.38 ± 5.23	.29 ± .06
60	23.05 ± 3.99	.29 ± .05	21.38 ± 4.34	.26 ± .05
90	22.29 ± 4.27	.28 ± .05	19.95 ± 4.86	.24 ± .06
120	20.19 ± 3.88	.26 ± .06	19.86 ± 3.97	.24 ± .04
150	20.57 ± 4.62	.27 ± .06	18.90 ± 4.57	.23 ± .06
180	19.52 ± 2.80	.25 ± .05	17.81 ± 4.40	.22 ± .05

* PT, peak torque; BW, body weight.

Table 2. Eccentric and Isometric Peak Torque (Nm) and PT/BW* Ratio Mean Values (± SD) for Ankle Eversion in Control (Uninjured) and Experimental (Functional Instability) Groups

Velocity (°/s)	Control (PT)	Control (PT/BW)	Experimental (PT)	Experimental (PT/BW)
0	30.14 ± 5.11	.37 ± .06	29.71 ± 7.63	.36 ± .07
30	29.76 ± 6.50	.37 ± .08	29.86 ± 7.86	.36 ± .08
60	30.57 ± 5.90	.37 ± .08	31.67 ± 6.78	.38 ± .07
90	31.10 ± 7.10	.39 ± .06	32.86 ± 6.76	.39 ± .06
120	31.90 ± 5.95	.39 ± .07	31.48 ± 5.95	.38 ± .06
150	31.05 ± 6.76	.38 ± .08	31.43 ± 6.02	.37 ± .06
180	28.14 ± 6.09	.35 ± .08	29.67 ± 5.71	.35 ± .06

* PT, peak torque; BW, body weight.

DISCUSSION

Strength of the peroneus longus and brevis muscles is highly important in the absorption of stress and in providing support to the lateral ligaments of the ankle.[29] Kaumeyer and Malone[35] indicated that the evertor and pronator muscles play a major role in preventing ligamentous injuries of the ankle. Our study did not show evertor muscle weakness in subjects with unilateral FAI when compared with a control group of subjects with uninjured ankles. This finding was evident when each of the concentric, eccentric, and isometric PT values was analyzed. A follow-up analysis using PT/BW ratios also produced no significant differences and was consistent with the analysis using PT measures only. This was important, considering the effect that body mass has on force production. Our research findings are inconsistent with the earlier conclusions of several researchers[8,11,14,20–23] who reported evertor strength deficits in subjects with FAI. Several inconsistencies in strength measurement exist with these earlier studies. Various reports[8,11,20–23] used subjective manual muscle tests to assess strength. This method of strength assessment provides a less accurate measure and does not reflect the true dynamic nature of the inversion-eversion ankle motion. The availability of newer isokinetic dynamometers provides a more accurate and precise assessment of ankle strength. In contrast with the earlier studies, the results of our study are consistent with several recent reports[15,24–27,36] that have shown no deficits in eversion strength in subjects with FAI. Lentell et al[15] examined concentric eversion ankle strength and found no differences between the uninjured and chronically unstable ankles in the same subjects. This was later supported in a follow-up study[26] that again showed no bilateral differences in eversion strength in subjects with FAI. The authors concluded that there appears to be a greater need for retraining proprioception capabilities than muscle strengthening at the ankle joint in those who experience ankle instability.[26] We would suggest that, unless an obvious weakness in the ankle evertors exists, strength training of these muscles may be a waste of time and energy.

One major difference between our study and several of the previously mentioned studies[25–27,36] is that we used a control group instead of the opposite, uninvolved ankle for comparison. The primary reason for using an uninjured matched control group was the concern that, if FAI was present in 1 ankle, the same factors that led to that instability might have made the opposite, so-called uninvolved ankle just as susceptible. Biomechanical compensatory changes or motor patterns might have developed differently in the opposite uninvolved extremity. In our own clinical experiences, we have found it difficult to recruit subjects who have sprained only 1 ankle. If we do, who is to say that the predisposing factors that produced the sprain may not also exist in the uninjured ankle, even if it has not yet been sprained? We knew beforehand that we would sacrifice a bit of statistical power by adding a between-subjects factor (group status); however, we more than offset that by conducting an a priori power analysis and settling on a subject pool of 21 in each group. The fact that we had more than the necessary number of subjects, yet found no differences in eversion strength between the groups, lends further credibility to our results and our suggestions about strength training.

The failure to reject the null hypothesis (no difference between the groups) raised 2 interesting questions: (1) How robust was our statistical test in detecting significant differences? (2) Was our instrument reliable? A post hoc power analysis is often used to help explain the nonrejection of the null hypothesis. At the end of our study, we performed a post hoc power analysis using the standard deviations derived from our isokinetic PT/BW values and found a power value of >0.995. We were convinced that we did indeed have enough power to detect statistically significant differences had they existed. The next question we had to answer involved the reliability of the measurements themselves. In our previous work,[31] we concluded that the Kin Com was a reliable device for measuring inversion and eversion isokinetic strength; however, we questioned the validity of the footplate attachment device. That study was conducted on a Kin Com II isokinetic dynamometer. The Kin Com 125 AP isokinetic dynamometer used in this study was part of the new generation of Kin Com dynamometers. In these newer dynamometers, the footplate connection to the load cell was reconfigured, which in turn corrected the problems we faced in our original investigation concerning validity. We believe the other modifications to the new generation Kin Com (eg, exterior design) did not negatively affect reliability of assessing ankle inversion and eversion. As such, we were reasonably confident that our measurement protocol produced reliable PT values. Having answered these 2 questions, we were confident that the results were an accurate depiction of the lack of eversion strength differences between the 2 groups.

Very little research exists on the measurement of eccentric ankle strength for comparison with our study. Schrader[24] examined eversion and dorsiflexion eccentric PT values in subjects with FAI and concluded that muscle strength was not a factor contributing to chronicity. Bernier et al[25] also examined eccentric ankle strength using the Kin Com dynamometer at a velocity of 90°/s. They found no significant differences in the eccentric strength of the ankle invertors and evertors between the injured and uninjured ankles in the FAI group and the dominant and nondominant ankles in the nondisabled group. Our results seem to support the assertion that eversion muscle strength may not be drastically altered in those with functional ankle instabilities. It appears that, at various concentric and eccentric velocities, functionally unstable ankles perform the same as uninjured ankles do. In addition, the lack of differences in either concentric or eccentric eversion strength between the groups measured may support the contention that individuals with FAI may not be different in relation to their strength level before an injury encounter. This supports Schrader's[24] claim that individuals may not be predisposed to ankle sprain because their muscles are weaker than those same muscles in uninjured individuals.

Determining the actual presence of eversion muscle weakness in individuals who subjectively indicate FAI presents an interesting challenge for the researcher. The subjective method of determining FAI has been questioned in prior reports because relying on subjects to assess their own FAI may provide inaccurate information.[8,11,21] Tropp[14] assessed concentric ankle strength and found significant eversion muscle weakness when comparing the unilateral injured ankle with the contralateral uninjured ankle. He concluded, however, that the muscular impairment was due to inadequate rehabilitation and secondary muscle atrophy and not true FAI as his subjects had reported. The subjects in our study had all undergone some form of rehabilitative strength therapy following their initial ankle injury, yet still experienced episodes of instability. This finding supports the contention that lack of strengthening may lead to further ankle instability, but that rehabilitation may counteract future episodes of instability due solely to eversion weakness.[14,28]

Termansen et al[37] concluded that plantar flexion strength in the functionally unstable ankle was significantly less than in the opposite, uninjured ankle that served as control. A closer look at the mean values indicates that the difference was quite small and probably clinically insignificant. In addition, strength was assessed only isometrically, thereby not providing an accurate dynamic assessment of the true strength output of the muscle. Although we did not examine plantar flexion strength, an earlier study by Termansen et al[37] may indicate the need to assess plantar flexion strength in addition to eversion strength in those with FAI. Confusing the matter is evidence from a more recent report[38] that indicates ankles with greater plantar flexion strength had a higher incidence of inversion ankle sprain. Interestingly, Schrader[24] found concentric dorsiflexion strength in a group of chronically sprained ankles to be stronger than the contralateral, never-sprained ankles. If strength is an issue for those suffering from FAI, it appears that it lies in muscles other than those involved in eversion and dorsiflexion.[24] Several more recent reports[27,39] have found inversion performance deficiencies in the involved extremity of subjects with FAI. Further study is needed to examine combined multiplanar ankle motions, invertor deficiencies, and eversion-to-inversion strength ratios.

Glick et al[29] examined the biomechanics of ankle sprains and showed that subjects with FAI exhibited increased inversion just before heel strike during normal walking. In addition, electromyogram recordings showed an increase in the contraction time of the peroneus brevis before heel strike. Tropp et al[40] later showed that, if the ankle is inverted at the moment the foot touches the ground, the result could be a varus thrust from an inversion lever through the subtalar axis. If the evertor muscles are not strong enough to counter this motion, the tensile strength of the lateral ligaments is exceeded and injury results. Bernier et al[25] theorized that, if the functionally unstable ankle strikes the heel in an inverted position, the ankle pronators are called on to stabilize the ankle with every step. In addition, they suggested that walking and functional activities alone may have acted to return muscle function in the injured ankle. Many of the subjects in our study were intercollegiate athletes who, despite their instability, had continued participating in their respective sports. The rigors of athletic competition may have been instrumental in maintaining adequate muscle strength in the ankle evertors. In 2 recent studies[36,38] examining ankle injury risk factors, the authors concluded that improved peroneal muscle strength may represent an adaptive mechanism to protect an ankle susceptible to injury. Our results seem to support this rationale because, despite the fact that the subjects suffered repeated episodes of ankle sprain, no differences in peroneal eversion strength were evident.

Muscle strengthening protocols have been an integral part of ankle rehabilitative programs for many years. Freeman[6] reported initially on the importance of regaining strength in the prevention of FAI. The focus on muscle strengthening has long been considered the traditional approach to treating and preventing FAI. Although none of our experimental group subjects were currently involved in a rehabilitation program, they had all indicated previous participation in some form of rehabilitative therapy. Included as part of that therapy was some form of strength training. The length of time spent in therapy ranged from a few days to several weeks. Seto and Brewster[41] indicated that most chronic lateral ankle sprains require more time for appropriate recovery than acute sprains, due to compensations that have occurred with motion and strength, repeated irritation of the soft tissues, decreased proprioception, and atrophy of muscles. It appears from the results in our study that the FAI subjects may have achieved success from their rehabilitative programs, at least with regard to the strength component. Therefore, the functionally unstable subjects may have regained strength and muscular stability in their ankle evertors. This is consistent with the findings of Tropp et al[40] and Schrader,[24] who indicated that strength rehabilitation can improve the functional disability that muscle weakness purportedly contributes to FAI. Despite this finding, the experimental group subjects in our study continued to suffer subsequent episodes of instability. Further study examining the role of previously mentioned risk factors is warranted.

A considerable amount of attention has been given to examining deficits in proprioception as a cause of FAI. Several researchers[9,11–13,15,16,42] have concluded that long-term ankle instabilities can be related to decreased joint proprioception. In fact, several recent reports[26,43] have suggested that decreased proprioception as a cause of FAI is a more important consideration than first thought. Lentell et al[26] concluded that deficits in passive movement sense and anatomical stability are of greater concern than strength deficits when managing the ankle with functional instability. This finding supports the earlier work by Garn and Newton,[44] who demonstrated decreases in passive movement sense in those with functionally unstable ankles. The lack of differences in both concentric and eccentric strength between groups tends to lend support to the earlier conclusions drawn by Fiore and Leard,[45] who suggested that muscle mechanoreceptors may control the instantaneous and qualitative muscle contractions necessary for foot control. Research by Lofvenberg et al[43] showed that a delayed proprioceptive response of the ankle was a cause of chronic lateral ankle instability. Furthermore, the lack of neuromuscular control may prove to be a better explanation for the cause of chronic ankle injury than any of the other previously reported causes of instability. Although we did not examine proprioceptive parameters, it appears that the results point to potential causes of FAI other than muscular strength deficits.

CONCLUSIONS

The neuromuscular and biomechanical relationships in the ankle are complex. In order to fully understand the nature of FAI, the clinician must be able to comprehend these complex relationships. Based on the results of our study, statistically significant eversion muscle strength deficits were not found to exist between a group of subjects who self-reported FAI and a group of uninjured control subjects. Clinicians should be careful in determining whether or not eversion strength training exercises will be beneficial in those with FAI. Strengthening exercises in individuals without obvious weaknesses may prove to be costly and a waste of time. Future research should examine other purported causes of FAI. Recent reports have suggested that differences in proprioception measures exist, as well as strength differences in reciprocal muscle groups (evertors to invertors). Further study of eccentric muscle actions in the ankle and their contributions in ankle injury prevention is also needed.

ACKNOWLEDGMENTS

This research was supported by an equipment loan from Chattanooga Group, Inc (Hixson, TN). We also thank Brent Arnold, PhD, ATC; Joe Gieck, EdD, ATC, PT; and Ethan Saliba, PhD, PT, ATC, for their guidance and support.

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