The Effects of a 10-Minute Warm-up on Postural Control in Subjects with Functional Ankle Instability

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Objective

The purpose of this study was to determine the effects of a 10-minute warm-up on the postural control of subjects with functional ankle instability.

Design and Setting

A pretest-posttest design was used in this study. All data was collected in the Athletic Training Laboratory at the University of North Florida.

Subjects

Three male and nine female subjects participated in this study.

Measurements

The Chattecx Balance System (CBS) was used to calculate postural sway in the anterior/posterior (AP) and medial/lateral (ML) directions in centimeters for each individual who participated. The CBS also produces a stability index value, which is a function of the two previous values.

Results

We found that subjects swayed more during the control sessions than the experimental sessions. Specifically, or the ML slide condition during the control session the stability index was .14 units greater than the values found during the experimental session. Furthermore, AP sway was 1.31 cm greater during the control compared to the experimental session. For the AP slide condition, the AP sway value was .91 cm greater during the control session when compared to the experimental session.

Conclusions

Based on our results a 10-minute warm-up may decrease postural sway, although we did not find any pretest to post test differences. Further research is needed in this area.

Key Words

Warm-up, Postural sway, Functional ankle instability.

Introduction

Ankle injuries are one of the most common injuries in sport and frequently cause loss of playing time and performance.[1, 2] These injuries can lead to instability. The functionally unstable ankle was first described by Freeman [3] as a, "…tendency for the foot to give way after an ankle sprain." Along with the subjective complaint of instability, this definition refers to the recurrence of sprains.[2, 4, 5] The chance of developing chronic instability is fairly high. Approximately 40% of inversion ankle sprains will develop chronic instability.[3]

Many authors have found a correlation between functional ankle instability and a reduction in proprioceptive sense.[1, 2, 6, 7] Past research has shown that postural control is a measure of ankle proprioception. [1, 8, 9] Additionally, Tropp [5] found that dynamic postural control is primarily maintained by ankle control. Most postural control research regarding the ankle has used static postural sway measurement devices,[1, 5, 9, 10, 11, 12] but dynamic postural control has also been shown to be a reliable measuring device of proprioception.[13]

Very little research has assessed the effect of warm-up on postural control. The only related literature found pertained to rigorous activity and sensory processes. This type of activity increases the rate of reaction to perturbations of muscle length.[14] Also, an increase in core temperature caused by activity influences the velocity of muscle shortening.[15] Warming up prior to activity is a universally accepted method to prevent injuries. [16] Intense activity increases the rate of reaction to perturbations of muscle length and influences kinesthetic sensation. This raises the question if this neuromuscular effect can be replicated by measuring postural sway after a short activity.

Therefore, the purpose of this study was to determine if a 10-minute warm-up improves postural control in subjects with a functionally unstable ankle.

Subjects

Twelve subjects consisting of 3 males and 9 females (height = 167.00 ± 11.05cm, weight = 62.65 ± 10.36kg, age = 20.5 ± 1.78yr) volunteered to participate in this study. All subjects were verbally screened to meet the following study inclusion criteria: classified as having a functionally unstable ankle according to Freeman's definition of a feeling of giving way during normal activity [3], no history of any mental, neurological or other deficit that impaired their balance, no history of head injury within the last year, no lower extremity reconstructive surgery and no visual, vestibular or sensory disorders. All subjects were also required to read and sign and informed consent agreement approved by the University Institutional Review Board for the Protection of Human Subjects.

Instrumentation

In this study postural sway was assessed using a Chattecx Balance System (CBS) (Chattanooga Corporation, Hixson, TN). The CBS measures an individual's center of balance (COB), the point at which body mass equals the distributed amount of weight across four quadrants while standing.[17] The CBS can calculate postural sway in the anterior-posterior (AP) and medial-lateral (ML) directions in centimeters. The CBS also calculates a stability index (SI), which is a function of the combined AP and ML sway. These three measures were our dependent variables. The CBS platform can also move forward and back to create a dynamic balance situation. In this study, AP, ML, and SI were calculated for a stable platform condition, an AP slide condition, and a ML slide condition.

Procedures

Subjects reported for 2 different test sessions. In one session, subjects' underwent a pretest where their postural sway was assessed for the 3 platform conditions. Subjects stood unilaterally on the CBS platform on the extremity with the functionally unstable ankle for 30 seconds during each platform condition. They were instructed to stand with their knees and hips straight and arms at their sides and were instructed to maintain their balance as best as possible during the test. If the subject felt as if they needed to grab the handrails to maintain balance they were instructed to briefly touch the handrail to regain their balance as quickly as possible. Subjects rested for 1 minute in between the 3 platform conditions, and were instructed to stand bilaterally and rest their test extremity. After the pretest, subjects sat quietly for 10 minutes. Then their postural sway was assessed a second time using the same procedures.

In the other session, subjects underwent the pretest as described above. The subjects then performed a ten-minute warm-up consisting of a combination of running, stretching and selected calisthenics. Each individual completed three minutes of running, followed by bilateral stretching of the lower extremity which included: hamstrings, quadriceps, gastrocnemius/soleus complex, hip adductors and hip abductors. Each stretch was held for 30 seconds and repeated three times. After the stretching, each subject performed one minute of a crossover running pattern and one minute of side shuffles, both between a set of marks that were twenty feet apart. Upon completion of the 10-minute warm-up, subjects repeated the balance assessment. The testing order and platform condition was completely counterbalanced to control for possible learning effects.

Data Analysis

To analyze the data three separate 2 (gender) x 2 (test) x 2 (test session) mixed model repeated measure ANOVAs were used to examine the results under the 3 platform conditions. We chose Tukey' s HSD (honestly significant difference) test to examine any significant interactions that were found. The a priori α level for all statistical analyses was set at $p \leq .05$.

Results

The mean and standard deviations of each sway value and platform slide condition during each testing session can be found in Tables 1, 2 and 3, respectively. For the medial/lateral slide condition, we found a significant ($F_{(1,11)} = 11.24$, p=.006) main effect between the control and the experimental test sessions. During the control test session, the stability index (SI) was .14 units greater than the experimental test session. During the medial/lateral slide condition, we found a significant difference ($F_{(1,11)}=8.32$, p=.015) in AP sway between the control and the experimental test sessions. During the control test session subjects deviated 1.31 cm more from COB than the experimental test session. For the anterior/posterior slide condition we found a significant difference ($F_{(1,11)} = 15.148$, p=.003) in AP sway between the control and the experimental test sessions. Subjects deviated .91 cm more during the control session than the experimental test session. We found no other significant main effects or interactions.

Discussion

For the medial/lateral slide condition we found a significant increase in anterior/posterior sway (1.31 cm) between the control and experimental testing sessions, with greater anterior/posterior sway during the control test session overall. Although this result may help support our hypothesis that postural sway would decrease after a warm-up, the difference was not seen between the pre and posttests. During the medial/lateral slide condition a significant main effect was found between the control and experimental testing sessions for stability index. Individuals had an increased amount (.14 units) of postural sway during the control session. The stability index is a function of medial/lateral sway and anterior/posterior sway. Therefore, because we found a significant main effect during this same slide condition for anterior/posterior sway, that could explain the significant difference in stability index. The significant main effect could also be due to many of the same circumstances as stated with the increase in anterior/posterior sway, including limited subject size, a learning effect, and criteria for participation that was not strict enough. The length and type of exercises included in the warm-up could have also had an effect on the results.

During the anterior/posterior slide condition, a significant difference was found between the control and experimental testing sessions. Individuals swayed more (.91 cm) in the anterior/posterior direction during the control testing session than in the experimental testing session. The possible explanations for this include many of the same reasons stated previously: number of subjects was limited, and the criteria for participation in this study may have not been strict enough.

A strong explanation for the significant amount of sway in the anterior/posterior direction during the anterior/posterior slide condition can be traced back to the anatomy of the ankle. As stated before, the ankle has an increased amount of range of motion in the anterior/posterior direction. Part of this is due to the anatomical bony make-up of the ankle. The ankle is a hinge joint where a mortise for the calcaneus to sit in is made by the tibia and fibula allowing most of the range of motion to be within one plane, the sagittal plane. During the anterior/posterior slide condition, the platform was moving in this same plane. The movement of the platform in the same direction and plane as the increased range of motion of the ankle would facilitate and increased amount of sway in the anterior/posterior direction.[17, 18]

There were several limitations in this study that may have affected the results. The number of subjects (12) was a limitation, and we believe that if more subjects were tested it is possible differences expected between pre and post-tests would become evident. Subjects were limited in this study because of time constraints and because of a limited pool of candidates that met our criteria.

The criteria for participation in this study may have also not been strict enough, allowing individuals to participate who did not have clinically functionally unstable ankles. Individuals without functionally unstable ankles will naturally sway less.[3, 4, 10, 19, 20] This difference in natural sway would in turn have an effect on our overall results. Konradsen et al [4] studied reaction patterns in thirty soccer players and cross country runners with stable and unstable ankles to determine if reflex stability was disrupted due to functional instability of the ankle. They found that individuals with functional instability also had increased peroneal reaction times and in turn had an increased amount of postural sway. Cornwall et al [19] investigated the effect of inversion ankle sprains on postural sway. Fifty individuals, all with a previous history of inversion ankle sprains, performed a barefoot, single-leg stance on each extremity with their eyes open and closed for 12.8 seconds on a force platform. The order of testing was randomly determined. They found that the experimental group swayed significantly more than the control group allowing him to conclude that individuals with a history of inversion ankle sprains are less stable. There may have also been a learning effect between the control and experimental testing sessions, which could help to explain the significantly different sway value found. We used a double counter-balance order to help control for learning effects, but it still could have influenced the results in this study.

In regard to the warm-up techniques used, different activities may have a greater effect in decreasing postural sway than the activities we included in the study. A different warm-up protocol may have produced different results, and it is also possible that the warm-up duration was not long enough. With a more intense and extensive warm-up, a greater difference in postural sway may have been observed. Several authors, including Kulund et al [21] and Safran et al [22] have reviewed the literature concerning the effectiveness of warming up. Both concluded that a warm-up should be intense enough to cause the individual to sweat but not intense enough to cause fatigue. Stewart et al [23] examined the role of warm-up intensity on range of motion and anaerobic performance. There were nine male union rugby players involved in his study. Each individual was involved in several testing sessions of treadmill running for 15 minutes at different percentages of their personal VO_{2max}. After each run, three minutes of contract-relax stretching of the hamstrings, hip flexors, gastrocnemius and quadriceps followed. He concluded that warm-up is always essential but needs to be performed at 60-70% of a persons VO_{2max} to have the desired positive effects.

The different values found only in anterior posterior sway may be partially explained by examining the anatomy of the ankle. The ankle has more range of motion in the dorsiflexion/planterflexion (anterior/posterior) movements than in the inversion/eversion (medial/lateral) movements.[17] The increase range of motion allows for more sway in those directions. It is also natural for an individual to sway more in the anterior/posterior direction because it is easier to compensate for the sway because of the musculature involved in those movements. The tibilas anterior, gastrocnemius and solues are the major muscular stabilizers for ankle during dorsiflexion and planterflexion. These muscles play a larger role in postural control than the tibilas posterior and fibularius longus and brevis, which are responsible for the inversion/eversion movements of the ankle.[17, 18]

We believe that a larger group of subjects would have increased the power of the study and may have had an effect on our results. A learning effect could also have played a role in the results we observed. A double counterbalance order was used to attempt to control for a learning effect, but this may have not been as effective as we had planned. The type and length of warm-up could have played a part in the results that were observed. A typical warm-up can include such a multitude of activities; therefore it is very possible that with different activities, different results would have been seen. We included common activities utilized in a typical warm-up, but it is possible that different activities would have different effects on postural stability in subjects with functionally unstable ankles. The duration of the warm-up may have also had an effect, and it is possible that with a longer more intense warm-up results would have been different.[21, 22, 23]

Conclusion

In this study we found that there was no change in postural control in subjects with functionally unstable ankles. However, we did find that subjects had significantly better AP postural control and SI in the experimental test session during ML platform slide conditions. Furthermore, subjects had significantly better AP postural control during AP platform slide conditions. Future research should investigate whether a different warm up protocol produces different results. Other considerations for future investigation include using different warm-up durations and intensities. Other investigators may also consider using more stringent inclusion criteria when screening for subjects with functionally unstable ankles.

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Table 1. Medial/Lateral Slide Condition Values

		Control		Experimental	
		MEAN	SD	MEAN	SD
A/P sway (cm)	PRE	5.80	0.54	4.47	0.35
	POST	6.19	0.56	4.91	0.45
M/L sway (cm)	PRE	4.03	0.19	4.05	0.24
	POST	4.16	0.29	4.01	0.23
Stability Index	PRE	1.28	0.07	1.20	0.79
	POST	1.41	0.10	1.21	0.07

Table 2. Anterior/Posterior Slide Condition Values

		Control		Experimental	
		MEAN	SD	MEAN	SD
A/P sway (cm)	PRE	6.14	0.35	5.26	0.24
	POST	6.14	0.63	5.20	0.38
M/L sway (cm)	PRE	2.58	0.13	2.85	0.14
	POST	3.12	0.17	2.73	0.13
Stability Index	PRE	1.12	0.06	1.07	0.04
	POST	1.22	0.12	1.07	0.06

Table 3. Stable Platform Condition Values

		Control		Experimental	
		MEAN	SD	MEAN	SD
A/P sway (cm)	PRE	3.01	0.32	3.35	0.38
	POST	3.38	0.31	3.77	0.30
M/L sway (cm)	PRE	2.34	0.15	2.30	0.21
	POST	2.63	0.20	2.65	0.14
Stability Index	PRE	0.77	0.09	0.74	0.07
	POST	0.80	0.06	0.97	0.07