The effect of prophylactic ankle braces on postural sway

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Abstract

Ankle braces are commonly used in an attempt to decrease the risk of injury during sport. Despite the widespread use of ankle braces, their efficacy of use for uninjured ankles is questionable. The purpose of this study was to investigate the effects of a prophylactic ankle brace on postural sway, in the ankle of a previously uninjured athlete. Twenty healthy individuals aged between 20 and 27 years, who were currently involved in a sporting activity, participated in this study. Participant's single leg postural sway was evaluated on both legs, via three trials of 10 seconds each. Results indicated that ankle bracing had a small effect on the postural sway patterns in the healthy ankle. Further research is necessary to ascertain the role of bracing the uninjured ankle to improve ankle stabilisation and prevent injury.

Key Words: ankle stability, ankle brace, postural sway

Introduction

Ankle injuries provide many problems to the athlete and health care practitioner. This is particularly the case in sports that require participants to frequently jump and land on one foot (eg. netball) or in sports where the athlete is expected to make quick changes in direction (eg. basketball, soccer, football and volleyball). In one study it was stated that 18-40% of all sports injuries were localised to the ankle joint (Bot and van Mechelen, 1999). Another study (Hume and Gerrard, 1998) found that ankle sprains result in one-sixth of time lost in sport due to an injury.

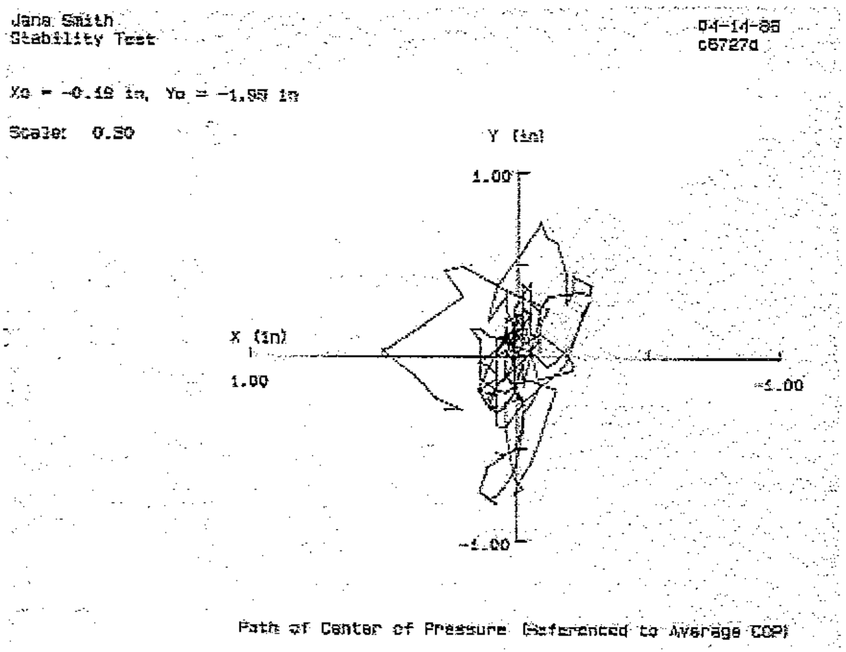
The mechanism of ankle injury usually involves forced plantar flexion and foot inversion (Yaggie and Kinzey, 2001). The most common risk factor for ankle sprains in sport is a history of previous sprain (Thacker et al., 1999). Athletes who have previously experienced ankle sprains are about twice as likely to re-injure the same ankle (Bot and van Mechelen, 1999). As a result, today's health care practitioners are constantly challenged in therapeutic and preventative measures in reducing ankle injuries.

Recently, ankle braces have become a more prevalent method of preventing ankle injuries (Callaghan, 1997). This recent change is due to the long term cost-effectiveness, ease of re-application, maintenance of movement restriction and decreased risk of skin irritation compared with tape (Hume and Gerrard, 1998). One study has reported that braces restrict ankle range of motion as effectively as tape, and that they do not adversely affect athletic performance (Shapiro et al., 1994). It has also been reported that bracing the ankle joint increases external lateral support to the joint without significantly restricting functional ability (Yaggie and Kinzey, 2001).

In the erect standing posture the body undergoes a constant swaying motion called postural sway. Norkin and Levangie (1992) stated that postural sway in someone with their feet 10cm apart can be up to 12° in the sagittal plane and 16° in the frontal plane. Gravitational forces act downwards from the centre of gravity to the bodies centre of pressure (COP). The gravity line must fall within the borders of the feet to maintain upright stance. In unilateral stance the gravity line falls within the foot.

Norkin and Levangie (1992) further suggest that the path of the COP, which defines the extent of postural sway, can be determined by plotting the COP at regular intervals when a person is standing on a force platform (Fig. 1).

Fig 1 – Path of the Centre of Pressure on a Force Platform, whilst performing a one legged stance.



Postural sway according to Norkin and Levangie (1992), is produced by gravitational forces acting through joints of the body. Receptors in and around the joints of the soles of the feet detect these positional changes and relay the information to the central nervous system (CNS). The CNS analyses the inputs and makes an appropriate response to maintain postural stability to help conserve the body's energy.

McGuine et al. (2000) documented that subjects with high postural sway scores (poor balance) had nearly seven times as many ankle injuries as subjects who had low postural sway scores. The authors concluded that subjects with a low postural sway were less likely to suffer an ankle injury. These results indicate that postural sway may be used as a predictor of ankle sprain susceptibility. It was hypothesised by McGuine et al. (2000) that using devices that reduce postural sway could be a means of reducing ankle injuries.

Proprioception is the ability to provide information about sense of position and awareness of a limb as it moves through its range of motion (kinesthesia). Bear et al (1996) states there are three different types of proprioceptors, which are:

1. Joint capsule mechanoreceptors – are sensitive to extremes of joint angle.
2. Muscle spindle receptors – respond to changes in muscle length and predominantly determine joint angle.
3. Cutaneous mechanoreceptors – provide information about joint position.

McGuine et al. (2000) stated that the ability to maintain postural control and balance depends on information provided by visual cues, vestibular function, and somatosensory feedback from structures in the lower limb. The authors also noted that a loss of somatosensory function could result in an increased postural sway (loss of balance) in otherwise healthy individuals. Nishikawa and Grabiner (1999) reported that the increase in cutaneous-mechanoreceptor stimulation via a brace, resulted in an increase in motor neuron excitability. This suggests that a braced unstable ankle will correct itself earlier than the unbraced unstable ankle, due to increased somatosensory stimulation. A device, such as an ankle brace, that may improve somatosensory feedback could possibly be beneficial to the sporting athlete wanting to prevent an ankle injury.

Bracing may enhance proprioception and thus stimulate neuromuscular control, this is supported by Feuerbach et al. (1994), Firer(1990), Glick et al(1976), Heit et al (1996), Jerosch et al (1995) and Karlsson and Andreasson (1992). Feuerbach et al. (1994) states that the ankle brace may return the ankle to a more stable neutral position prior to ground contact, reducing the likelihood of the foot landing in an inappropriate position. This is supported by Eils and Rosenbaum (2003), who reported that the main function of ankle braces is to restrict motion during the free fall phase before loading with bodyweight. Eils and Rosenbaum (2003) also state that the inversion angle at the end of the free fall phase has a predominant influence on ankle sprains, because more inversion leads to an increased moment arm at the subtalar joint at ground contact, and therefore to higher torque when load is applied.

Garrick and Requa (1973) stated that taping only benefits the subject for the first 10 minutes and provides little or no measureable support after 30 minutes. Shapiro et al. (1994) reported that there is a 12%-50% decrease in the stabilizing effect of tape after 10 minutes of exercise. When the tape does loosen it needs to be taken off and new tape needs to be reapplied via an experienced practitioner. Yaggie and Kinzey (2001) state that braces have been shown to maintain their mechanical properties throughout the entire activity period. Colosky et al. (2001) reported that results have shown braces perform better than tape over time. This may be important as most sporting activities are for periods longer than 10 minutes.

Hume and Gerrard (1998) suggest taping cannot provide enough mechanical restriction to prevent an ankle sprain. For an external support to provide mechanical support to a ligament it should exceed the strength of the ligament. Hume and Gerrard (1998) reported that for the anterior fibular ligament it is a force between 6 and 56kg. Another problem with taping athletes is the common effects on the skin, with many athletes having an allergic reaction to elastoplast or zinc oxide.

Bot and van Mechelen (1999) reported that the supportive quality of semirigid and lace-up braces has been comparable with, or superior, to that of tape. This study also stated that ankle taping was less effective in preventing injury and re-injury than a lace-on ankle brace. In a study by Baier and Hopf (1998) it was suggested that rigid and flexible ankle braces significantly reduced mediolateral sway of injured athletes compared to injured athletes without orthosis.

Greene and Hillman (1990) reported 85% of ankle injuries involve lateral ankle ligaments from inversion sprains. Paris et al. (1995) suggested an important attribute of ankle braces is there ability to significantly limit ankle inversion and eversion range of motion pre-exercise, during exercise and post-exercise. Tropp et al. (1985) states that the incidence of ankle sprains was significantly lower in a group of players who used braces (3%) compared to those that did not (17%).

Although braces can be quite expensive, in the long run they can prove to be cost effective. Rolls of tape are quite expensive and over time this cost accumulates, making the preventative measure of taping dearer than the one of ankle bracing.

Summary

McGuine et al (2000) indicated that athletes with increased postural sway have an increased risk of injuring their ankle, when compared to athletes who have minimal postural sway. This study also indicated that most subjects who had a previous ankle injury also had an increase in postural sway.

Callaghan (1997) found that ankle braces have been shown to facilitate joint proprioception in uninjured ankles. Feuerbach et al. (1994) reported that this improvement in joint position sense was thought to be due to the stimulation by the brace of the cutaneous receptors in the foot and shank, which might have increased the afferent feedback. Nigg et al. (1999) state that the increase in afferent feedback contributes to human balance control. As a result, this improvement in position sense via an ankle brace may result in reduced postural sway. The reduction in postural sway plus the other benefits of longer term cost-effectiveness, ease of re-application, maintenance of movement restriction and decreased risk of skin irritation compared to tape, may lead to ankle braces becoming more widely used by health care practitioners and sports trainers to reduce ankle injuries.

Aim

The aim of this study was to investigate whether ankle braces reduce postural sway in the previously uninjured individual, as it may provide further information regarding the effective methods in preventing ankle injuries.

Method and Procedure

Participants

Twenty subjects were recruited from a Victorian Osteopathic Medicine Course. Subjects were recruited via notices that were placed on Victoria University notice boards. The form outlined details about the study, inclusion and exclusion criteria and the time involved. Space was provided on the form where subjects provided their name and a phone number to contact them on.

The inclusion/exclusion criteria required participants to be between 18 and 30 years of age. Subjects with previous brain, spine, pelvic, knee or ankle surgery were excluded. Subjects must not have suffered any previous trauma to their head, spine, pelvic, knee or ankle in the previous three months, such as sprains, strains and fractures. They must not be using a lower limb orthotic device. At the time of testing subjects must be competing in a weekly sporting activity, for example, netball, basketball or football. Prior to recruitment subjects were required to pass a full lower limb neurological examination.

Procedure

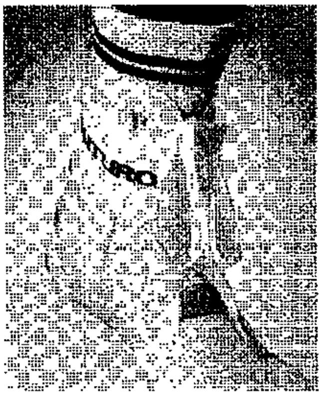
Testing was conducted in the Victoria University Biomechanics Laboratory at Flinders Street. Informed consent was obtained from all subjects before testing. The study was approved by the Victorian University Human Ethics Committee.

Postural sway is defined by Guskiewicz and Perrin (1996) as the measurement of the time and distance a subject spends away from an ideal centre of pressure. Norkin and Levangie (1992) states the path of the COP which defines the extent of postural sway, can be determined by plotting the COP at regular intervals when a person is standing on a force platform. COP was plotted through an AMTI force platform linked to a 486DX computer running BEDAS-2 data analysis software. Anteroposterior force was measured along the Y-axis and mediolateral force was measured along the X-axis.

COP was firstly tested without the ankle brace. Wearing their athletic shoes of choice, subjects were taken over to the AMTI force platform. When instructed, each subject stood still on the force platform and their COP was recorded. As most ankle injuries occur while on one leg, postural sway was tested on the force platform with the subject during unilateral stance. Following a COP testing protocol by McGuine et al. (2000), each evaluation involved three trials of 10 seconds. The subjects then went through the same procedure on the other leg. To reduce error, every second subject was initially tested on an alternate leg to the subject tested before them.

Once COP was evaluated without a brace, participants were taken to the treatment table and a Futuro Figure Six Ankle Stabiliser brace (Fig 2) was applied over their socks on both feet. It is a common lace up semi rigid ankle brace that can be bought off the shelf at most chemists. The ankle braces were correctly fitted, as determined by the guidelines given by Futuro. The subject then put their shoes back on and the procedure was repeated with the subject again standing on the platform for three trials of 10 seconds, as their COP was evaluated.

Fig 2 – Figure Six Ankle Stabiliser and guidelines for the correct fitting as advised by Futuro.



Small	Medium	Large
15.0-20.0cm	20.0-23.0cm	> 23.0cm

To work out the correct size the circumference was measured in centimetres (cm's) immediately above the malleoli.

Statistical Analysis

Microsoft Excel was used to compare the postural sway of non-ankle braced athletes against ankle braced athletes. This will be done using effect size data. Ideally, t-test statistics would have been used, however due to the high number of subjects required to obtain significant results, this was not feasible. This study may act as a basis for future researcher's to calculate the number of subjects required.

Results

Data in Table 1.1 indicates that there was not a large difference for mean postural sway values under both testing conditions. According to Cohen (1988), the effect size for this study is small (0.301). Although there is a slight reduction in the mean postural sway scores for subjects with a brace compared to subjects with no brace.

Table 1.1

Mean Postural Sway Without a Brace (cm)	44.760
Mean Postural Sway With a Brace (cm)	42.553
Mean of the Difference (cm)	2.208
Standard Deviation of the Difference (cm)	7.342
Effect Size (d)	0.301

The raw data (Table 1.2) indicates individual differences between subjects for postural sway scores with a brace and without a brace. Although there were 20 subjects, each subject had their left and right leg tested. This gave 40 comparisons between postural sway scores with a braced ankle and an un-braced ankle.

Seven subjects had an 11cm or greater difference in their postural sway between the non-braced and braced ankle. However, not all of the postural sway scores were reduced after putting on the brace. One of these seven subjects had an increase in their postural sway score once the brace was placed on (11.1cm). In twenty-eight of the forty cases, there was a reduction in postural sway once the ankle brace was used (Table 1.2).

Table 1.2

Subject	Age	Sex	Tested Leg	Postural Sway Without Brace	Postural Sway With Brace	Difference
1	27	M	Left	53.8	38.7	15.1
			Right	38.8	42.8	-4
2	24	M	Left	28.8	24.5	4.3
			Right	26.6	23.1	3.5
3	22	F	Left	30.5	36.7	-6.2
			Right	36.3	28.8	7.5
4	22	F	Left	37.5	36.6	0.9
			Right	52.3	38.1	14.2
5	22	M	Left	38.6	37.4	1.2
			Right	40.4	45.4	-5
6	23	M	Left	34.5	33.2	1.3
			Right	41.7	38.9	2.8
7	23	F	Left	50.4	45.8	4.6
			Right	62.1	50	12.1
8	24	F	Left	49.8	59	-9.2
			Right	48.6	66.6	-18
9	22	M	Left	59	47.7	11.3
			Right	59.2	55.1	4.1
10	24	M	Left	30.1	29.8	0.3
			Right	35.1	34.6	0.5
11	23	F	Left	42.5	45	-2.5
			Right	44.8	52.3	-7.5
12	24	M	Left	43.5	35.2	8.3
			Right	49.5	44.6	4.9
13	20	F	Left	42.1	39.9	2.2
			Right	50.8	45.8	5
14	20	F	Left	49.5	45.6	3.9
			Right	59.7	42.5	17.2
15	20	F	Left	44.8	41.9	2.9
			Right	40.7	42.1	-1.4
16	23	M	Left	61.7	66.4	-4.7
			Right	69.6	67.7	1.9
17	22	M	Left	41.3	35	6.3
			Right	46.4	42.4	4
18	24	F	Left	31.4	42.5	-11.1
			Right	28.1	32.6	-4.5
19	23	M	Left	41.1	35.2	5.9
			Right	50.6	38.3	12.3
20	25	M	Left	46.4	49.1	-2.7
			Right	51.8	45.2	6.6

Discussion

If a large difference in postural sway patterns between the braced and non-braced participants was demonstrated, it may have supported the argument in explaining the effectiveness of ankle bracing in sport. Although ankle braces have been proven as a prophylactic device in reducing ankle injuries, the actual mechanism by which bracing performs this function is undefined. Baier and Hopf (1998) suggested that ankle braces provide a combined structural and proprioceptive supportive mechanism for the ankle joint when it is under high levels of stress and prone to injury. Kavounoudias et al. (1998) and Nigg et al. (1999) support this by stating that the use of orthotics provides somatosensory benefits because cutaneous afferents contribute to human balance control. Nigg et al. (1999) also believe orthotics may provide neutal alignment for proper muscle activation and reduce unnecessary strain on already stressed soft tissue.

The study revealed there was not a large difference in postural sway patterns between the semi-rigid braced and non-braced uninjured athlete. This is supported by Baier and Hopf (1998) who reported no significant change in postural sway patterns when a rigid brace was used on a healthy ankle. They did, however, report a significant reduction in postural sway when using a rigid brace on an injured ankle. This is supported by Guskiewicz and Perrin (1996), who tested subjects with acute ankle sprains. They found that ankle braces significantly reduced postural sway between the orthotic and non-orthotic conditions during anteroposterior and mediolateral sway.

A large difference between the braced ankle and the non-braced ankle may have been demonstrated if injured subjects had been used. As stated by McGuine et al. (2000), proprioception deficits and increased postural sway are the result of previous ankle sprain injuries. The participants in this study were healthy and uninjured, so their proprioception and postural sway were not influenced by semi-rigid braces as greatly as injured athletes may have been.

When the uninjured athlete wore a brace, testing was unable to report a large reduction in postural sway. Although this investigation may assist in providing more support for a study by Eils and Rosenbaum (2003), who believe that ankle braces reduce injury by putting the foot into a more suitable position prior to ground contact. The authors suggest there was no difference between the braced and non-braced ankle, in reaction times of peroneus longus when the ankle is stressed into an inverted position. Eils and Rosenbaum's findings, along with the results of this study, indicate that braces may not stimulate neuromuscular control as much as was thought.

Ankle bracing may be a suitable preventative measure for reducing postural sway in injured athletes, as reported by Baier and Hopf (1998). In the present study postural sway was not greatly affected by using an ankle brace in the uninjured athlete. Postural sway can be assessed via many different methods. This study did not look at all of these, so future testing needs to investigate postural sway more thoroughly. There are many reasons an uninjured athlete would benefit from wearing a prophylactic ankle brace. In a study by Mattacola and Dwyer (2002) position sense has been shown to increase with the application of an ankle brace. Also previous authors, such as Eils and Rosenbaum (2003), Tropp et al. (1985), Surve et al. (1994) and Sitler et al. (1994), have assessed ankle braces using different methods and have reported significant reductions in ankle injuries.

Serious consideration must be given to further research that involves a more accurate replication of the environmental conditions of footwear-ground contact. As stated by Guskiewicz and Perrin (1996), ligamentous instabilities occur during loading and unloading of the ankle joint when the articular surfaces are not optimally aligned within the mortise. Single limb stance is much more static and requires a much smaller range of ankle movement than most athletic activities, therefore it probably does not adequately test the full stability of the ankle joint.

In this study an off the shelf lace up semi-rigid brace was used. In previous studies orthotics have been used which have been individually moulded to the participants foot. Data on universal ankle braces that can be bought off the shelf is minimal. Future studies would benefit from giving consideration to the type of bracing used as there are many different ankle supports that may vary greatly in the support they give the athlete.

Conclusion

The results of this study indicate that semi-rigid bracing of the uninjured athlete has a small effect on reducing postural sway. Previous research has reported a significant reduction in postural sway when the injured ankle is braced. Future research may need to incorporate a more realistic environment for foot-ground contact, such as a more dynamic assessment. Furthermore, there is a large variety of prophylactic ankle braces that can be bought off the shelf. This study assessed only one of these. At this stage there is minimal benefit from the uninjured athlete wearing prophylactic ankle braces.

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