

# Effects of strapping the tendo-Achilles

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## Abstract

**Objectives.** To determine the effects of strapping the tendo-Achilles (t-A) on soleus and gastrocnemius electromyographic activities and postural sway.

**Design.** A pre-test, post-test experimental design was used. Ten male university students (mean age 24 years) participated by voluntary consent.

**Setting.** Data collection in the physiotherapy research laboratory at the University of Durban-Westville ensured that electromyographic signals were minimally contaminated.

**Interventions.** All subjects were monitored under four conditions, namely, standing on one and two legs with and without strapping the right t-A. The 10 mm Smith and Nephew strappal and the South African Rugby Football Union technique were used. Recordings were taken for 1 minute in each condition.

**Main outcome measures.** Soleus and gastrocnemius electromyographic activities were recorded using 8 mm silver/silver chloride (Ag/AgCl) surface electrodes connected to the Biopac electromyographic (EMG) system. Postural sway was monitored in degrees using a specially designed headgear with writing pen manufactured by the University of Durban-Westville Engineering Department.

**Results.** Soleus activity in the 2-legged standing position with strapping was reduced significantly ( $p = 0.015$ ),

compared with the 2-legged standing without strapping or the 1-legged standing position with strapping. Angle of postural sway decreased significantly ( $p = 0.001$ ) in the 2-legged standing position with strapping compared with the 2-legged standing without strapping. The postural sway in the 1-legged strapped condition was significantly different ( $p = 0.009$ ) from that in the 2-legged standing position without strapping.

**Conclusion.** The stabilising effect of strapping the t-A is supported by a reduction in angle of sway and decreased EMG activity of the soleus. This physiological evidence for the effectiveness of strapping the t-A could change the objectives for which strapping is used in clinical practice and training programmes.

## Introduction

Strapping has always been a popular strategy in the management of sports injuries.<sup>3,10,16</sup> It is used to 'prevent' injuries in almost all codes of sport.<sup>4,15</sup> Anecdotally, in many cases it seems to provide psychological support to the athlete who refuses to admit defeat in the face of pain or injury. Callaghan<sup>1</sup> reported that post-traumatic strapping controlled swelling of the injured area by compression and provided support to the joint by restricting motion.

Strapping has a rich heritage that dates back to the ancient Greeks who used a cloth soaked in olive oil, lead oxide and water.<sup>16</sup> Due to its popularity, various types of material have proliferated and have been used on a trial and error basis, while others have been scientifically tested.<sup>2,12</sup> Health care and sports professionals have used a variety of techniques to apply strapping to various parts of the body. The strapping technique should not restrict the biomechanical function of the body part but should support the weakened part by restricting some degree of motion.

Despite the proliferation of strapping material and information on the uses and benefits of strapping, very few studies have formally evaluated the physiological basis for strapping regardless of what it is used for.<sup>16</sup> Karlissen *et al.*<sup>9</sup> reported no difference in the response time of an injured strapped ankle compared with that of a healthy strapped one. The development of muscular responses through cutaneous stimulation may help in the functional and mechanical

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stability of joints.<sup>1,6</sup> Even though the restrictive effect of the tape may be lost after exercise, the neuromuscular and sensory mechanisms are still important<sup>1,13</sup> in injury prevention. Garrick and Requa<sup>3</sup> demonstrated a reduction in the number of injuries of the ankle joint following strapping to support the medial and lateral ligaments. Rose<sup>14</sup> believed that functional strapping allowed for earlier resumption of activity but did not clarify what the strapping actually did.

The physiological effects of taping the tendo-Achilles (t-A) has not been well described in the literature. Taping the t-A has been shown to decrease the error in a position-matching task in the plantar-dorsiflexion plane in healthy subjects.<sup>7</sup> However Kauranen *et al.*<sup>8</sup> also showed reduced motor performance after ankle strapping.

Biomechanically, the effects of strapping will be reflected in the degree of sway during standing. Sway is the displacement measure commonly referred to as the centre of gravity (COG). The centre of pressure (COP) is also a displacement measure but independent of the COG. The COP is equal and opposite to a weighted average of all downward forces acting on the force plate. These forces are under the motor control of the ankle muscles. Winter<sup>17</sup> states that the COP is the neuromuscular response to imbalances in the body's COG, for example, in order to correct anterior sway the subject will increase the COP by increasing plantarflexion activation.

The purpose of the present study was to examine the effects of strapping the right t-A on electromyographic activity of the gastrocnemius and soleus muscles and the angle of postural sway.

## Methods

The sample consisted of 10 young male university students (aged between 18 and 30 years, mean age 25 years) who had not sustained any injury to any muscles or nerves, ligaments or tendinous structures of the trunk or lower limbs. All subjects participated after voluntary informed consent was signed. The height and weight of each subject was measured using a calibrated Clover medical scale. Pairs of 8 mm silver/silver chloride (Ag/AgCl) surface electrodes were placed on the motor points of the right medial gastrocnemius muscle (15 cm below the medial femoral condyle) and the right lateral soleus muscle (10 cm proximal to the lateral malleolus close to the posterior midline of the leg). The ground electrode was placed on the lateral malleolus of the right leg. The electrode placement sites were first shaved, then cleaned with isopropyl alcohol. Electrode gel medium was used as a conducting agent. Electrode leads were connected to Biopac EMG amplifiers (Biopac Inc., California) and the data were stored on a computer for later analysis. To ensure consistency, each author undertook a certain component of the experiment, for example, one investigator strapped all subjects, and another investigator monitored the recording of angle of sway for all subjects.

The angle of postural sway in either the 1-legged or 2-legged standing positions was recorded by attaching a pen to a headgear (University of Durban-Westville Engineering Department). The right t-A was strapped in the 1- or 2-legged standing positions. The pen drew on a sheet of paper on the wall behind each subject as he swayed naturally when stand-

ing. A protractor was used to determine the sway angles.

Elastoplast low adhesive strappal (40 mm by 10 mm, Smith and Nephew) was used to strap the t-A in 10 degrees of plantarflexion following the technique used by the South African Rugby Football Union (SARFU).

The SARFU technique of strapping was applied as follows. Anchors were applied around the lower leg and mid-foot. The first strip was applied on the midline of the t-A connecting the anchors on the leg and foot, with the foot in 10 degrees of plantarflexion. A second strip was applied on the inside of the first strip starting at the foot anchor and ending at the outside of the leg anchor. A third strip was applied similar to the second strip but starting from the outside of the first strip at the foot and ending on the inside of the leg anchor. Applying anchors over the original anchors completed the strapping. The technique was applied by one of the investigators who has clinical expertise in strapping rugby players. Due to the location of the soleus motor point, electrodes monitoring soleus activity were covered by the strapping.

## Procedure

The procedure was explained to each subject and a consent form signed. Each subject was asked to stand up straight, barefoot on a designated marked area with the heels against the wall and with the feet 2 inches apart. The headgear with the writing pen was applied. The EMG electrodes were applied to the muscles as described earlier. Gastrocnemius and soleus muscle activities and angle of sway were monitored for 1 minute while the subject stood on both feet. Thereafter strapping was applied to the right t-A and data collected while the subject stood on both legs, for another minute. Data were collected for another minute while the subject stood on the right-strapped leg. The strapping was then removed and the subject stood on the right leg while variables were monitored for a further minute.

## Data analysis

The individual, mean and standard deviation of the angles of sway were calculated for each test position. The raw EMG activities of the gastrocnemius and soleus muscles were processed and smoothed to produce a linear envelope. Average peak amplitude of activity within the 1-minute monitoring period was determined. Muscle activity was normalised using the unstrapped 2-legged standing position as a standard for each subject. The mean and standard deviations for individual and group data were then obtained. Data were analysed using one-way analysis of variance (ANOVA) and the Fisher's LSD (least square differences) post hoc test with a probability of 0.05.

## Results

The height of the subjects ranged from 1.55 m to 1.80 m, with a mean of 1.69 m. The subjects weighed between 60 and 76 kg, with a mean of 67 kg.

As shown in Table I, the greatest sway occurred when the subjects assumed the standing on 1 leg position without strapping. However, when strapping was applied on the right leg on which the subject stood, the degree of sway decreased significantly. The sway in the 2-legged standing

**TABLE I. Height and weight of each subject; and individual, mean and standard deviation of the angles of sway during the four experimental positions**

Subject no	Height (m)	Weight (kg)	2 LW0 degrees	2LW degrees	1LW0 degrees	1LW degrees
1	1.63	64.5	11	8	15	10
2	1.72	65.0	9	5	12	7
3	1.80	76.0	8	5	18	7
4	1.78	68.0	10	3	10	3
5	1.61	62.0	9	6	8	5
6	1.78	66.0	6	4	10	4
7	1.58	60.0	7	4	7	5
8	1.74	72.0	8	5	10	5
9	1.68	69.0	10	5	10	5
10	1.55	63.0	6	3	8	5
Mean	1.69	66.55	8.4	4.8	10.8	5.6
SD	0.09	4.83	1.7	1.5	3.4	2.0

2LW0 = 2-legged standing without strapping; 2LW = 2-legged standing with strapping; 1LW0 = 1-legged standing without strapping; 1LW = 1-legged standing with strapping.

**TABLE II. Mean angle of sway, mean soleus and gastrocnemius muscle activity (arbitrary units) for the four test conditions, percentage of control muscle activity, confidence intervals (CIs) and probability values for pairs of comparisons**

Sway	Angle of sway (degree)	% of control	95% (CI)	P-value
2 leg without strapping	8.4 ± 1.7	100	REF	
2 leg with strapping	4.8 ± 1.5	57	1.6 - 5.7	0.001
1 leg without strapping	10.8 ± 3.4	129	-4.5 - -0.4	0.023
1 leg with strapping	5.6 ± 2.0	67	0.8 - 4.9	0.009
<b>Soleus activity</b>	<b>AU (x 100)</b>	<b>% of control</b>	<b>95% CI</b>	<b>P-value</b>
2 leg without strapping	4.2 ± 0.2	100	REF	
2 leg with strapping	4.0 ± 0.3	93	5.9 E-4 - 5.2 E-3	0.015
1 leg without strapping	4.1 ± 0.3	98	-1.5 E-3 - 3.1 E-3	0.486
1 leg with strapping	4.2 ± 0.1	100	-2.7 E-3 - 1.9 E-3	0.727
<b>Gastrocnemius activity</b>	<b>AU</b>	<b>% of control</b>	<b>95% CI</b>	<b>P-value</b>
2 leg without strapping	0.296 ± 0.015	100	REF	
2 leg with strapping	0.297 ± 0.016	101	-1.38 E-2 - 1.05 E-2	0.789
1 leg without strapping	0.297 ± 0.005	100	-1.32 E-2 - 1.11 E-2	0.858
1 leg with strapping	0.286 ± 0.014	97	-2.75 E-3 - 2.15 E-2	0.125

AU = arbitrary units.

position without strapping was significantly greater than that in the 1 and 2-legged strapped standing positions. The sway was significantly different between the 1-legged and 2-legged standing with strapping positions.

Although there was no correlation between height, weight and sway in this controlled sample, subject number 3 who was the tallest and heaviest swayed the most when he stood on one leg without strapping. Strapping, however, made a significant difference to the angle of sway in this position (Table I).

When the 2-legged standing subject's right t-A was strapped, soleus activity decreased significantly compared with that during standing on 2 legs without strapping (Table II). Soleus activity decreased significantly in the 2-legged strapped standing compared with the 1-legged strapped standing position. Although soleus activity increased in the 1-legged standing position without strapping compared with that with strapping, this increase was not significant. The gastrocnemius muscle showed no significant change in activity at any time (Table II).

## Discussion

A host of literature describes with some scientific basis, the effects of strapping the ankle on sensory stimulation,<sup>1,5,13</sup> motor performance,<sup>9</sup> co-ordination and timing effects<sup>7,8</sup> and reduction of injury and support during recovery<sup>1,13</sup> in athletes. No studies have focused on specific physiological effects of strapping the t-A.

Human standing is characterised by spontaneous changes in the projection of the (COG), commonly known as postural sway.<sup>11</sup> The COP, which is the neuromuscular response to imbalances in the body's COG allows for stability in standing. Anterior/posterior or medial/lateral sways occur relatively independently.<sup>11</sup> Plantar and dorsiflexors of the feet control the net ankle moments to regulate the COG in the standing position.<sup>17</sup> In order to correct the forward sway the subject will increase his COP by increasing plantarflexor activity, i.e. among others the soleus muscle contracts to counter the gravitational moment through its pull on the tibia.<sup>9</sup> When the central nervous system is informed that the posterior shift of the COG needs correcting the COP decreases by decreasing plantarflexion activation until the COP lies posterior to the COG.<sup>17</sup>

This study compared the angles of postural sway occurring in the frontal plane with selected ankle muscle activities to determine the effect of strapping the right t-A during normal single and double-legged standing. Strapping decreased the stabilising activity of the soleus when standing on 2 legs as indicated by the decreased electromyographic activity (Table II). This decreased activity of the soleus and/or the stabilising effect of strapping are demonstrated by the corresponding decrease in the angle of sway (Table II).

When the subjects moved from standing on 2 legs to standing on 1 leg, both test positions without strapping, a decrease in stability was demonstrated by an increase in the angle of sway. Both the soleus and gastrocnemius changes in activity were non-significant. This could be related to the fact that recordings were taken from the lateral soleus and medial gastrocnemius. The greatest response of the soleus

and gastrocnemius muscles as ankle stabilisers is believed to occur when the COG is displaced anteriorly.<sup>17</sup> In the present study frontal plane sway was recorded. A further study is required to elucidate the role of the muscles in the anterior compartment of the leg and the posterior tibial muscles during frontal plane sway. In addition the activities of the soleus and gastrocnemius muscles should be recorded and compared with sagittal plane sway.

The angle of sway was greatest in the 1-legged position without strapping because the base is small and the position is very unstable. The gastrocnemius activity remained unchanged and the soleus activity decreased marginally and insignificantly. The stabilising action of the soleus was not elicited and this could be related to the direction of sway as measured in this study, or other muscles at play. The subjects were naïve about the purpose of the study. Cognitive and psychological factors could have come into play. These factors or the effects of other postural muscles were not monitored in this study.

The stabilising action of strapping the t-A is clearly demonstrated when the positions of 1-legged standing with strapping and 1-legged standing without strapping are compared regardless of the fact that frontal plane sway is not specifically correctable by the ankle plantarflexors.<sup>17</sup> The angle of sway was significantly greater in the 1-legged standing position without strapping and the soleus muscle activity increased. However, the role of strapping the t-A in stabilising the tibia over the foot is seen when the 2-legged position with strapping is compared with the unstrapped standing on 2 legs position. Soleus activity decreased significantly in the former condition. Physiologically a complex system of neural inputs seem to be at play to stabilise the upright frame and the physiological study of one component may lead to misleading conclusions.

This study was carried out in two static positions using a selected sample, specific strapping technique, specific ankle stabilisers and recording sway in one plane only. In addition, only one of a set of ankle stabilising and one of a set of mobilising muscles were monitored. Both these muscles are located on the posterior aspect of the leg. In addition frontal plane sway was measured. Although some physiological effects of strapping the t-A were revealed by this study, the total effect of strapping the t-A cannot be determined from this one study. A series of studies will contribute towards making informed decisions about the effectiveness of the selected technique versus other techniques, or the type of strapping.

Due to inadequate computer storage capacity it was not possible to record from more than two muscles at a time.

## Conclusion

The results confirm the stabilising effects of strapping the t-A in the standing position, based on the responses of the soleus muscle in relation to changes in postural sway. More studies where several groups of muscles are monitored are required to elucidate the effects of strapping the t-A clearly.

Clinically if the activity of stabilisers is reduced as a result of strapping, the duration of strapping a structure could have implications for the strength of the 'protected muscles'.

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Strapping could have a very useful role in protecting injured muscles, so preventing further injury. In addition the risk of injury to compensating muscles during strapping must be carefully monitored.

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