STEPHEN ARJANTO | AIMEE GEROLD | BAYLEE HEARD | MYNAH HOLLOWAY | MAITÉ MARIN-MERA | AUTUMN PHILLIPS

The Effect of Lasso Compression Socks on Ankle Inversion and Eversion

Objective : This study is aimed at examining the effect of Lasso compression technology on ankle inversion and eversion.

Background : There are several rehabilitation tools for ankle injuries, including ankle tape, ankle braces, and kinesio tape. It has been shown in prior studies that ankle tape and ankle braces can weaken the ankle with extended use due to their rigidity. These solutions also require patient education or physician involvement for their application. The Lasso Compression Sock is designed to provide strong support to ankle to help maintain its position to prevent ankle inversion and eversion during physical activities such as walking, running, sports, and fitness routines. In addition, Lasso Compression Socks, due to its design elements as a sock, eliminates elaborate physician involvement in manual taping the ankles and required patient education. The level of support in the Lasso Compression Sock has never been explored before.

Methods : An ankle simulation testing rig was built and utilized to simulate ankle inversion and eversion. An Arduino was utilized to measure angle changes in the ankle due to the application of different forces. Several forces were tested under three conditions: barefoot, athletic sock, and Lasso Compression Sock.

Results : A total of 9 control trials and 18 testing trials were included in the analysis. It was found that Lasso Compression Socks reduce ankle inversion and eversion by 75%, compared to a standard athletic sock. This difference was statistically significant.

Conclusion : Lasso Compression Socks provide meaningful, preventative ankle support compared to standard athletic socks and barefoot conditions.

Objective

This study is aimed at examining the effect of Lasso compression technology on ankle inversion and eversion. Specifically, we compare athletic socks with Lasso compression and those without in preventing ankle inversion.

Introduction

In the US, there are roughly 628,000 ankle sprains per year[1]. The median cost of a trip to the emergency room in the US for an ankle sprain is $1,008[2]. In other words, roughly $630 million is spent on treating people with ankle sprains every year. The primary treatment for ankle injuries involves ankle tape or ankle bracing, but both solutions have a tendency of weakening supportive tissues within the ankle due to heavy movement restriction. This leaves the athlete dependent on these solutions for ankle health.[3]

When it comes to ankle injury prevention, the most commonly used solution is kinesio-taping which involves flexible tape that supports the joint without overly restricting motion.[9] The effectiveness of kinesio taping has been questioned by many, including studies that have shown kinesio taping to be no better than placebo or sham taping[4,8,10]. There is also limited understanding of how kinesio taping works.

The Lasso Compression Sock is an ankle support solution developed by BWHealth to provide ankle support within a garment as an alternative to kinesio taping. The development of the sock was preceded by detailed analysis of how ankles twist and the force needed to prevent ankle sprains that results from the twist. Lasso Compression Socks utilize Lasso Compression Technology, which simulates the patterns and support of kinesio tape using targeted compression woven into the garment.

This study seeks to determine the effects of the Lasso Compression Technology on ankle inversion and eversion. Instead of relying on subjective assessments of pain by patients, which are susceptible to placebo effects, we applied real force on simulated ankles and compared the twist factor with Lasso socks and with regular athletic socks.

Methods

An ankle movement simulator was built to test the impact of Lasso Compression Socks on ankle inversion and eversion. The ankle was simulated using a ball and socket joint, which was built into a foot mannequin that was suspended in air.

This simulator was operated by several wires that controlled and measured motion of the foot. A hanging wire was set up to hold a weight which caused the ankle to invert or evert. A second wire was connected to an Arduino that was programmed to measure a change in inversion/eversion angle of the ankle. The ankle joint limited ankle inversion and eversion at 45 degrees (see Figure 1).

The process of collecting one sample is as follows:

1. Suspend ankle with attached sock (or no sock) depending on testing group
2. Pull sock taut and attach top of sock to hooks near top of the simulator
3. Level the foot and make sure there is no pulling force on the foot
4. Record the starting angle
5. Gently attach test weight to wire on pulley, and keep weight from swinging
6. Record final angle
7. Calculate the change in angle

This process was repeated for each condition - barefoot (no sock), a standard athletic sock, and a

Lasso Compression Sock, and three samples were collected for each condition.

Figure 1 - The testing simulator being adjusted to fit the Lasso Compression Sock

All three conditions were tested at 500g, 1000g, and 1500g of weight. These weights were selected based on the construction of the ankle joint in order to closely match the force applied during a natural ankle roll. The data recorded for the change in angle are reported below for each of the three test conditions, at each weight.

The mean change in angle in the Lasso sock condition was compared to the change in angle in the regular sock condition and a t-test was run.

Table 1 - Results from the testing process

Type of Sock	Weight (g)	Mean ΔAngle	Standard Deviation
Lasso	500	2.18	0.47
Lasso	1000	5.22	0.58
Lasso	1500	6.08	0.15
Ath. Sock	500	8.07	1.32
Ath. Sock	1000	17.87	2.22
Ath. Sock	1500	24.57	0.14
Barefoot	500	19.29	6.08
Barefoot	1000	MAX	-
Barefoot	1500	MAX	-

The resulting p-values for each testing condition were all below 0.001, which fit within our 0.05 threshold. This successfully shows a statistically significant difference between Lasso socks and standard athletic socks.

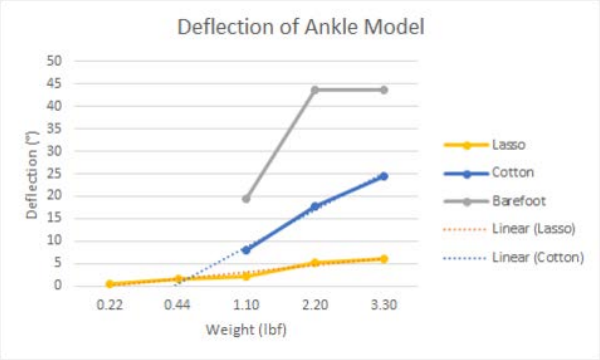

Figure 2 - A graph depicting the deflection of the ankle based on the weight applied in each testing condition

Conclusion

In all weight conditions, the change in angle with Lasso sock was significantly less than the change in angle with a regular athletic sock. In fact, the average change in angle with Lasso sock (4.49) was

less than 30% of the change in angle with conventional sock (16.84). Further, in the largest weight condition that mimicked the most severe sprain, the change in angle (and thus the preventive strength) of Lasso sock was more than 75% less than of the change in angle with a regular athletic sock.

Lasso socks, with their compression technology, offer a significant reduction in ankle inversion and eversion over regular athletic socks, creating a preventative alternative to ankle taping that does not exist today. If the change in angle were interpreted to be equivalent to the potential for reducing the incidence of sprain, Lasso socks appear to reduce sprain probability by about 75% over regular socks.

References

1. Waterman, Captain Brian R, et al. The Epidemiology of Ankle Sprains in the United States. The Journal of Bone and Joint Surgery-American Volume, vol. 92, no. 13, 2010, pp. 2279–2284., doi:10.2106/jbjs.i.01537. [PubMed]
2. Shah, Shweta, et al. Incidence and Cost of Ankle Sprains in United States Emergency Departments. Sports Health: A Multidisciplinary Approach, vol. 8, no. 6, 2016, pp. 547–552., doi:10.1177/1941738116659639. [PubMed]
3. Garrick JG, Requa RK. Role of external support in the prevention of ankle sprains. Med Sci Sports. 1973 Fall;5(3):200–203. [PubMed]
4. Miller EA, Hergenroeder AC. Prophylactic ankle bracing. Pediatr Clin North Am. 1990 Oct;37(5):1175–1185. [PubMed]
5. Tropp H, Askling C, Gillquist J. Prevention of ankle sprains. Am J Sports Med. 1985 Jul-Aug;13(4):259–262. [PubMed]
6. Firer P. Effectiveness of taping for the prevention of ankle ligament sprains. Br J Sports Med. 1990 Mar;24(1):47–50. [PMC free article] [PubMed]
7. Hollis JM, Blasier RD, Flahiff CM. Simulated lateral ankle ligamentous injury. Change in ankle stability. Am J Sports Med. 1995 Nov-Dec;23(6):672–677. [PubMed]
8. RARICK GL, BIGLEY G, KARST R, MALINA RM. The measurable support of the ankle joint by conventional methods of taping. J Bone Joint Surg Am. 1962 Sep;44-A:1183–1190. [PubMed]
9. Pope MH, Renstrom P, Donnermeyer D, Morgenstern S. A comparison of ankle taping methods. Med Sci Sports Exerc. 1987 Apr;19(2):143–147. [PubMed]
10. Tweedy R, Carson T, Vicenzino B. Leuko and Nessa Ankle braces: effectiveness before and after exercise. Aust J Sci Med Sport. 1994 Sep-Dec;26(3-4):62–66. [PubMed]
11. Anderson DL, Sanderson DJ, Hennig EM. The role of external nonrigid ankle bracing in limiting ankle inversion. Clin J Sport Med. 1995;5(1):18–24. [PubMed]
12. Capasso G, Maffulli N, Testa V. Ankle taping: support given by different materials. Br J Sports Med. 1989 Dec;23(4):239–240. [PMC free article] [PubMed]
13. Stover CN. Air stirrup management of ankle injuries in the athlete. Am J Sports Med. 1980 Sep-Oct;8(5):360–365. [PubMed]
14. Sitler M, Ryan J, Wheeler B, McBride J, Arciero R, Anderson J, Horodyski M. The efficacy of a semirigid ankle stabilizer to reduce acute ankle injuries in basketball. A randomized clinical study at West Point. Am J Sports Med. 1994 Jul-Aug;22(4):454–461. [PubMed]
15. Surve I, Schwellnus MP, Noakes T, Lombard C. A fivefold reduction in the incidence of recurrent ankle sprains in soccer players using the Sport-Stirrup orthosis. Am J Sports Med. 1994 Sep-Oct;22(5):601–606. [PubMed]
16. Karlsson J, Andreasson GO. The effect of external ankle support in chronic lateral ankle joint instability. An electromyographic study. Am J Sports Med. 1992 May-Jun;20(3):257–261. [PubMed]
17. Rovere GD, Clarke TJ, Yates CS, Burley K. Retrospective comparison of taping and ankle stabilizers in preventing ankle injuries. Am J Sports Med. 1988 May-Jun;16(3):228–233. [PubMed]
18. Leanderson J, Wredmark T. Treatment of acute ankle sprain. Comparison of a semi-rigid ankle brace and compression bandage in 73 patients. Acta Orthop Scand. 1995 Dec;66(6):529–531. [PubMed]

19. Laughman RK, Carr TA, Chao EY, Youdas JW, Sim FH. Three-dimensional kinematics of the taped ankle before and after exercise. Am J Sports Med. 1980 Nov-Dec;8(6):425–431. [PubMed]
20. Paris DL, Kokkaliaris J, Vardaxis V. Ankle ranges of motion during extended activity periods while taped and braced. J Athl Train. 1995 Sep;30(3):223–228. [PMC free article] [PubMed]
21. Konradsen L, Ravn JB, Sørensen AI. Proprioception at the ankle: the effect of anaesthetic blockade of ligament receptors. J Bone Joint Surg Br. 1993 May;75(3):433–436. [PubMed]
22. Feuerbach JW, Grabiner MD, Koh TJ, Weiker GG. Effect of an ankle orthosis and ankle ligament anesthesia on ankle joint proprioception. Am J Sports Med. 1994 Mar-Apr;22(2):223–229. [PubMed]
23. Johnson MB, Johnson CL. Electromyographic response of peroneal muscles in surgical and nonsurgical injured ankles during sudden inversion. J Orthop Sports Phys Ther. 1993 Sep;18(3):497–501. [PubMed]
24. Jerosch J, Hoffstetter I, Bork H, Bischof M. The influence of orthoses on the proprioception of the ankle joint. Knee Surg Sports Traumatol Arthrosc. 1995;3(1):39–46. [PubMed]
25. Lentell G, Baas B, Lopez D, McGuire L, Sarrels M, Snyder P. The contributions of proprioceptive deficits, muscle function, and anatomic laxity to functional instability of the ankle. J Orthop Sports Phys Ther. 1995 Apr;21(4):206–215. [PubMed]
26. Robbins S, Waked E, Rappel R. Ankle taping improves proprioception before and after exercise in young men. Br J Sports Med. 1995 Dec;29(4):242–247. [PMC free article] [PubMed]
27. Robinson JR, Frederick EC, Cooper LB. Systematic ankle stabilization and the effect on performance. Med Sci Sports Exerc. 1986 Dec;18(6):625–628. [PubMed]
28. Pienkowski D, McMorrow M, Shapiro R, Caborn DN, Stayton J. The effect of ankle stabilizers on athletic performance. A randomized prospective study. Am J Sports Med. 1995 Nov-Dec;23(6):757–762. [PubMed]
29. Verbrugge JD. The effects of semirigid Air-Stirrup bracing vs. adhesive ankle taping on motor performance. J Orthop Sports Phys Ther. 1996 May;23(5):320–325. [PubMed]
30. Wiley JP, Nigg BM. The effect of an ankle orthosis on ankle range of motion and performance. J Orthop Sports Phys Ther. 1996 Jun;23(6):362–369. [PubMed]