PJAHS
Philippine Journal of Allied Health Sciences

Original Article

Biomechanical Taping and standard physical therapy were effective in the management of acute ankle inversion sprain: a pre- and post- intervention study

Valentin Dones III,[a,b] Lyle Patrick Tangcuangco[a], Mark Angel Serra[a], Angeleah Abad[a], Zacharie Fuentes[a], Phyll Josh Labad[a], Jannie Mauren Liboon[a], Judy April Emmanuelle Miano[a], Gian Karlo Reyes[a], Marc Ryan Gerald Sabatin[a], Maria Bianca Vergel de Dios[a]

[a]Department of Physical Therapy, College of Rehabilitation Sciences, University of Santo Tomas, Manila, Philippines; [b]Center for Health Research and Movement Sciences, College of Rehabilitation Sciences, University of Santo Tomas, Manila, Philippines

Correspondence should be addressed to: Valentin Dones III,[a,b]; vcdones@ust.edu.ph

Article Received: October 31, 2019

Article Accepted: December 28, 2019

Article Published: February 14, 2020 (Online)

Abstract

Background: Ankle inversion sprain is a common musculoskeletal injury due to an inward foot twist. It results in pain, swelling, limited movement, instability, and tenderness of the injured ankle. Standard physical therapy (PT) for acute ankle inversion sprain involves cryotherapy, range of motion, balance, and strengthening exercises. Biomechanical Taping (BMT) is an adjunct to PT. **Objectives**: To identify the short-term effects of BMT and PT on pain and function of individuals with acute ankle inversion sprains. **Methods**: Two licensed physiotherapists screened the participants. Eligible participants were treated 3x/week with BMT and PT, with a day of home exercises in between treatments. Participants answered the Visual Analogue Scale (VAS) and Foot and Ankle Ability Measure (FAAM). Friedman Test was used to determine differences in pre-post measurements of VAS and FAAM. **Results**: 17 participants (10 males: 7 females) with unilateral acute ankle inversion sprains were included in the study with a mean (95% CI) age of 21 (20-22) years. BMT and PT (a) decreased VAS mean rank scores at Treatments 3 and 5 ($p<0.05$); (b) improved FAAM-ADL mean rank scores in Treatments 1 and 3 ($p<0.05$); (c) improved FAAM-Sports mean rank scores in all Treatments ($p<0.05$); and (d) improved in VAS, FAAM ADL and Sports scores between Treatment 1, Treatment 2 and Treatment 3 ($p<0.00001$). **Conclusion**: BMT may be an effective adjunct to PT in improving pain and function of participants with acute ankle inversion sprains. The increased stability created by BMT may underpin the improved pain and function of participants.

Keywords: Biomechanical Taping, ankle injuries, fascia, physical therapy, lateral ligament ankle, pain

INTRODUCTION

Ankle inversion sprain is the most common traumatic ankle injury associated with lateral ankle pain and difficulty in walking.[1] It is described as stretching, partial or complete rupture of anterior talofibular ligament (ATFL), a commonly injured lateral ankle ligament, after a sudden forceful inward movement of the foot due to miscalculated step.[1,2] Ankle inversion sprain has a prevalence rate of 93 per 1,000 persons among athletes.[3]

Typical clinical presentations of acute ankle inversion sprain (up to 4-6 days post-injury) are the presence of severe ankle pain especially on the lateral portion with or without ankle motion, localized heat, inability to severe difficulty bearing weight, and/or increased levels of localized swelling usually with ecchymosis.[4] In the presence of equivocal evidence on the use of Protection, Rest, Ice, Compression, and Elevation (PRICE) protocol is widely used in clinics and research as standard physical therapy (PT) in managing acute ankle sprain.[5] Ice combined with exercise therapy reduced pain and swelling of the ankle.[6] Ice with compression combined with elevation or rest is common treatment for acute

ankle inversion sprain.[6] Functional rehabilitation consisting of ankle stabilization and progressive weight-bearing and exercise is considered the standard of care for acute ankle inversion sprains. Generally, early range of motion (ROM) exercises are followed by strengthening, proprioception, and functional exercises. This early functional rehabilitation may aid in improving function and enabling a faster recovery.[7]

Taping is an adjunct treatment tool used with PT in the management of acute ankle inversion sprains. Inelastic tapes improve neuromuscular control, support and partially limit ankle joint movement. It allows early weight-bearing by preventing excessive unnecessary movements of the ankle joint area.[8] The Biomechanical Taping Technique (BMT) is a taping technique that addresses pain secondary to acute ankle inversion sprains. BMT uses fascia tape, an inelastic tape, that pinches the skin and hypothesized to lift the deep fascia. The lift creates light skin fold potentially allowing movement between deep fascia and underlying muscles. Unlike inelastic tape, it does not limit ankle joint movement.[9]

Considering that BMT is an emerging taping technique, no study reports on the effectiveness of BMT on ankle inversion sprain. The effectiveness of BMT, however, was reported by Dones et al. in the management of lateral elbow pain, which reported significantly decreased lateral elbow pain ($p<0.05$), increased handgrip strength ($p<0.05$) and improved function ($p<0.0001$) of 23 patients with lateral epicondylalgia. Improvements in clinical symptoms and functions were reported after three applications of BMT (on Days 1, 3 and 5).[9]

This study aimed to determine the effectiveness of BMT and PT on pain and function of patients with acute ankle inversion sprains.

METHODS

Ethics. This study was approved by the Ethics Review Committee of the College of Rehabilitation Sciences of the University of Santo Tomas (Ethics protocol number: SI 2017-005-OR).

Study Design. This is a pre- and post-intervention experimental study.

Sample Size. Using G*Power 3.1.9.2, a minimum sample size of 30 was needed to determine the effectiveness of PT and BMT on acute ankle inversion sprains. This was computed using the following information: mean (95% CI) VAS values of 1.04 (0.20, 1.88), alpha value of 0.05 and power of 0.20, as reported by Dones et al.[9]

Setting. This study was done at the Physical Therapy Skills Laboratory of the College of Rehabilitation Sciences of the University of Santo Tomas.

Biomechanical Tape. BMT fascia tape is inelastic tape (Figure 1) with a height of 6 cm and a length of 5.5 m. The BMT fascia tape is more stretchable than Leukoplast and Mueller tapes.[9]

Figure 1. The BMT fascia tape that was used in the study.

Outcome Measures. Visual Analog Scale (VAS) for pain (Appendix A) and Foot and Ankle Ability Measure (FAAM) (Appendix B) for function were used to determine the effectiveness of BMT and PT on acute ankle inversion sprain.

VAS is a continuous scale of ten centimeters (100mm) in length with two verbal descriptors, one for each extreme. It uses descriptors of "no

pain at all" and "pain as bad as it could be" or "worst imaginable pain". The participants were asked to draw a line perpendicular to the VAS line corresponding to their pain. The score was determined by measuring the distance (mm) between the "no pain" anchor to the patient's mark using a ruler. A longer distance suggested greater pain intensity. The minimal clinically significant difference was 1.1 points on an 11-point scale (or 11 points on a 110-point scale). The minimum clinically important difference was 1.37 cm. VAS was highly correlated with a 5-point verbal descriptive scale and a numeric rating scale graded from no pain with worst pain with correlations ranging from 0.71–0.78 and 0.62–0.91, respectively).[10] VAS was sensitive (sensitivity = 0.70) and reliable (between groups r = 0.97) in measuring the intensity of pain.[11-15]

FAAM a self -report measure, assesses the physical function of individuals who had lower leg, ankle, and foot musculoskeletal disorders. It is a 29-item questionnaire that has two subscales: ADLs subscale (21 items) and sports subscale (8 items). Subscale scores are based on a Likert scale (4-no difficulty; 3- slight difficulty; 2-moderate difficulty; 1- extreme difficulty; 0-unable to do). The participants answer N/A for the activities limited by other factors other than the foot and ankle. Participants assess their current functional level as "normal", "nearly normal", "abnormal" and "severely abnormal". N/As are not counted. The score is determined by the sum of the points divided by the total possible score. A higher score reflects a higher level of physical function. The minimal detectable changes for the activities of daily living and sports subscales are 5.7 and 12.3 respectively.[16-18] The ADL and Sport subscales demonstrated the following associations:

- strong with SF-36 physical function subscale (r = 0.84, 0.78)
- strong with physical component summary score (r = 0.78, 0.80)
- weak with SF-36 mental function subscale (r = 0.18, 0.11) and
- weak with mental component summary score (r = 0.05, -0.02).19

PT Management for Acute Ankle Inversion Sprain. Participants received the PRICE protocol namely; Protection, Rest, Ice, Compression, and Elevation. Ice and elevation above heart-level were done for ten (10) minutes. Participants received the following based on their ability to perform the exercises:

- Ankle dorsiflexion, plantarflexion, eversion, and inversion for 10 repetitions within the pain-free range;
- Ankle isometric exercises towards dorsiflexion, plantarflexion, eversion, and inversion for 10 repetitions with a 6-second hold for each repetition;
- Balance exercises in the following sequence:
    - Single leg stance with eyes open for 30 seconds,
    - Single leg stance on unaffected limb swinging for 30 seconds, and
    - Single leg squats for 30 seconds.

The progression of the balance exercises was from eyes opened to eyes closed.[7,20]

Recruitment and Eligibility Criteria of Participants. Potential participants were recruited through purposive sampling from November 2017 to March 2019 in clinics, sports clubs, and barangays. Information dissemination was done using social media, posters, brochures, flyers, and personal invitations. Participants were screened by either one of the two licensed physiotherapists using the Initial Screening Checklist (Appendix C).

The inclusion criteria used were as follows:

- Male or female aged 18-35 years old;
- Has an ankle sprain with at least Grade 1 tenderness suggesting inflammation 1 day to 3 weeks before being seen by the group; and
- Diagnosed with Grade 1 or 2 ankle sprain using the West Point Ankle Grading System

The exclusion criteria used were as follows:

- (+) fracture on the ankle/foot for < 6 weeks
- (+) neurologic deficits in the lower extremities
- (+) for Squeeze Test, External Rotation Stress test, and syndesmosis ligament palpation. These potential participants would have suffered a syndesmotic ankle injury
- (+) chronic ankle instability as reported by participants
- infected skin

- previous surgical treatment on the ankle/foot for >= 6 weeks
- Those who took medications that had altered pain intensity
- Two or more recurrent ankle sprains in the past six (6) months

Eligible participants were oriented as to the purpose and protocol of the study. Consenting participants sign the informed consent form.

Study Protocol. Eligible participants answered the VAS for pain and FAAM prior to PT and immediately after BMT, for each of the three treatment sessions. Participants were treated three times per week separated by a day of home exercises. For days without treatment, participants were asked to perform the following exercises and update diary (Appendix D):

- Active range of motion exercises on ankle towards all planes for 10 repetitions, in supine;
- Ankle isometric exercises towards all planes for 10 repetitions with a 6-second hold for each repetition, in supine;
- Balance exercises in the following sequence: a. single-leg stance with eyes open; b. single-leg stance on the unaffected limb with opposite leg swinging, and c. single-leg squats for 30 seconds done for 3 repetitions.

BMT application. Immediately after the standard physical therapy, the first strip of BMT fascia tape was placed on the skin overlying the painful area (of the injured ankle) (Figure 2). The second strip of BMT fascia tape was applied directly on top of the first BMT fascia tape leaving shallow skin folds on the painful ankle area (Figure 3). The distal end of the first strip of BMT fascia tape was anchored on the posterior aspect of the Achilles tendon. The third strip of BMT fascia tape was applied on top of the second tape starting from the painful area and was anchored on the medial side of Achilles tendon (Figure 4). The participants were instructed to wear the BMT tape for up to three (3) hours.

Figure 2. First BMT fascia strip. The participant was in a long sitting position with the injured ankle placed in a neutral position. The first strip of BMT fascia tape was applied without tension over the painful lateral ankle area.

Figure 3. Second BMT fascia strip. The second strip of BMT fascia was anchored on the participant's skin overlapping the first BMT fascia strip. The tape was pushed towards the posterior aspect of the ankle by the investigator creating a skin lift (green arrow) over the painful area. The distal end of the second BMT fascia strip was anchored laterally to the Achilles tendon.

Figure 4. Third BMT fascia strip. The third BMT fascia strip was anchored on the participant's skin overlapping the previous BMT fascia strips. The tape was pushed towards the posterior aspect of the ankle by the investigator creating a skin lift over the painful area. The distal end of the BMT fascia strip was attached to the medial aspect of the Achilles tendon.

Statistical Analyses Used. Descriptive statistics (median, range) were used to describe baseline demographics of participants. Using MedCalc version 15.2.2. Friedman Test was used to determine differences in pre-post measurements of VAS and FAAM. Friedman Test is the non-parametric equivalent of repeated measures one-way ANOVA). Alpha value at $p<0.05$ with a calculated 25th-7th percentile range will be determined.[21] Imputation method was used during intention-to-treat-analysis. The last VAS, and FAAM scores of non-compliant participants at Treatment 3 were carried forward and used in data analysis.

RESULTS

During this 2-year study, a total of 17 out of 30 patients were investigated. Using post hoc analysis by G*Power 3.1.9.2, the power was calculated at 61% with an effect size of 0.50, and an alpha value of 0.05.[22]

A total of 30 participants were recruited for the study. 11 were excluded due to pain experienced on the posterior aspect of the ankle and negative anterior drawer test. Two (2) potential participants did not participate due to scheduling difficulties. Seventeen (17) patients (10 male: 7 females) with unilateral ankle inversion sprains (11 left: 6 right) were included in the study with mean (95% CI) age of 21 (20-22) years. At baseline, patients reported mean (95% CI) VAS scores of 3.40 (2.11 to 4.69). Two participants did not return on Treatment 5. The mean (95% CI) FAAM ADL and Sports Subscale Scores were 72.56 (67.90 to 77.22) and 62.87 (54.50 to 71.23).

The following number of participants received the three treatments (Treatments 1, 2, and 3) on the following days:

- 13 participants on Days 1, 3 and 5;
- 2 participants on Days 1, 3 and 7;
- 1 participant on Days 1, 4 and 7;
- 1 participant on Days 1, 4 and 6.

15 of 17 participants performed the home exercise program with two (2) participants resting the injured ankle.

Shapiro-Wilk Test reported non-normal distribution of VAS scores, FAAM ADL and FAAM Sports Subscale Scores ($p<0.01$). Using Friedman Test, a difference in VAS, FAAM ADL and Sports scores was found between Treatment 1, Treatment 2 and Treatment 3 ($p<0.00001$). Conover post-hoc test found improved differences in VAS, FAAM ADL and Sports Scores ($p<0.05$) between:

- Treatment 1 Pre vs Treatment 2 Post
- Treatment 2 Pre vs Treatment 3 Post
- Treatment 1 Pre vs Treatment 3 Post

Except on Day 1, the pre- and post-VAS Scores were different in Treatment 3 and Treatment 5 ($p<0.05$). Table 1 reports the mean ranks between pre- and post-VAS scores.

Except in Treatment 3, the pre- and post-FAAM ADL Subscale Scores were different in Treatment 1 and Treatment 3 ($p<0.05$). Table 2 reports the mean ranks between pre- and post-FAAM ADL Subscale Scores.

The pre- and post-FAAM Sports Subscale Scores were different in Treatments 1, 2 and 3 ($p<0.05$) Table 3 reports the mean ranks between pre and post FAAM Sports Subscale Scores.

No adverse reactions (skin redness, itchiness, blisters) to BMT were reported by the participants.

Table 1. Pre and Post VAS Mean Rank for each treatment

Treatments		Mean Rank	p-value
1	Pre	4.85	>0.05
	Post	4.44	
2	Pre	4.32	<0.05*
	Post	3.38	
3	Pre	2.47	<0.05*
	Post	1.53	

*p<0.05 significant value
Legend: VAS, Visual Analogue Scale

Table 2. Pre and Post FAAM ADL Subscale Mean Rank for every treatment

Treatments		Mean Rank	p-value
1	Pre	1.47	<0.05*
	Post	3.06	
2	Pre	2.41	<0.05*
	Post	3.82	
3	Pre	4.76	>0.05
	Post	5.47	

*p<0.05 significant value
Legend: ADL, Activities of Daily Living; FAAM, Foot and Ankle Ability Measure

Table 3. FAAM Sports Subscale Mean Rank for each treatment

Treatments		Mean Rank	p-value
1	Pre	1.50	<0.05*
	Post	2.50	
2	Pre	2.71	<0.05*
	Post	3.79	
3	Pre	4.91	<0.05*
	Post	5.59	

*p<0.05 significant value
Legend: FAAM, Foot and Ankle Ability Measure

DISCUSSION

Biomechanical Taping is an emerging taping technique used in reducing pain and improving the function of individuals with musculoskeletal conditions. This study found that BMT and PT: (a) decreased VAS mean rank scores at Treatments 2and 3 (p<0.05); (b) improved FAAM-ADL Subscale mean rank scores in Treatments 1 and 2 (p<0.05); (c) improved FAAM-Sports Subscale mean rank scores in all Treatments (p<0.05); and (d) improved in VAS, FAAM ADL and Sports scores between Treatment 1, Treatment 2 and Treatment 3 (p<0.00001).

The significant improvement in VAS, FAAM ADL and Sports Subscale mean rank scores (p<0.05) may be secondary to the physical changes brought about by the skin lift created by the BMT fascia tape. The skin lift could have tightened the superficial fascia that promoted stability on the injured ankle area while it was moving. We assumed that the skin lift likewise created an increased space between deep fascia and muscle that promoted slide thereby movement in between these apposed layers. Similar improvement in VAS and function scores were reported by Dones et al. on handgrips of 23 patients with Lateral Epicondylalgia during BMT application (p<0.05).[9]

No difference in pre and post VAS mean rank scores were found on Day 1 (p>0.05). Three (3) of 17 participants reported increased pain immediately after doing the exercises. We speculate that the skin lift created by tape caused further tightening of the injured ankle area perceived as uncomfortable by the participants thus, possibly affecting the reported VAS scores.

The improved FAAM ADL subscale means rank scores on Day 5 albeit non-significant was possibly due to the ceiling effect of the treatments provided. The majority of the participants reached a higher percentage on Treatment 2 compared to Treatment 1 in which a significant increase in scores was difficult to achieve. Albeit not used in the study, a personal narrative on perceived improvements by the participants could have been used in describing changes brought by the use of BMT.

Despite the 2-yearlong study, we only evaluated and treated 17 participants with true ATFL injury. This had decreased the power of our study to 60%, limiting the external generalizability of our results. The absence of a control group in the study precludes the determination on the sole effects of BMT on pain and function of individuals with ankle inversion sprain. This study only determined the short-term effects of BMT and PT. Given the three (3)

treatment sessions, the effectiveness of BMT as an adjunct to PT may be evident more so, not causing additional pain or limitation in function on the injured ankles of participants.

Implications to practice. BMT with PT may be used in the treatment of acute ankle inversions sprains. The increased stability provided by a possibly compact superficial fascia secondary to the skin-lift created by BMT fascia tape may underpin the improved pain and function of participants. BMT fascia tape allows the mobility of ankle while maintaining a certain level of stability.

Albeit no adverse skin reactions were reported in the study, the application of BMT fascia tape may potentially cause skin reactions to the involved area such as redness, itching, and blisters. Regular monitoring of the skin condition throughout the treatment period is recommended. Patients should be instructed to keep the tape for a maximum of three (3) hours from the time of application to minimize skin reactions.

Implications to research. A large-scale randomized controlled trial is needed to increase the external generalizability of the reported effectiveness of BMT on pain and function of individuals with acute inversion ankle sprains.

CONCLUSION

Biomechanical Taping may be an effective adjunct to PT in managing pain and improving the function of patients with an acute inversion ankle sprain. The stability the BMT is assumed to create in the ankle joint decreased pain promoting functional improvement, such as experienced when walking. The basic science underpinning the mechanism on pain improvement experienced by patients with ankle inversion sprain during BMT application has yet to be investigated.

Acknowledgments

The authors would like to thank the following students of the University of Santo Tomas-College of Rehabilitation Sciences for assistance during data collection and writing of draft: Audrely Nicole Boiser, Regine Paola Galanga, Angela Beatriz Imperio, Mary Helen Kagaoan, Marcus Ian Lizardo, Sheree Mae Silvia, Mary Jude Karla Soller, Guineviere Tubay and Patricia Mae Yumol.

Individual author's contributions

The following are the authors' contributions to the paper:

Valentin C. Dones III – writing of research proposal, research implementation, writing of drafts, writing of final manuscript;

Lyle Patrick Tangcuangco Mark Angel Serra, Angeleah Abada, Zacharie Fuentesa, Phyll Josh Labada, Jannie Mauren Liboona, Judy April Emmanuelle Mianoa, Gian Karlo Reyesa, Marc Ryan Gerald Sabatina, Maria Bianca Vergel de Diosa– writing of research proposal, research implementation, writing of drafts.

Disclosure statement

This paper did not receive any funding.

Conflicts of interest

VCD was the originator of Biomechanical Taping. Albeit he trained the researcher who applied the BMT on participants, he took no part in the actual taping of participants and collection of outcome measures. Other authors had no conflict of interest.

Supplementary files

Appendix A. Visual Analogue Scale

Appendix B. Foot and Ankle Ability Measure

Appendix C. Screening Checklist

Appendix D. Participant's Diary

References:

1. Czajka CM, Tran E, Cai AN, DiPreta JA. Ankle sprains and instability. Medical Clinics. 2014 Mar 1;98(2):313-29.

2. Fallat L, Grimm DJ, Saracco JA. Sprained ankle syndrome: prevalence and analysis of 639 acute injuries. The Journal of Foot and Ankle Surgery. 1998 Jul 1;37(4):280-5.
3. Doherty C, Delahunt E, Caulfield B, Hertel J, Ryan J, Bleakley C. The incidence and prevalence of ankle sprain injury: a systematic review and meta-analysis of prospective epidemiological studies. Sports Medicine. 2014 Jan 1;44(1):123-40.
4. Millas D. Ankle sprain-conservative versus operational treatment: A literary review. 2017
5. van den Bekerom MP, Kerkhoffs GM, McCollum GA, Calder JD, van Dijk CN. Management of acute lateral ankle ligament injury in the athlete. Knee Surgery, Sports Traumatology, Arthroscopy. 2013 Jun 1;21(6):1390-5.
6. Kerkhoffs GM, van den Bekerom M, Elders LA, van Beek PA, Hullegie WA, Bloemers GM, de Heus EM, Loogman MC, Rosenbrand KC, Kuipers T, Hoogstraten JW. Diagnosis, treatment and prevention of ankle sprains: an evidence-based clinical guideline. British Journal of Sports Med. 2012 Sep 1;46(12):854-60.
7. Mattacola CG, Dwyer MK. Rehabilitation of the ankle after acute sprain or chronic instability. Journal of Athletic Training. 2002 Oct;37(4):413.
8. Kuni B, Mussler J, Kalkum E, Schmitt H, Wolf SI. Effect of kinesiotaping, non-elastic taping and bracing on segmental foot kinematics during drop landing in healthy subjects and subjects with chronic ankle instability. Physiotherapy. 2016 Sep 1;102(3):287-93.
9. Dones III VC, Serra MA, Kamus III GO, Esteban Jr AC, Mercado AM, Rivera RG, Vergara AC, Francisco III RJ, De Ocampo LM, De Jesus PJ. The effectiveness of Biomechanical Taping Technique on visual analogue scale, static maximum handgrip strength, and Patient Rated Tennis Elbow Evaluation of patients with lateral epicondylalgia: A cross-over study. Journal of Bodywork and Movement Therapies. 2019 Apr 1;23(2):405-16.
10. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual analog scale for pain (vas pain), numeric rating scale for pain (nrs pain), mcgill pain questionnaire (mpq), short-form mcgill pain questionnaire (sf-mpq), chronic pain grade scale (cpgs), short form-36 bodily pain scale (sf-36 bps), and measure of intermittent and constant osteoarthritis pain (icoap). Arthritis Care & Research. 2011 Nov;63(S11):S240-52.
11. Williamson A, Hoggart B. Pain: a review of three commonly used pain rating scales. Journal of Clinical Nursing. 2005 Aug;14(7):798-804.
12. Jamison RN, Gracely RH, Raymond SA, Levine JG, Marino B, Herrmann TJ, Daly M, Fram D, Katz NP. Comparative study of electronic vs. paper VAS ratings: a randomized, crossover trial using healthy volunteers. Pain. 2002 Sep 1;99(1-2):341-7.
13. Price DD, McGrath PA, Rafii A, Buckingham B. The validation of visual analogue scales as ratio scale measures for chronic and experimental pain. Pain. 1983 Sep 1;17(1):45-56.
14. Jensen MP, Karoly P, Braver S. The measurement of clinical pain intensity: a comparison of six methods. Pain. 1986 Oct 1;27(1):117-26.
15. Scott J, Huskisson EC. Graphic representation of pain. Pain. 1976 Jun 1;2(2):175-84.
16. Foot and Ankle Ability Measures. (n.d.). Retrieved March 31, 2018, from https://www.sralab.org/rehabilitation-measures/foot-and-ankle-ability-measures
17. Carcia CR, Martin RL, Drouin JM. Validity of the Foot and Ankle Ability Measure in athletes with chronic ankle instability. Journal of Athletic Training. 2008 Mar;43(2):179-83.
18. Mazaheri M, Salavati M, Negahban H, Sohani SM, Taghizadeh F, Feizi A, Karimi A, Parnianpour M. Reliability and validity of the Persian version of Foot and Ankle Ability Measure (FAAM) to measure functional limitations in patients with foot and ankle disorders. Osteoarthritis and Cartilage. 2010 Jun 1;18(6):755-9.
19. Martin RL, Irrgang JJ, Burdett RG, Conti SF, Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). Foot & Ankle International. 2005 Nov;26(11):968-83.
20. Bleakley CM, O'Connor S, Tully MA, Rocke LG, MacAuley DC, McDonough SM. The PRICE study (Protection Rest Ice Compression Elevation): design of a randomised controlled trial comparing standard versus cryokinetic ice applications in the management of acute ankle sprain [ISRCTN13903946]. BMC Musculoskeletal Disorders. 2007 Dec;8(1):125.
21. Schoonjans F. MedCalc statistical software [Internet]. MedCalc. MedCalc Software; 2019 [cited 2019Jan20]. Available from: https://www.medcalc.org/
22. G*Power 3.1 manual [Internet]. [cited 2018Jan20]. Available from: http://gpower.hhu.de/fileadmin/redaktion/Fakultaeten/Mathematisch-Naturwissenschaftliche_Fakultaet/Psychologie/AAP/gpower/GPowerManual.pdf