A study on the effectivness of balance training program using thera tube in improving balance and activities of daily living in patients with chronic ankle sprain

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INTRODUCTION

Sprain is defined as an injury in a joint, caused by the ligament being stretched beyond its capacity. Sprain can occur in any joint but are most common in the ankle and wrist. Lateral ankle sprains are among the most common injuries incurred while performing daily living and sports activities that are mostly concerned with young physically active individuals [1,2,3]. Chronic ankle sprain usually refers to the fact that either the injury occurred over six (6) weeks ago or if it is still painful, or if there occurs a repetitive injuries to the same ankle.

It has been estimated that the incidence is about one ankle sprain per 10,000 people per day [4] and the rate of recurrence for an ankle sprain has been reported to be as high as 70%. [5,6] Simple ankle sprains are not as innocuous as many believe with high rates of prolonged symptoms, decreased physical activity, recurrent injury and self-reported disability.[7,8]When an acute sprain is left untreated, the ankle may develop chronic ankle instability - a condition with persistent discomfort and a continual "giving way" of the ankle

and pain during activity. It is estimated that approximately 30% will develop chronic ankle instability after the first initial lateral ankle sprain.[7]

A chronic ankle sprain is often also known as chronic ankle instability. This is almost always a result of repetitive accidents to the ankle joint. Chronic ankle instability, usually a result of recurrent sprains, is an ongoing problem, especially among active individuals. The incidence of residual symptoms and development of chronic ankle instability after lateral ankle sprain have been reported to be between 31% and 40%. Independent of the initial treatment, persistent symptoms or re-injuries remain in 10–30% of individuals.[9]

In the chronic ankle sprain condition, the ligaments have become stretched out to the point that the ankle continually subluxes or "turns under". Usually a chronic ankle sprain is the result of multiple acute sprains where the ligaments have not been allowed to heal correctly. This can range from a mild nuisance to a severely debilitating condition with associated other issues. Individuals who have chronic ankle sprain, repeatedly sprained their ankle may feel unstable and "floppy" when walking in their ankle. If an acute sprain is left untreated, the ankle may develop chronic ankle instability - a condition with persistent discomfort and a continual "giving way" of the ankle and pain during activity [10,11]

If one has sprained the ankle in the past, one may continue to sprain it if the ligaments did not have time to completely heal. If the sprain happens frequently and pain continues for more than four weeks to six weeks, you may have a chronic ankle sprain. Activities that tend to make an already sprained ankle worse include stepping on uneven surfaces, cutting actions and sports that require rolling or twisting of the foot.

Ankle instability can be defined as either mechanical or functional instability[9]. Mechanical instability refers to objective measurements of ligament laxity, whereas functional instability is defined as recurrent sprains and/or the feeling of giving way. Causal factors include a proprioceptive deficit, muscular weakness, and/or absent coordination.

Ankle sprains vary in severity and consequential disability based on the degree to which the ligaments are damaged. In most cases, ankle sprains are graded as mild, moderate, or severe. Depending upon the severity of the injury to the ankle, a sprain may cause both pathologic laxity[12,13] and impaired sensorimotor control about the ankle.[14] Increased ankle joint laxity and sensorimotor deficits from a single or multiple ankle sprains have been shown

to be related to impaired balance[15] and diminished lower extremity function. Chronic ankle sprain is a result of grade 2 and grade 3 injury. When these injuries do not heal completely due to repeated injury to the same region may lead to ankle instability which will have its effect in affecting the balance.

The incidence of recurrent ankle sprain is high and leads to ligamentous damage as well as damage to the mechanoreceptors. Damage not only occurs to the structural integrity of the ligaments but also to various mechanoreceptors in the joint capsules, ligaments, and tendons about the ankle complex. Collectively, the receptors offer feedback regarding joint pressure and tension, ultimately providing a sense of joint movement and position. When afferent input is altered after injury, appropriate corrective muscular contractions may be altered. Long-term effects of repetitive ankle trauma leave an individual more susceptible to degenerative changes. Because of the degenerative changes and a reduction in proprioceptive awareness, a correlation to postural instability may exist, leading to a sense of not being coordinated and a loss of movement control. A deficiency in any area, results in perceived sense of instability. Thus, damage to the mechanoreceptors surrounding the ankle joint with a lateral ankle sprain may contribute to functional impairments and chronic instability subsequent to initial injury and later leading to balance deficits during quite standing[16] thereby leading to impairment in performing the activities of daily living.

Postural-control deficits during quiet standing after acute lateral ankle sprain and in those with chronic ankle instability have been frequently reported. While it is difficult to directly prove that an ankle sprain causes impaired balance, there is indirect evidence that balance is impaired following an ankle sprain and impairments in balance can be improved using rehabilitative exercise.[17] Prospective studies have shown that ankle injury prevention exercises are effective in reducing the incidence of ankle injuries.[18]

The ankle joint plays an essential role in balance control as the location of the center of pressure depends on the ankle joint position and leg muscle (plantar flexor and dorsiflexor) activity. Balance control in unilateral standing will be disturbed in patients with functional ankle instability.

Following an ankle sprain, a relatively high percentage of individuals develop chronically unstable ankles and these individuals report a feeling of giving way when on

balancing and performing daily activities. Balance deficits have been frequently reported in individuals with chronically unstable ankles[19,20] a combination of strengthening and coordination exercises, with an ankle disk or wobble board, to rehabilitate the injured ankle joint.[21,22,23]These exercises have been recommended by numerous authors[9,23] to improve balance,[9,23] and to reduce the incidence of ankle sprains.

In ankle instability, balance problems occur and are a result of proprioceptive deficits. This factor probably plays an important role in recurrence of ankle sprain. For rehabilitation after injury or prevention of re-injuries, proprioceptive training has been recommended throughout the literature.[24,25,26]

A variety of rehabilitation exercises, such as an ankle disk, weight training, elastic resistance exercises, and foam exercises to rehabilitate the ankle joint. Elastic tubing and elastic bands are often used in therapeutic exercise programs.[27,28] There are many inherent advantages of elastic resistance exercises: ease of use, low cost, they are highly versatile and finally they impose a weight bearing overload on the joint to be rehabilitated[29]. Elastic tubing exercise is often used in conjunction with other rehabilitation exercises to promote ankle strength and balance in patients with recurrent ankle sprains. When utilizing elastic resistance exercise to rehabilitate a chronically unstable ankle, the unaffected ankle is attached to the elastic tubing and the affected ankle experiences a weight-bearing overload to resist against the perturbation force. To maintain balance in response to the balance- disrupting force imposed by elastic tubing, the weight-bearing ankle must actively resist in the opposite direction against the imposed perturbation force.

Thus, in my study, I use thera band to improve the balance in patients with chronic ankle instability and thereby improving the activities of daily living thereby preventing recurrence of injury.

1.1 AIM OF THE STUDY

The aim of this study is to find the effectiveness of balance training program using thera tube in improving balance and activities of daily living in patients with chronic ankle sprain.

1.2 HYPOTHESIS

Null hypothesis (H_0): There is no significant improvement in balance and activities of daily living in patients with chronic ankle sprain by using thera band in the balance training program.

Alternate hypothesis (H_1): There is significant improvement in balance and activities of daily living in patients with chronic ankle sprain by using thera band in the balance training program.

1.3 BACKGROUND OF THE STUDY

The research report “Ankle Instability Is Associated with Balance Impairments: A Meta-Analysis” by Arnold et al published in the Medical Science for Sports Exercise, Volume 41; December 2009 suggested that balance is affected following ankle sprain.

On the basis of their results, it appears that individuals with ankle instability have deficits in their balance. These deficits appear to exist regardless of whether balance is assessed with static or dynamic tests.

Ankle instability is common after ankle sprains and is characterized by feelings of "giving way" at the ankle and recurrent ankle sprains and have predicted ankle sprain injury in physically active individuals. As a result of this association between balance deficits and ankle sprain injury, single-leg balance tests have been used as clinical and research examinations to assess postural instabilities associated with ankle instability.

One reason balance tests are used to evaluate postural instabilities associated with ankle instability is due to the work of Freeman et al., who reported that functional ankle instability. Freeman et al. proposed that disrupted sensorimotor pathways associated with ankle instabilitydiminished postural reflex responses, causing single-leg balance deficits. However, the balance literature on ankle instability lacks consistency in reporting balance deficits associated with ankle instability, as some researchers have indicated that balance impairments exist with ankle instability, and other researchers have reported that balance deficits are not associated with ankle instability.

1.4 NEED AND SIGNIFICANCE OF THE STUDY

The purpose of this study is to describe the outcomes measures of patients with chronic ankle sprain when being treated with thera bands. Evidences suggest that thera band training can be effective in restoring balance and functional stability in patients with chronic ankle sprain. But there is no evidence these patients exhibit improvement following the training. Thus, the significance of this study is to find if thera band balance training can be effectively in improving the balance and activities of daily living following a chronic ankle sprain. The implication of the findings of these studies is that balance training using thera band may be an important element in the successful rehabilitation of patients with chronic ankle sprain thereby improving the balance may help alleviate the symptoms of functional ankle instability and reduce the rate of recurrent ankle sprains.

1.5 OPERATIONAL DEFINITION:

1. **Chronic ankle sprain** [11]: chronic ankle sprain is a condition, in which the ligaments have become stretched out to the point that the ankle continually subluxes or "turns under". Usually a chronic ankle sprain is the result of multiple acute sprains where the ligaments have not been allowed to heal correctly.

2**. Balance** [11]: Balance is the ability to maintain upright posture while keeping the center of gravity within the base of support.

3. **Chronic ankle instability** [11]: Chronic ankle instability is a condition characterized by a recurring “giving way” of the outer (lateral) side of the ankle. This condition often develops after repeated ankle sprains.

REVIEW OF LITERATURE

1. El Sayed Mohamed Moneer Atta 2012*:* Balance Exercises and its Role in the Treatment of Chronic Ankle Instability; World Journal of Sport Sciences 6 (2): 95-101.

The study suggests that balance is affected in people with ankle instability. The study also concluded that balance training improves the stability of balance. Balance exercises help

to remove the pain of the ankle and helps in restoring the dynamic stability. Balance exercises worked to strengthen the muscles. The functional efficiency of the ankle also improved after the use of balance exercises.

2.Alyson Filipa, et al 2010: Neuromuscular Training Improves Performance on the Star Excursion Balance Test in Young Female Athletes, Journal of Orthopedic Sports of Physical Therapy; 40(9):551-558

The study demonstrated an improved performance on the star excursion balance test (SEBT) after NMTP that focused on lower extremity strength. And the star excursion balance test is an effective tool of measuring both the static and dynamic balance of the lower limb.

3.Diarmaid Fitzgerald, et al 2010: Effects of a Wobble Board-Based Therapeutic Examine System for Balance Training on Dynamic Postural Stability and Intrinsic Motivation Levels, Journal of Orthopedic Sports of Physical Therapy; 40(1):11-19.

Star excursion balance test scores showed a statistically significant improvement in the posteromedial and posterolateral direction. The findings suggest that exercising with the therapeutic examine system showed similar improvements in dynamic postural stability.

4.Santos MJ, Liu W et al 2008: Possible factors related to functional ankle instability. Journal of Orthopedic Sports for Physical Therapy; 38:150-157.

The study proposes that mechanical alterations in the ankle joint may influence several aspects of the ankle's functional ability. Alterations in the afferent processes, represented in this study by ankle proprioception, may affect the evertors' strength or vice versa. More importantly, individuals with functional ankle instability might exhibit high variability in ankle deficits.

5. McKeon PO, Hertel J 2008 Systematic review of postural control and lateral ankle instability, part I: can deficits be detected with instrumented testing. Journal of Athletic Training; 43(3):293-304.

The study concludes that instrumented postural control testing on stable force plates is better at identifying deficits that are associated with an increased risk of ankle sprain and that occur after acute ankle sprains than at detecting deficits related to chronic ankle instability.

6. Ingersoll CD, Kerrigan DC, et al 2008: Balance training improves function and postural control in those with chronic ankle instability. Medical Science of Sports Exercise; 40(10):1810-1819

The study suggests that a four weeks of balance training significantly improved self-reported function, static postural control as detected by TTB measures, and dynamic postural control as assessed with the SEBT. TTB measures were more sensitive at detecting improvements in static postural control compared with summary COP-based measures.

7.Marcos de Noronha, et al 2008: Relationship between Functional Ankle Instability and Postural Control. Journal of Orthopedic Sports of Physical Therapy; 38(12):782-789

The study concludes that there is a relationship between ankle instability with that of the postural control. Ankle control is affected in people with functional ankle instability in tasks of postural control after landing from a hop.

8. Scott E Ross, et al 2008: Assessment Tools for Identifying Functional Limitations Associated with Functional Ankle Instability Journal of Athletic Training. Jan-Feb; 43(1): 44–50.

The Ankle Joint Functional Assessment Tool (AJFAT) was an excellent assessment tool for discriminating between ankle groups. The AJFAT more accurately discriminated between groups. This tool is used to differentiate between a stable ankle with that of the unstable ankle.

9.Christopher R Carcia, et al 2008: Validity of the Foot and Ankle Ability Measure in Athletes with Chronic Ankle Instability Journal of Athletic Training. Mar-Apr; 43(2): 179–183.

The Foot and Ankle Ability Measure may be used to detect self-reported functional deficits related to chronic ankle instability. And the foot and ankle ability measure is a very effective tool to assess the functional impairments in ankle instability patients.

10. Hertel J et al 2008: Sensorimotor Deficits with Ankle Sprains and Chronic Ankle Instability. Clinical Sports Medicine; 27; 353-370

The study concludes that alterations in a spectrum of sensorimotor measures make it apparent that conscious perception of afferent somatosensory information, reflex responses, and efferent motor control deficits are present with ankle instability. The specific origin of these deficits local to the ankle ligaments or at the spinal or supraspinal levels of motor control have yet to be fully elucidated. It is clear, however, that both feedback and feedforward mechanisms of motor control are altered with ankle instability.

11. Hale SA, et al 2007: The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability.Journal of Orthopedic Sports of Physical Therapy; 37:303-311

The study results demonstrate postural control and functional limitations exist in individuals with CAl. In addition, rehabilitation appears to improve these functional limitations. There is evidence to suggest the star excursion balance test may be a good functional measure to monitor change after rehabilitation for ankle instability.

12.Hubbard TJ, et al 2007: Contributing factors to chronic ankle instability. Foot Ankle International; 28:343-354

The results of this study elucidate the specific measures that best discriminate between individuals with and without CAI. Both mechanical (anterior and inversion laxity) and functional (strength, dynamic balance) insufficiencies significantly contribute to the etiology of CAI. Prevention of CAI may be possible with proper initial management of the acute injury with rehabilitation aimed at those factors that best discriminate between individuals with and without CAI.

13.Hubbard TJ, et al 2007: Correlations among multiple measures of functional and mechanical instability in subjects with chronic ankle instability. Journal of Athletic Training; 42:361-366.

The study suggests that certain measures of functional instability were significantly correlated. Additionally, the significant correlations between measures of functional (balance, strength) and mechanical instability (laxity, hypomobility) demonstrate that the 2 factors are not completely dichotomous and need to be examined together.

14.Docherty CL, et al 2006: Postural control deficits in participants with functional ankle instability as measured by the balance error scoring system. Clinical Journal of Sports Medicine; 16:203-208.

The study suggests that postural control deficits were identified in participants with functional ankle instability. These deficits could be a contributing factor to the repeated episodes of instability and giving way that often occurs following an ankle sprain

15.Hubbard TJ, et al 2006: Mechanical contributions to chronic lateral ankle instability. Sports Medicine; 36:263-277.

The study shows the development of repetitive ankle sprains and persistent symptoms after injury has been termed chronic ankle instability. One of the purported causes of ankle instability is mechanical ankle instability. Mechanical ankle instability results in abnormal ankle mechanics. Both hypermobility and hypomobility may change a joint's axis of rotation and result in abnormal joint mechanics. Assessment and treatment should focus on both hypermobility and hypomobility and although injury may seem to be isolated to the talocrural joint, the inferior tibiofibular and subtalar joints should also be thoroughly examined.

16.Brandi L. et al 2006: Proprioceptive exercises balance ankle stability and activity; Biomedicals October 2006: 1-6

The study concludes that Chronic ankle instability, sometimes is associated with multiple ankle sprains, can lead to difficulty with walking, running, jumping, and cutting and reduction in the overall functional activities. Although functional instability can lead to impaired performance, the literature shows that proprioceptive exercise may help with overall balance.

17. Verhagen E, et al 2004: The effect of a proprioceptive balance board training program for the prevention of ankle sprains: a prospective controlled trial. American Journal of Sports Medicine; 32:1385-1393.

Based on the results of this study, it is evident that postural sway can be improved in subjects with functional instability of the ankle following 4 weeks of coordination and balance training. Balance and coordination training should continue to be an integral part of rehabilitation protocols.

18.Tropp H.et al 2002: Commentary: functional ankle instability revisited. Journal of Athletic Training; 37:512-515.

The study reviews that a local mechanoreceptor injury or muscle-strength imbalance contributes to chronic ankle instability and impairment in functional activities, but coordination training and proprioceptive training are clearly the treatments of choice and can

help prevent recurrent sprains. Balance training also plays an important role in improving balance.

19.Riemann BL.et al 2002: Is there a link between chronic ankle instability and postural instability? Journal of Athletic Training; 37:386-393.

The conclusion of study is that postural instability is potentially more important. The issue of whether postural control becomes disrupted as a result of ankle injury is the effect on the selection of sensory and motor strategies leading to balance impairments and that thereby leading to functional activities impairment.

20. Mattacola et al 2002: Rehabilitation of the Ankle After Acute Sprain or Chronic Instability: Journal of Athletic Training; 37(4): 413–429.

He stated that Rehabilitation of ankle injuries should be structured and individualized. In the acute phase, the focus should be on controlling inflammation, reestablishing full range of motion, and gaining strength. Once, pain-free range of motion and weight bearing have been established, balance-training exercises should be incorporated to normalize neuromuscular control. Advanced-phase rehabilitation activities should focus on regaining normal function.

21. Loram ID et al 2002: Human balancind of an inverted pendulum: Journal of Physiology; 540:1111-1124

The study suggests that using the ankle musculature, subjects balanced a large inverted pendulum. The equilibrium of the pendulum is unstable and quasi-regular sway was observed like that in quiet standing.

22.Craig R. Denegar, et al 2002:The Effect of Lateral Ankle Sprain on Dorsiflexion Range of Motion, Posterior Talar Glide, and Joint Laxity Journal of Orthopedic and Sports Physical Therapy. 2002; 32(4):166-173.

In this study, residual ligamentous laxity was commonly found following lateral ankle sprain. Dorsiflexion range of motion was restored in the population studied despite evidence of restricted posterior glide of the talocrural joint. Although restoration of physiological range of motion was achieved, residual joint dysfunction persisted.

23.Simoneau GG, et al 2001: Biomechanics of elastic resistance in therapeutic exercise programs.Journal of Orthopedic Sports of Physical Therapy; 31:16-24

The study concludes that there are advantages in using elastic material for purposes of strengthening exercises and also helps in controlling the progression of the exercise program and also helps in attaining self built resistance by the patient. These elastic material help is attributing the resistance offered by the patient in performing strengthening exercises.

24.Hertel J, et al 2001: Serial Testing of Postural Control after Acute Lateral Ankle Sprain. Journal of Athletic Training Dec; 36(4):363-368.

This study identifies subjects' changes in postural control during single-leg stance in the 4 weeks after acute lateral ankle sprain. Postural control was significantly impaired in the injured limbs at day 1 and during week 2 after lateral ankle sprain. Consistent improvement in postural control measures on both injured and uninjured limbs was seen throughout the 4 weeks after ankle sprain.

25. McKay GD, et al 2001: Ankle injuries in basketball: injury rate and risk factors. British Journal of Sports Medicine; 35:103-108

The study reviews that ankle injuries occurred at a rate of 3.85 per 1000 participations. The three identified risk factors, and landing, should all be considered when preventive strategies for ankle injuries. Ankle injuries are said to be most common in active individuals and in individuals related to outdoor sports.

26. Eric eils et al 2001: A multi-station proprioceptive exercise program in patients with ankle instability. Medical Science for Sports Exercise; 33: 1991-1998

Based on the present results, a multi-station proprioceptive exercise program can be recommended for prevention and rehabilitation of recurrent ankle inversion injuries. The multi-station proprioceptive exercise program led to significant improvements of proprioceptive capabili ties in chronically unstable patients. The main advantage compared with other programs is the relatively low training frequency.

27. Hertel J, Denegar R, et al 1999: Talocrural and subtalar joint instability after lateral ankle sprain. Medical Science of Sports Exercise; 31:1501-1508.

The data of the study suggest the existence of a subpopulation of patients with a history of LAS who demonstrate a pattern of combined talocrural and subtalar laxity. The talocural and the subtalar ligament laxity are the most common in individuals following lateral ankle sprain and this ligament laxity may be a factor leading to ankle instability.

28. Holme E, et al 1999: The effect of supervised rehabilitation on strength, postural sway, position sense and re-injury risk after acute ankle ligament sprain. Scandinavian Journal of Medicine and Science in Sports; 9:104-109.

The study proposes the effect of an early rehabilitation program, including postural training, on ankle joint function after an ankle ligament sprain was investigated prospectively. These data showed that an ankle injury resulted in reduced ankle strength and postural control. However, the findings demonstrated that supervised rehabilitation may reduce the number of re-injuries, and therefore may play a role in injury prevention.

29. Rozzi SL, et al 1999: Balance training for persons with functionally unstable ankles. Journal of Orthopedic Sports of Physical Therapy; 29:478-4

This study suggests that balance training is an effective means of improving joint proprioception and single-leg standing ability in subjects with unstable and nonimpaired ankles. Balance training plays a very major and an important part in improving balance as well as improving functional performance ability.

30. Docherty CL, et al 1998: Effects of strength training on strength development and joint position sense in functionally unstable ankles. Journal of Athletic Training; 33:310-314.

The result of the study was that Ankle-strengthening exercises improved strength, inversion JPS, dorsiflexion JPS, and plantar flexion JPS in subjects with functionally unstable ankles. Ankle strengthening exercises for plantarflexor, dorsiflexors, invertors and evertors will improve ankle strength and thereby improving functional ability.

31. Julie N. Bernier et al 1998:Effect of Coordination Training on Proprioception of the functionally Unstable Ankle. Journal of Orthopedic and Sports Physical Therapy; 27(4):264-275.

Based on the results of this study, it is evident that postural sway can be improved in subjects with functional instability of the ankle following 6 weeks of coordination and

balance training. Balance and coordination training should continue to be an integral part of rehabilitation protocols.

32.Bahr R, Bahr IA1997: Incidence of acute volleyball injuries: a prospective cohort study of injury mechanisms and risk factors. Scandinavian Journal of Medicine and Science in Sports; 7:166-171

The study suggests that ankle sprains are the most common injuries accounting for about half of all injuries and with an incidence of about one per 1000 player hours. Ankle sprains mainly result from technical errors during take-off and landing after blocking and attacking, but previous ankle injury is the main risk factor.

33.Hoffman M, et al 1995: The effects of proprioceptive ankle disk training on healthy subjects. Journal of Orthopedic Sports of Physical Therapy; 21:90-93.

According to research, proprioceptive training enables injured subjects to reduce proprioceptive deficits and increase postural control. Proprioceptive ankle disk training significantly decreased postural sway in both the medial-lateral and anterior-posterior directions.

34.Gauffin, et al 1988: Effect of ankle disk training on postural control in patients with functional instability of the ankle joint. International Journal of Sports Medicine;9:141–144

The study attributed that there was improvement in postural control after ankle disk training. The study has also emphasized the importance of ankle disk training for ankle instability. The postural control with functional instability (FI) of the ankle joint, i.e., recurrent sprains and or a feeling of giving way, was studied before and after ankle disk training. In the present study, we found increased postural sway with functional instability, was found to be improved after ankle disk training.

35. Balduini,et al 1982: Historical perspectives on injuries of the ligaments of the ankle. Clinical Sports Medicine;1:3–12

As is readily apparent, there is not a consensus regarding the treatment of lateral ligamentous ruptures of the ankle. Certainly, the elimination of functional instability is the goal of treatment. It appears that degenerative changes can result from mechanical instability.

Treatment regimen will provide the most consistent results with the least incidence of functional instability.

36. Nashner LM et al 1976: Adapting reflexes controlling the human posture. Experimental Brain Researsh 26:59-72.

The intent of this study was to discover the stabilizing role of stretch reflexes acting upon the ankle musculature while human subjects performed stance tasks requiring several different postural sets. And the study concludes that appropriate reflexes should come in to play in maintaining the effective posture.

37. Freeman MA, et al 1965: The etiology and prevention of functional instability of the foot. Journal of Bone Joint Surgeries; 47:678-685.

The study concluded: a) that ligamentous injuries at the foot and ankle frequently produce a proprioceptive deficit affecting the muscles of the injured leg; b) that such a deficit is responsible for the symptom of "giving way" of the foot; and c) that the incidence of both the proprioceptive deficit and the symptom of "giving way" can substantially be reduced by treatment after injury with the coordination exercises described in this study.

METHODOLOGY

3.1 STUDY SETTING

Clinical setting

3.2 STUDY DESIGN

Experimental study.

3.3 POPULATION OF STUDY

Chronic ankle sprain

3.4 SAMPLE SIZE

30 subjects

3.5 SAMPLING TECHNIQUE

Simple random sampling method

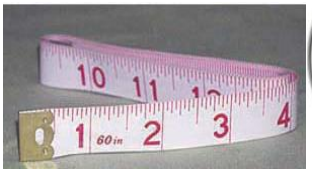
3.6 INCLUSION CRITERIA

1. Both male and female patients
2. Age 20-40yrs
3. A history of at least one unilateral ankle sprain with pain and/or limping for greater than one day
4. Multiple episodes of the ankle giving way within the past 12 months
5. self reported giving way of the involved ankle in the last 6 months
6. pain or instability attributed to initial injury

3.7 EXCLUSION CRITERIA

1. Bilateral ankle sprain
2. Prior balance training
3. History of balance disorder
4. History of fracture or surgeries to the foot, ankle and lower limb
5. Equilibrium dysfunction
6. Neurological disorder

3.8 TOOLS AND MATERIALS USED



Measuring tape

Stop watch

Various levels of thera bands

3.8 PROCEDURE

Thirty subjects both male and female with unilateral ankle sprain who fulfilled the inclusion and exclusion criteria should be evaluated through standardized history and physical examination. The star excursion balance test values for balance and the percentage of functional disability for the ankle joint should be recorded before the treatment. The subjects were advised to follow the exercise protocol for chronic ankle sprain. The star excursion balance test values for balance and the percentage of functional disability for the ankle joint should be recorded at the end of four weeks as post test values. Then both the pre test and post test values are tabulated and statistically analyzed.

PRE TEST

STAR EXCURSION BALANCE TEST

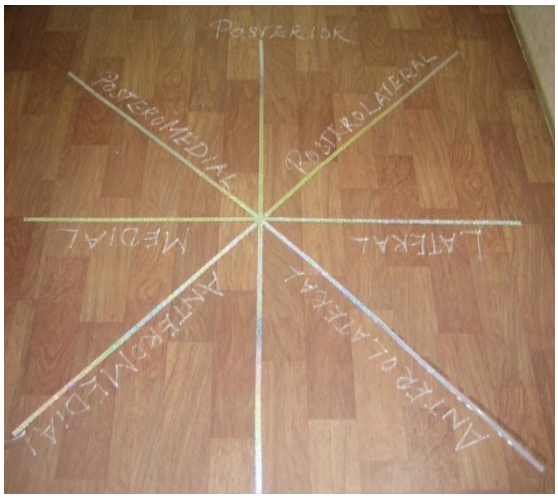
The star excursion balance tests (SEBTs) are functional tests that incorporate a single-leg stance on one leg with maximum reach of the opposite leg. The star excursion balance test are performed with the subject standing at the center of a grid placed on the floor, with 8 lines extending at 45° increments from the center of the grid. The 8 lines positioned on the grid are labeled according to the direction of excursion relative to the stance leg: anterolateral (AL), anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL), and lateral (L). The grid was constructed using a protractor and 3-in (7.62-cm)-wide adhesive tape and was enclosed in a 182.9-cm by 182.9-cm square on the hard tile floor.

A verbal and visual demonstration of the testing procedure was given to each subject by the examiner. Each subject performed 6 practice trials in each of the 8 directions for each leg to become familiar with the task. . To perform the SEBTs, the subject maintained a single-leg stance while reaching with the contra lateral leg (reach leg) as far as possible along the appropriate vector. The subject lightly touched the furthest point possible on the line with the most distal part of the reach foot. The subject was instructed to touch the furthest point on the line with the reach foot as lightly as possible in order to ensure that stability was achieved through adequate neuromuscular control of the stance leg. The subject then returned to a bilateral stance while maintaining equilibrium. The examiner manually measured the distance from the center of the grid to the touch point with a tape measure in centimeters. Measurements were taken after each reach by the same examiner.

Three reaches in each direction were recorded. Subjects were given 15 seconds of rest between reaches. The average of the 3 reaches for each leg in each of the 8 directions was calculated. Reach leg (right, left), order of excursions performed (clockwise, counterclockwise), and direction of the first excursion (A, M, L, P) were counterbalanced to control for any learning or order effect. All trials were then performed in sequential order in either the counterclockwise or clockwise directions.

Trials were discarded and repeated if the subject (1) did not touch the line with the reach foot while maintaining weight bearing on the stance leg, (2) lifted the stance foot from the center grid, (3) lost balance at any point in the trial, or (4) did not maintain start and

return positions for one full second. In other words, if the reach foot was used to widen the base of support, the trial was not recorded.



Layout of Star Excursion Test

THE FOOT AND ANKLE DISABILITY INDEX

The Foot and Ankle Disability Index is also a tool which is in a questioner pattern which is being dually filled by the patient himself. The Foot and Ankle Disability Index (FADI) is a region-specific self-report of function. The Foot and Ankle Disability Index is a 34-item questionnaire divided into two subscales: the Foot and Ankle Disability Index and the Foot and Ankle Disability Index Sport. The FADI has 26 items, and the FADI Sport has 8. The FADI contains 4 pain related items and 22 activity related items. Each of the 34 items is scored on a 5-point Likert scale from 0 (unable to do) to 4 (no difficulty at all). The 4 pain items of the FADI are scored 0 (none) to 4 (unbearable). The FADI has a total point value of 104 points, whereas the FADI Sport has a total point value of 32 points. The FADI and FADI Sport are scored separately as percentages, with 100% representing no dysfunction.

The foot and ankle disability index was designed to assess functional limitations related to foot and ankle conditions. Hale and Hertel advocate the use of the FADI and FADI Sport self-report instruments in clinical care and research applications in young adults with CAI.

Eechaute et al concluded that the FADI and FAAM were the most appropriate evaluative instruments to quantify functional disabilities in athletes with chronic ankle instability. An advantage of the FADI and FAAM is that they both have a sports subscale in addition to an activities of daily living subscale.

METHOD OF USE OF THE FOOT AND ANKLE DISABILITY INDEX

Each of the 34 items is scored on a 5-point Likert scale from 0 to 4. The FADI has a total point value of 104 points, whereas the FADI Sport has a total point value of 32 points. The FADI and FADI Sport are scored separately and then transformed into percentages.

EXERCISE PROTOCOL

Rehabilitation exercises, such as an ankle disk, weight training, elastic resistance exercises, and foam exercises to rehabilitate the ankle joint. Elastic tubing and elastic bands are often used in therapeutic exercise programs. There are many inherent advantages of elastic resistance exercises: ease of use, low cost, they are highly versatile and finally they impose a weight bearing overload on the joint to be rehabilitated. Physical therapists often use elastic tubing exercise in conjunction with other rehabilitation exercises to promote ankle strength and balance in patients with recurrent ankle sprains. When utilizing elastic resistance exercise to rehabilitate a chronically unstable ankle, the unaffected ankle is attached to the elastic tubing and the affected ankle experiences a weight-bearing overload to resist against the perturbation force. To maintain balance in response to the balance-disrupting unstable ankle foot (exercise CAI group) force imposed by elastic tubing, the weight-bearing ankle must actively resist in the opposite direction against the imposed perturbation Elastic tubing exercises for the exercise group consisted of 4 different exercises: front pull, back pull, crossover, and reverse crossover. Subjects assigned to the exercise group made 3 visits per week, every other day for 4 weeks, to perform the elastic tubing exercises. Each exercise consisted of 3 sets of 15 repetitions, with the chronically unstable ankle foot. Initially the exercises are started with the least resistance band later on progressing to different levels of resistance.

1. Front Pull:

The subject faced away from the fixed attachment of the elastic tubing so that the tubing pulled the subject backward. Each subject stood on the affected foot with the unaffected foot positioned behind the affected foot with the hip and knee extended. While balancing on the affected foot, the subject flexed the unaffected hip and knee, pulling the tubing forward. The subject then slowly returned to the starting position.

2. Back Pull :

The subject faced toward the fixed attachment of the elastic tubing, so that the tubing pulled the subject for ward. The subject stood on the affected foot, with the unaffected foot positioned ahead of the affected foot with the hip and knee flexed. While balancing on the affected foot, the subject extended the uninjured lower extremity at the hip and knee, pulling the tubing Backward. The subject then slowly returned to the starting position. The subject stood on the affected foot, flexing the unaffected lower extremity at the hip and knee, while pulling the tubing backward (A to B), then slowly returned to the starting position (B to A).

3. Crossover:

The subject stood perpendicular to the fixed attachment of the elastic tubing, so that the unaffected foot was closer to the fixed attachment, with the feet slightly wider than shoulder width apart. The subject stood on both the affected and unaffected lower extremities, with hip and knees flexed. While balancing on the affected foot, the subject adducted the hips by crossing the unaffected foot in front of the affected foot. The subject then slowly returned to the starting position.

4. Reverse Crossover:

The subject stood perpendicular to the fixed attachment of the elastic tubing. The subject's unaffected foot was closer to the fixed attachment with the hips adducted and

lower extremities crossed so that the unaffected foot was in front of the affected foot. The subject stood on both the affected and unaffected lower extremities with hips and knees flexed. While balancing on the affected foot, the subject abducted the hip until the feet were slightly wider apart than shoulder width. The subject then slowly returned to the starting position.

DATA ANALYSIS AND INTERPRETATION

4.1 STATISTICAL METHOD

The collected data were tabulated and analyzed by using descriptive and interferential statistics. The data was analyzed by paired t-test. The Statistical package for social sciences (SPSS) package was used to calculate and analyze the above mentioned descriptive and inferential statistics.

1. To assess all parameters descriptive statistics like mean and standard deviation were used.

- **Mean:**

$$\bar{d} = \frac{\sum d}{n},$$

Where $\sum d$ is the summation of difference

n is the no of samples

- **Standard Deviation:**

$$\text{SD} = \sqrt{\left(\frac{\sum d^2}{n}\right) - \left(\frac{\sum d}{n}\right)^2},$$

Where d is difference between pre and post treatment values

n is no of samples

2. To find the changes that occurred in the same group during study measure of inferential statistics called paired‘t’ test was used.

- **‘t’ test formula:**

$$t = \frac{\bar{d}}{\left(\frac{s}{\sqrt{n-1}}\right)},$$

Where $\bar{d}$ is Mean of Samples

s is Standard Deviation

$\sqrt{n-1}$ Is Degrees of Freedom

The calculated values t – values is then compared with standard tabulated t a n-1 value where a is the level of significance which is usually maintained at 95%.

4.2 DESCRIPTION AND STATISTICAL ANALYSIS

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre test values for Star Excursion Balance Test	48.3843	30	7.79404	1.42299
	Post test values for Star Excursion Balance Test	51.2613	30	7.24416	1.32260
Pair 2	Pre test values for Foot and Ankle Disability Index	60.9000	30	8.36392	1.52704

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre test values for Star Excursion Balance Test	48.3843	30	7.79404	1.42299
	Post test values for Star Excursion Balance Test	51.2613	30	7.24416	1.32260
Pair 2	Pre test values for Foot and Ankle Disability Index	60.9000	30	8.36392	1.52704
	Post test values for Foot and Ankle Disability Index	55.5333	30	8.11866	1.48226

Paired Samples Correlations:

Ho: There is no significant relationship between the Pre and Post outcome measurements.
H1: There is a significant relationship between the Pre and Post outcome measurements.

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Pre test values for Star Excursion Balance Test & Post test values for Star Excursion Balance Test	30	.837	.000
Pair 2	Pre test values for Foot and Ankle Disability Index & Post test values for Foot and Ankle Disability Index	30	.962	.000

Inference:

From the above table, it shows the value of p is less than .05. So we reject the Ho. It may be conclude that the Pair 1 and Pair 2 Pre and Post outcome measurements are High Positively correlated with their Measurements.

4.3 TABULATION WITH INTERPRETATION

Paired Sample t – test: 1

Ho: There is no significance difference between the Pre and Post test values for Star Excursion Balance Test.

H1: There is a significance difference between the Pre and Post test values for Star Excursion Balance Test.

The level of Significance is 5%.

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre test values for Star Excursion Balance Test - Post test values for Star Excursion Balance Test	-2.87700	4.32659	.78992	-4.49258	-1.26142	-3.642	29	.001

Inference:

From the above table clearly shows that the value p is less than 0.05. So, we reject the null hypothesis. It may be conclude that there is a significance difference between the Pre and Post test values for Star Excursion Balance Test.

Paired Sample t – test: 2

Ho: There is no significance difference between the Pre and Post test values for Foot and Ankle Disability Index.

H1: There is a significance difference between the Pre and Post test values for Foot and Ankle Disability Index.

The level of Significance is 5%.

Paired Samples Test								
	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 2	Pre test values for Foot and Ankle Disability Index - Post test values for Foot and Ankle Disability Index	5.36667	2.28161	.41656	4.51470	6.21863	12.883	29	.000

Inference:

From the above table clearly shows that the value p is less than 0.05. So, we reject the null hypothesis. It may be conclude that there is a significance difference between the Pre and Post test values for Foot and Ankle Disability Index.

4.4 GRAPHICAL REPRESENTATION

Table- 1

Measurements	Mean	Std. Deviation
Pre test values for Star Excursion Balance Test	48.3843	7.79404
Post test values for Star Excursion Balance Test	51.2613	7.24416

Chart -1

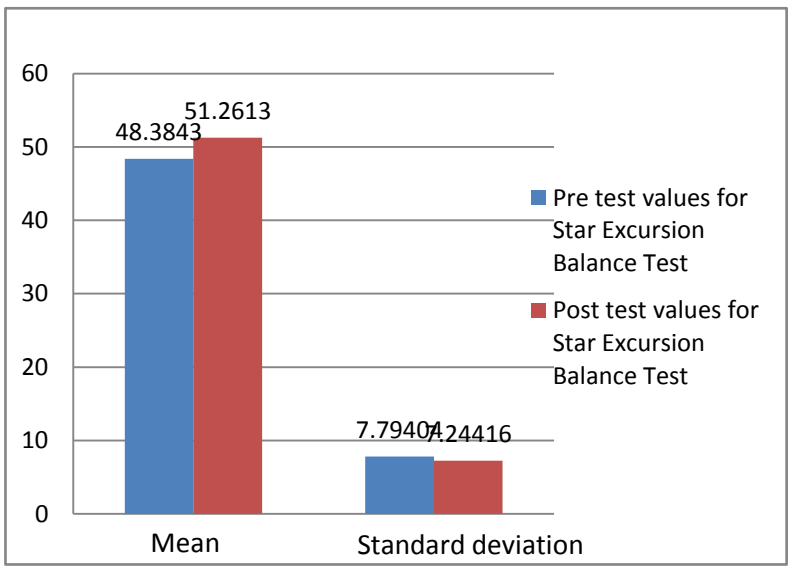


Table -2

Measurements	Mean	Std. Deviation
Pre test values for Foot and Ankle Disability Index	60.9	8.36392
Post test values for Foot and Ankle Disability Index	55.5333	8.11866

Chart – 2

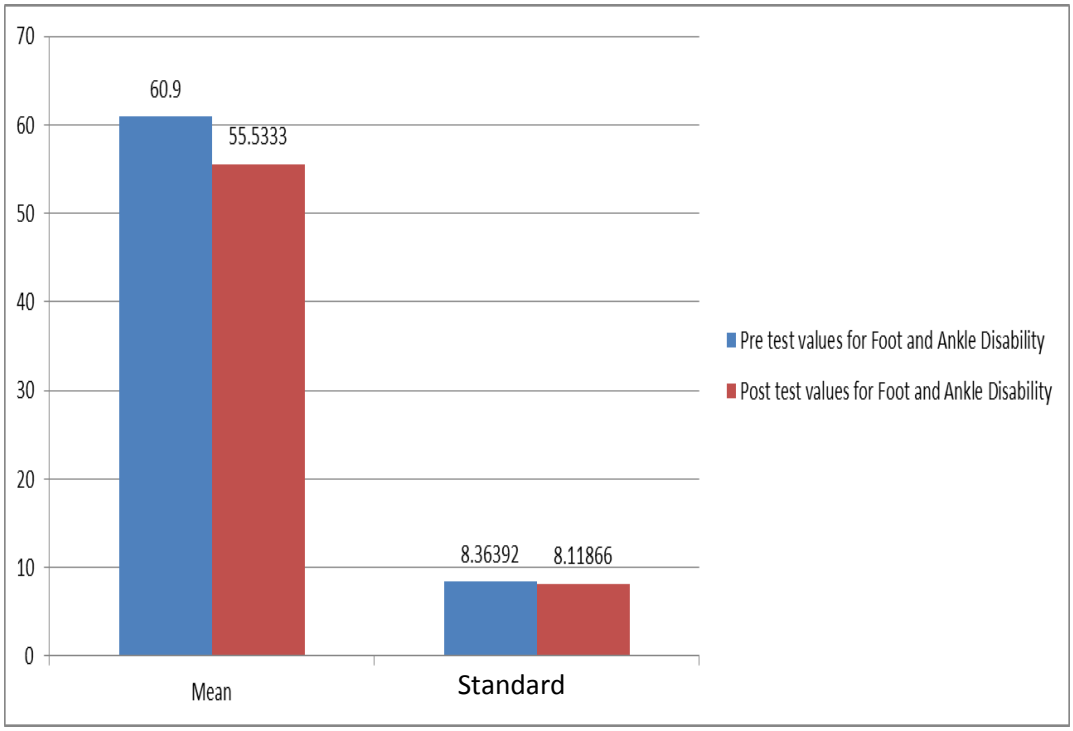


Table 3

Measurement	Mean
Pre test value for Star Excursion Balance Test	48.3843
Post test value for Star Excursion Balance Test	51.2613

Chart 3

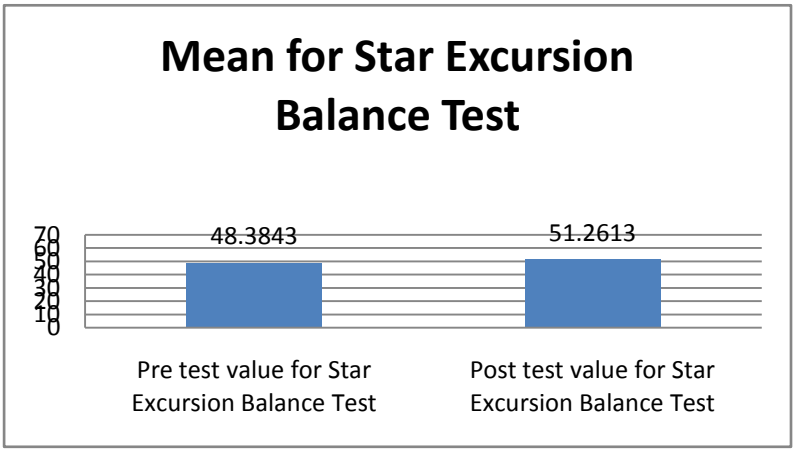
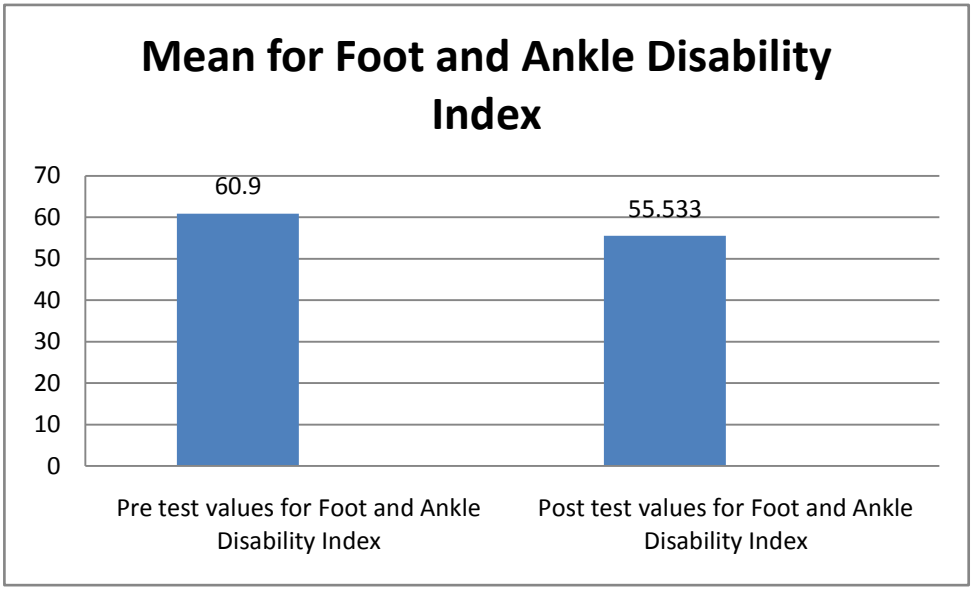


Table 4

Measurement	Mean
Pre test value for Foot and Ankle Disability Index	60.9
Post test value for Foot and Ankle Disability Index	55.533

Chart 4



4.5 RESULT

In this study there is a significant increase in the values of the Star Excursion Balance Test from a mean value of 48.38cm to a mean value of 51.26 cm.The Foot and Ankle disability values have found to be decreased from a mean value of 60.6 to a mean value of 55.53.

From the above table it shows that the value p is less than 0.05, so the null hypothesis is rejected. It may be decided that there is a significant difference exists in the pre and post measurements values and also infer that the intervention is effective in improving the balance and activities of daily living in chronic instability individuals.

DISCUSSION

The goal of this study is to determine the effects of a 4-week elastic resistance exercise program on balance and the improvement of activities of daily living in individuals with a history of ankle sprains. In the study of Mattacola et al[20] used elastic resistance exercises in rehabilitation because they enable the clinician to utilize a safe and effective weight-bearing progressive overload to rehabilitate the isnjured patient.

When using elastic resistance to rehabilitate an injured joint, the clinician can easily adjust the resistance in small increments to match the patient's progress by increasing or decreasing the stretch of the elastic tubing. Elastic resistance exercises have been primarily used by Docherty for shoulder, knee, and ankle joints rehabilitation.

Most ankle rehabilitation programs utilize a combination of strengthening exercises in conjunction with coordination exercises. The perturbation imposed by the elastic resistance exercise would elicit improvements in balance. The elastic resistance exercise program was equally effective in improving balance in subjects with and without a history of ankle sprains. The elastic resistance exercises utilized in this training program impose a postural control challenge that ankle, knee, and hip joints of the support limb must effectively resist to maintain balance. Balance is the ability to maintain upright posture while keeping the center of gravity within the base of support. To maintain balance in response to the balance disrupting force imposed by elastic tubing, the weight bearing ankle must actively resist in the opposite direction against the imposed perturbation.

Mechanoreceptors provide information to the three movement systems, which aid in the regulation of balance. The myotatic stretch reflex is the first mechanism to react at approximately 40 msec. An externally imposed rotation or increased load to the joint triggers muscle spindles to increase activity in the muscle and improve muscle stiffness properties. Muscle stiffness is described as the muscle's resistance to stretch and is dependent upon the level of activation of the muscle. Therefore, other movement systems which rely on alternate input are required to maintain balance.

The second system, which is the first effective response to control balance, comes from the automatic systems. They too are triggered by external perturbations. The response is somewhat slower than the myotatic stretch reflexes at 90-100 msec. Somatosensory input results in automatic responses which are governed by the degree of intensity of the stimulus in combination with the individual's past experiences.The third system involved in balance control is the voluntary system. It is the slowest responding system at approximately 150 msec. Voluntary

and automatic responses are often used in conjunction with each other, with automatic responses occurring first followed by voluntary purposeful behaviors.

Because the human body is not statically stable even during quiet double-limb stance, the central nervous system must constantly make adjustments to keep the center of mass over the base of support. Loram and Lakie[21] in their study recently suggested that the central nervous system utilizes a "throw-and catch" pattern to generate joint torques on opposite sides of the joint to maintain equilibrium while standing. In this study, subjects were required to maintain balance while resisting against the balance disturbing force caused by the tension in the elastic tubing. It is possible that the perturbation caused by the elastic tubing imposes an accentuated neural training effect similar to the throw-and-catch pattern proposed by Loram and Lakie.

Future research on the putative training mechanism caused by elastic resistance exercise would require analyzing both joint kinetics and muscle activation during the elastic resistance exercise. The balance perturbation provided by the elastic tubing exercises caused the weight-bearing ankle to resist forces causing inversion, eversion, dorsiflexion, and plantar flexion about the ankle joint. Clinical evidence has shown that balance training is effective in reducing the recurrence of ankle sprains. The underlying neural mechanisms of clinical observations of improving balance was being described in the study of Hertel.[24] He suggested that balance or postural control training might impose a neural stimulus that causes the central nervous system to "retune" input and output processing of somatosensory information necessary to control balance.

Freeman et al may have been the first to demonstrate that balance training using a tilting balance platform improves balance in individuals with functionally unstable ankles.

Eils[26] reported a significant reduction in TTD of CoP following a 6-week multistation proprioceptive exercise program in patients with ankle instability. The exercise program utilized by Eils and Rosembaum included elastic Thera-Bands in conjunction with uneven walkways, inversion boards, and a variety of additional proprioceptive rehabilitation exercises.

There are very few ankle rehabilitation training studies that have used exclusively elastic resistance exercises. In a study by Docherty et alsubjects with functionally unstable ankles showed an increase in dorsiflexion and inversion strength and an improvement in inversion and plantar flexion joint position sense following training.

In the study by Gaufin et al subjects trained for 8 weeks on an ankle disc. They report an improved pattern of balance control. This was evident in the injured limb as well as in the

uninjured, untrained limb. Gaufin et al proposed that this improvement implicated central motor control rather than peripheral proprioceptive control. If this theory holds true, it would be expected that the balance and coordination training in our study would improve measures of balance but would have no effect on the peripheral afferent receptors of the ankle and, thus, no effect on joint position sense.

The research study of Brandi L. Ross, on the topic of Proprioceptive exercises balance ankle stability and activity, concluded the study as Chronic ankle instability, sometimes is associated with multiple ankle sprains, can lead to difficulty with walking, running, jumping, and cutting and reduction in the overall functional activities. Although functional instability can lead to impaired performance, the literature shows that proprioceptive exercise may help with overall balance.

CONCLUSION

This study shows that balance training program using Thera tube can improve the balance and activities of daily living in individuals with ankle instability and this increase may be mediated in performing their functional activities. Balance was improved in individuals with a history of multiple ankle sprains using a 4-week elastic tubing exercise program, in which resistance movements were performed. Elastic resistance rehabilitation exercises do cause a reduction of functional instability and reduction in reoccurrence of ankle sprains

LIMITATIONS AND SUGGESTIONS

LIMITATIONS

- The study duration is very short.
- The population of the study is small
- The subjects taken were between age group 20-35 years
- The long lasting effect of balance is not permanent(once the balance training is discontinued the effects are deteriorating)

SUGGESTIONS

- The study can be done for a longer duration
- A larger population can be studied

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