EFFECTIVENESS OF PROPRIOCEPTIVE TRAINING ON ANKLE INSABILITY IN NORMAL HEALTHY INDIVIDUAL: AN EXPERIMENTAL STUDY

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1. INTRODUCTION

Ankle Anatomy

The ankle and foot complex is made up of total thirty three joints mutually with the long bones of the lower limb, although there are twenty-six individual bones of the foot. Although commonly referred to as the "ankle joint", here number of articulations which allow the motion of the foot [1].

Articulation of the talus, tibia and fibula formed the ankle joint which is a hinged synovial joint. Ankle joint is complex variety of synovial joint which made up of the three talocalcaneal (sabtalar), tibiotalar (talocrural) and transverse-tarsal (talocalcaneonavicular) joint [1].

The main movements of the ankle joint complex are plantarflexion and dorsiflexion that occurs in the sagittal plane, abduction and adduction that occurs in the frontal plane [2].

The talocrural joint is a situated between the talus, the medial malleolus of the tibia, and the lateral malleolus of the fibula, which is uniaxial type of synovial joint too identified as modified hinge variety of synovial joint. While performing dorsiflexion movement the talocrural joint provide more stability and in plantar flexion it provides more mobility. This Ankle joint is accountable for the anterior-posterior (dorsiflexion-plantarflexion) movement that occurs in ankle foot complex. [3, 4]

The deltoid and/or medial collateral ligament is one of the major ligaments which situated on the medial surface of the ankle joint. It made up from four separate ligaments; the tibionavicular, tibiocalcanean, and posterior tibiotalar ligaments which defend against talar abduction, and deep anterior tibiotalar ligament, which resists lateral translation and lateral rotation of the talus [2].

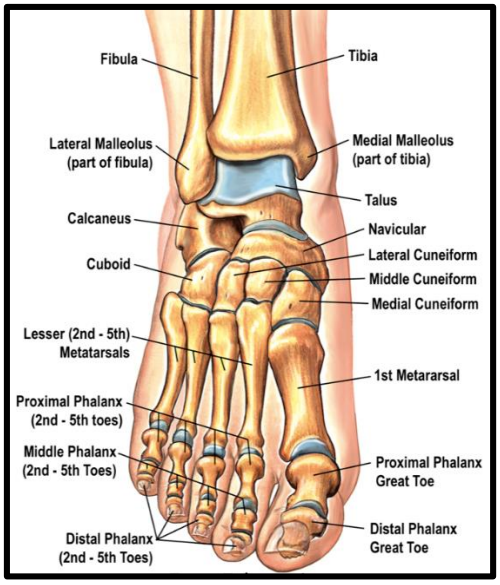


Figure 1.1 Ankle Anatomy

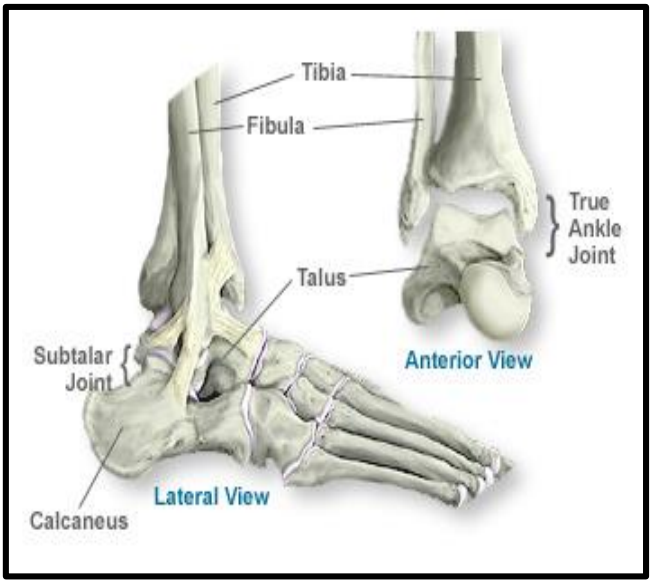


Figure 1.2 Ankle Articulations

Ankle Biomechanics

A) Motion of the foot and ankle

The ankle foot complex performs movement in all three plane- in the sagittal plane plantar flexion and dorsiflexion; in transverse plane abduction and adduction and in frontal plane inversion and eversion. The subtalar and tibiotalar joint allow three dimensional motions which are combinations of these motions called as supination and pronation [5].

B) Axis of rotation of the ankle

Many studies show that tibiotalar joint to be a simple variety of hinge joint, also there has been some proposal that it is multi-axial joint because the internal rotation that occurs during dorsiflexion, and the external rotation that occurs during plantarflexion [6,9].

In sagittal plane the axis of rotation occurs around the line passing through the medial and lateral malleoli the ankle joint complex. [9, 10]

The coronal plane axis of rotation performs around the intersecting point between the medial and lateral malleolus and the tibial long axis in the frontal plane. The long axis of the tibia intersects the midline of foot which allows the transverse plane axis of rotation. [10, 11]

C) Forces in the ankle foot complex

The ankle foot complex bears a force of around five times body weight during stance phase of normal gait cycle, and up to thirteen times of body weight during activities such while running, jumping, etc. From gait analysis the ankle moment exhibits a dorsiflexion moment at heel strike as the eccentric concentration of dorsiflexor to control the rotation of the foot on to the ground and that avoid the foot from slapping the ground. [1]

During gait most important muscles acting on the ankle joint which are either absorbing or generating powers for ankle joint complex. The negative values correspond with power absorption from the eccentric contraction of plantar flexors during the heel and ankle rocker phases. Some experimental studies show that tibiotalar joint transmitted approximately 83% of load, and fibula transmitted remaining 17% of load. [12]

Ankle Instability

Ankle sprains are a generally common and potentially disabling injury for normal individuals. Disability from ankle sprains in athletes also can be severe; with 40% of patients have dysfunction that perseveres for as long as six months after the injury. This dysfunction mainly includes a diminution in proprioception after acute ankle sprains. This loss in proprioception due to ligament injury is a potential risk factor for re-injury. [13]

There are three main factors responsible to cause functional instability of the ankle joint which is anatomical or mechanical instability, muscle weakness and deficits in joint proprioception. Deficit of joint proprioception leads to the combination of mechanical instability and decrease neuromuscular control may result in functional instability of the ankle joint. [14]

Prevalence

The prevalence of functional ankle instability was established to be 18.4% in Males (29%) which are more affected than females (14%). The prevalence of functional ankle instability was seen most commonly in the age group of 21-25 years healthy individuals. [15]

Overall, ankle sprains and other mechanical injury are slightly more expected to occur in males (50.3%) than in females (49.7%) and nine times more likely to occur in younger than in older individuals.[16]

Only 5% of all ankle sprains engage the medial aspect of the ankle joint injury result from eversion as the strong medial deltoid ligament is resistant to tearing[17].It also concluded that 20% to 40% of ankle sprain leads to functional ankle instability. [18]

Proprioception

Proprioceptive information is mainly generated by ligamentous mechanoreceptors, Golgi tendon organs, and muscle spindles, which are transducer for the mechanical distortion of the neighboring connective tissue. [19] Ankle injury rehabilitation and prevention have mainly focused on muscular strengthening while neglecting the most common cause of functional instabilities, proprioceptive deficits of surrounding tissues. [20]

Proprioception is also known as the consciousness of posture, movement, and deviations in equilibrium as well as the information of position, weight, and resistance to objects in relation with body. Proprioceptive rehabilitation program includes balance exercise devices, such as unstable balance platforms, in order to address proprioceptive deficits and reestablish functional stability of the ankle joint. [20]

In 1965, Freeman gives the relationship between ankle injury, proprioceptive, and balance deficits. Since this time altered joint proprioception has been proposed as main predisposing factor to ankle injury when deficits exist. The worsening of proprioceptive sensibility leads to difficulties in postural control and makes instability in the ankle joint. [15]

In the healthy individual, a sensible sense of passive joint motion is in part attributed to the type II mechanoreceptors implanted in the capsular, ligamentous, and adipose structures of ankle joint complex. [19]

Proprioceptive Training

Proprioceptive training for the ankle joint consists of standing on a single leg with the eyes closed, balancing on a wobble board or ankle disk, and balancing on a single leg while implementation a task such as catching and throwing a ball. These all kind of exercises can increase the sensorimotor system's ability to adapt to a changing environment and after protect the body from injury. [22]

The prophylactic proprioceptive training programs include the systematic review lacked standardization. Durations ranged from 10 to 30 minutes, frequencies ranged from 2 to 5 days per week, and lengths extended from 3 to 4 weeks. In addition, the preventive exercises ranged from balancing on a stable surface with the eyes closed to balancing on a tool such as a balance board and could be counted in as a warm-up, rehabilitative session, or home-based exercise program. [23]

Y - Balance Test

The Y-balance test (YBT) has built from previous research suggesting redundancy in the 8 directions of the (Star Excursion Balance Test) SEBT to develop a more time-efficient test which estimates dynamic limits of stability and asymmetrical balance in three directions (anterior, posteromedial, and posterolateral).[26]

Initial evidence on the YBT for injury prediction is also encouraging. Specifically, Pliskyet identified that healthy individuals with anterior left or right asymmetries more than 4 cm on the YBT were 2 to 2.5 times more likely to sustain a lower extremity injury. [27]

YBT regulate the proportion of service members with an YBT anterior reach limb asymmetry (>4cm difference) based on its association with increased injury risk of ankle joint. [28]

Each participant viewed an YBT instructional video and then executed 6 practice trials to minimize the error of a learning effect. After the instructional video, participants stood on the midpoint of footplate or stool. [29]

While continuing single leg stance on the left leg, the subject touched with the free limb (right leg) in the anterior, posteromedial, and posterolateral directions in relation to the stance foot by reaching as far as possible. Participant may also complete 3 consecutive trials for each reach direction and to reduce fatigue level participant altered limbs between each direction. [30]

The YBT is a functional evaluation test which requires strength, flexibility, neuromuscular control, stability, range of movement, balance, and proprioception. This test is use for functional testing because of its speed, efficiency, portability, consistency, and objectivity. [31]

It can be performed on different surfaces. In less than three minutes per subject one can perform a standardized protocol with high inter and intra-evaluate or reliability (95% CI: 0.88 –0.99 p<.01) [32].

Single Leg Stance Balance Test

The single leg stance balance test was well-defined as standing on single foot without wearing shoes with contralateral side knee bent and not touching to the weight bearing leg; both the hips were level to the ground; the eyes were open and fixed on a spot marked on the front wall and then the eyes were closed for next 10 seconds. [33]

The timed unipedal stance test (also mentioned to as single leg stance balance test) is a simplest test for measurement of static aspects of balance which can be used in a variety of settings and requires minimal amount of equipment or training. Decreased eyes open UPST time is also associated with an increased risk for falls.[34]

The UPST is defined as a technique of quantifying static balance ability. It is a valid measurement and is beneficial in explaining other variables of importance such as frailty and self-sufficiency in activities of daily living, gait performance and fall status. [35]

Eligible participant is asked to stand with barefooted on the limb of their choice, with the other limb elevated so that the elevated foot was near but not touching the ankle of their stance limb. Then a participant was requested to focus on a spot on the wall at eye level in front of him, for the duration of the eyes open test. Prior to raising the limb, the participant was educated to cross his arms over the

chest. The investigator took help of watch to measure the amount of time the participant was able to stand on one limb. Time started when the participant rose the foot off the floor. [34]

Time ended when the participant either: (1) used his/her arms (i.e., uncrossed arms), (2) used the elevated foot (moved it toward or away from the standing extremity or touched the floor), (3) moved the weight-bearing foot to sustain his balance (i.e., rotated foot on the ground), (4) a maximum of 45-50 seconds had passed, or (5) opened eyes on eyes closed trials. The technique was repeated 3 times and each time was recorded on the data collection sheet. The average of the 3 trials was also recorded. Participants achieved 3 trials with the eyes open, and after that 3 trials with the eyes closed, alternating between the conditions. [34]

NEED OF THE STUDY:

Ankle instability has always been one of the main stay for ankle injuries. Some amount of ankle injuries is always present among normal healthy injuries which usually cause ankle sprains and ankle injuries in otherwise normal healthy individuals. No study has proved the immediate effect of proprioceptive training on ankle injuries. Hence this study proves the immediate effect of proprioceptive on normal healthy individuals.

AIMS:

To prove the effectiveness of proprioceptive on ankle injuries in normal healthy individuals this can prevent future ankle injury in normal healthy individual and improve quality of life.

OBJECTIVES:

1] To check the effects of the proprioceptive training on posteromedial ankle injuries using Y balance test.

2] To check the effects of the proprioceptive training on posteromedial using single leg stance time with eyes closed.

RESEARCH HYPOTHESIS

H0: proprioceptive training is effective in improving ankle injuries among normal healthy individuals using YBT

H1: proprioceptive training is effective in improving ankle injuries among normal healthy individuals using single leg stance time with eyes closed.

H2: proprioceptive training is not effective in improving ankle injuries among normal healthy individuals using YBT.

H3: proprioceptive training is not effective in improving ankle injuries among normal healthy individuals using single leg stance time in eyes closed.

2. REVIEW OF LITERATURE

1. **Andreia S. P. Sousa et al (2017) studied on "Bilateral Proprioceptive Evaluation in Individuals with Unilateral Chronic Ankle Instability"** and concluded that Individuals with unilateral FAI had increased error ipsilaterally (injured limb) for inversion movement detection (kinaesthesia) and evertors force sense and increased error contra laterally (uninjured limb) for evertors force sense.
2. **Susan L. Rozzi et al (1999) studied on "Balance Training for Persons with Functionally Unstable Ankles"** and concluded that balance training protocol used in this study is an effective means of improving both unstable and healthy ankle joint proprioception, as assessed through single-leg standing ability.
3. **LTC Scott W. Shaffer et al (2013) studied on "Y-balance test: A Reliability study involving multiple Raters"** and concluded that among multiple raters with limited health care experience, the YBT showed good inter rater test-retest reliability and minimal levels of measurement error. The YBT has good inter rater test-retest reliability for both the maximal and average of 3 reaches. The measurement error was minimized and inters rater test-retest reliability improved when the mean of 3 reach trials was used.
4. **T H Trojian and D B McKeag studied that "single leg balance test to identify risk of ankle sprains"** and concluded that an association was recognized between a positive SLB test and ankle sprain. In athletes with a positive SLB test, not taping the ankle imposed a distended risk of sprain. The SLB test is a reliable and valid test for expecting ankle sprains.
5. **Cassandra Thompson (2018) et al studied on "Factors contributing to chronic ankle instability: A systemic review and meta-Analysis of systemic Review"** concluded that treatment of non-specific ankle instability, therapist should attention on dynamic balance, reaction time and strength discrepancies.
6. **Dr. G.K. Scindia et al studied that "Prevalence of functional ankle Instability among University Athletes"** concluded that functional ankle instability is one of the common causes of morbidity in the athletic population with consideration socio economic impact since it creates long term problems with high rates of recurrence. The evaluation of FAI is necessary in the athletes because many times correction of efficient ankle instability is ignored.

3. METHODOLOGY

A. Source of Data:

- Parul Institute of Physiotherapy, Parul University, Limda, Ta- Waghodiya, Dist. Vadodara.

B. Inclusion Criteria:

- Both male and female
- Subject between 18 to 30 years of age

- Participants who can understand English, Hindi or Gujarati
- Participants who can undergo proprioception training

C. Exclusion Criteria:

- Injury to spine and lower limb (Hip/ knee/ ankle) in last 6 months
- Any neuromuscular, cardio-pulmonary and vascular condition
- Participants with severe Visual deficit

D. Method of Collection of Data:

I) Study type: - Experimental Study

II) Sampling method: - Simple random sampling

III) Sample size: - Minimum 90 Participants

IV) Study duration: - 1 month.

E. Outcome Measures:

- Y Balance Test with Anterior
- Single leg stance time with eyes close

Data Collection Procedure, Interventions and Its Method

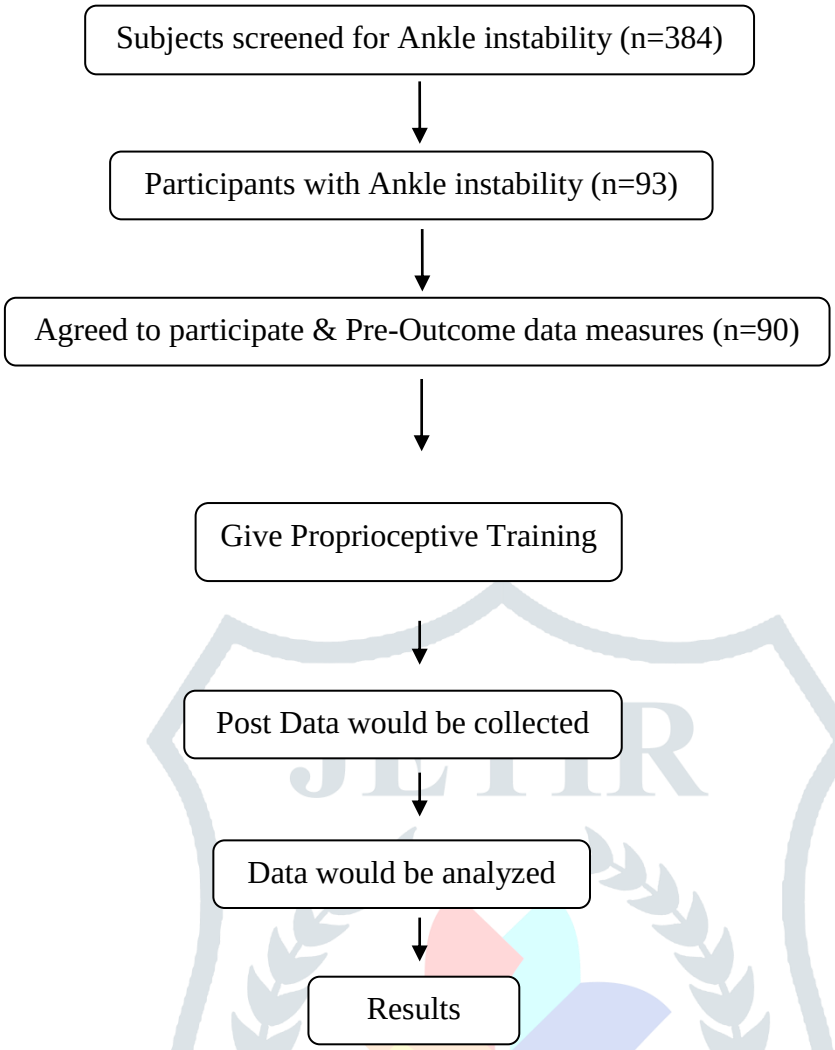
Material Used:

Measure tape,

Chalk,

Marker pen,

Stopwatch,



Procedure:

- Total 384 participants falling into Inclusive criteria were screened for ankle instability on Y Balance Test (YBT) and single leg stance balance test (SLSB) with age between 19 to 22 years.
- In which 93 participants diagnosed with ankle instability were employed for the study.
- An Inform and written consent about enrolment in the study and maintaining adequate privacy and confidentiality was taken from all the participants included in the study.
- All participants were subjected to a standardized interview including details regarding the event.
- A clinical history and a complete physical and functional physiotherapy examination were done in each participant.
- If the participant agrees to participate in the study, he/she was asked to sign the informed consent. Before starting the treatment, pre-test was done by use of Y-Balance test and SLSB test.
- 3 participants from were discontinued study due to they were not agreed for the intervention and drop out from the study.
- At the completion of intervention, outcome measures were re-evaluated at the end of session, then pre- and post-scores were compared.

- Scores were assessed by appropriate statistical methods.

Post intervention participants would be reassessed for the outcome measures and the data would be recorded.

For YBT, each participant was made to stand on the center point on stool, with the distal aspect of the right foot at the starting line. While continuing single leg stance on the right leg, the subject was touched with the free limb (left leg) in the anterior directions in relation to the stance foot by placing as much as possible. Then repeat it for opposite side in same manner. If the subject had an anterior reach asymmetry of larger than 4 cm suggesting ankle instability and potentially enlarged risk for injury around ankle joint.

The SLB test was as standing on one foot without shoes with the contralateral knee bent and not moving the weight bearing leg; the hips were at the level of the ground; prior to raising the limb, the participant was instructed to cross his arms over the chest; then the eyes are closed for 10 seconds. Any sense of imbalance was recorded and the investigator was noted if the subject's legs touched each other, the feet moved on the floor, the foot touches down, or the arms moved from their start position. If the participants had a positive test (failed to remain balanced or described a sense of imbalance) during the first trial, a second trial would be carried out, with the results of the second trial counting (positive or negative) for analysis. Both legs would be tested. An SLB test would be considered positive if the subject was unable to carry out the test effectively on either or both legs.

4. RESULT

In the present study, 93 subjects with ankle instability among healthy individual, age group between 18 to 22 years were taken. Total 90 participants completed the study program without any complications.

Microsoft Excel 2010 as used for the data analysis. For Pre and Post intervention comparison of within group, paired t-test as used. P value for analyzed data was 0.95. Before using this test, all data checked for normality analysis and all data followed normality assumption.

Table no. 1 Age Group Distribution

Age Group	No. of Subjects
18-19	3
20-21	46
21-22	19
22-23	22
Total	90

Graph 1 Age Group Distribution

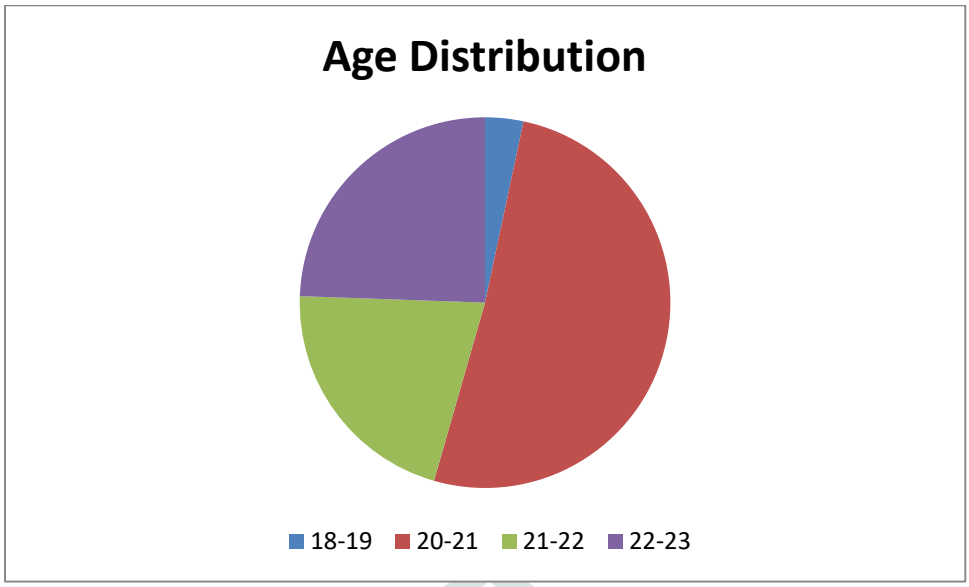


Table no. 2 Pre-Post comparison of Y-Balance Test

ANTERIOR (YBT)	PRE	POST	t - value	p - value	RESULTS
RIGHT	37.16 ± 11.85	43.11 ± 12.16	5.01	0.95	HS
LEFT	37.43 ± 12.02	46.14 ± 12.01	5.97	0.95	HS

Graph 2 Pre-Post comparison of Y-Balance Test

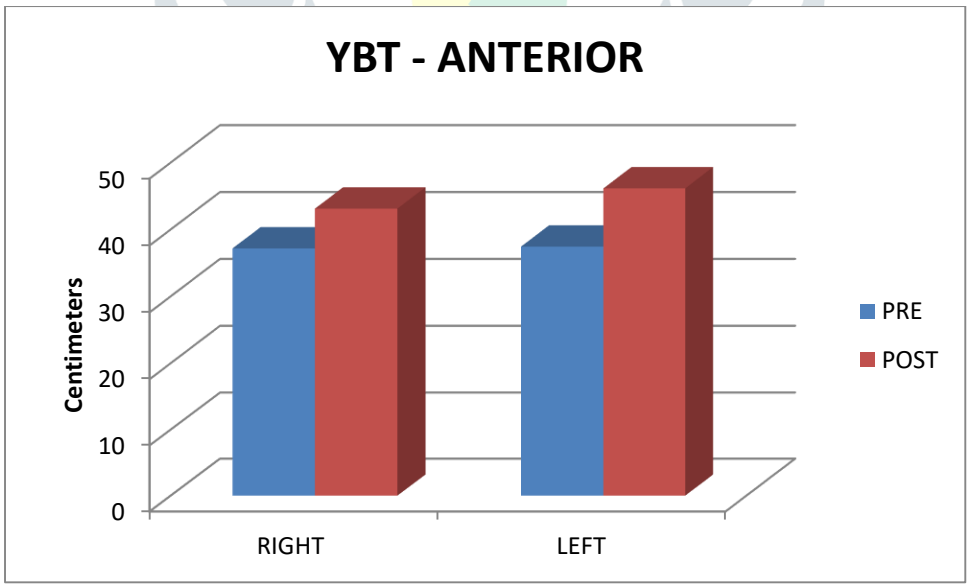
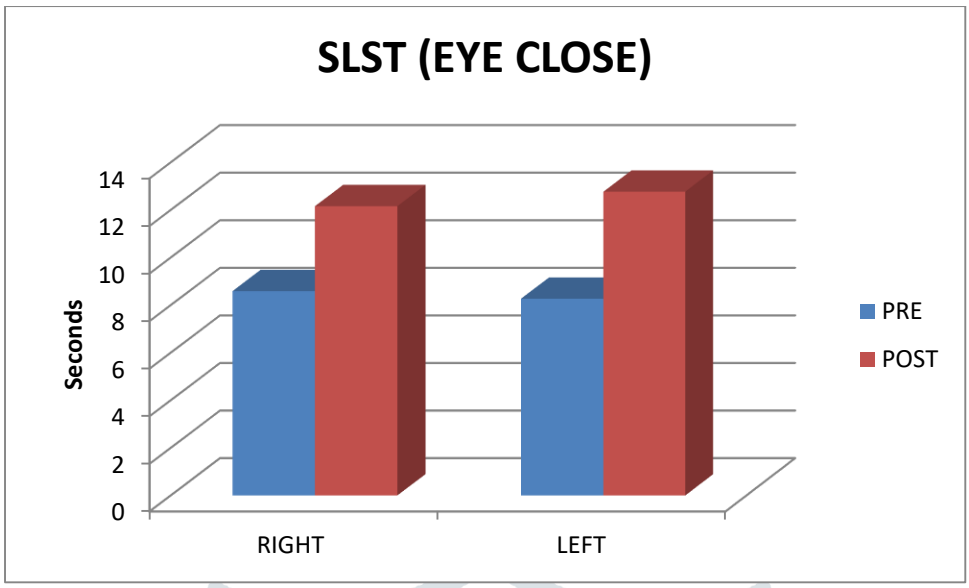


Table no. 3 Pre-Post comparison of Close Eye SLST test

SLST (EYE CLOSE)	PRE	POST	t - value	p - value	RESULTS
RIGHT	8.59 ± 5.39	12.16 ± 5.77	6.74	0.95	HS
LEFT	8.27 ± 4.28	12.77 ± 5.67	5.14	0.95	HS

Graph 3 Pre-Post comparison of Close Eye SLST test



5. DISCUSSION

The term proprioception is characterized by balance and stability of the joint by activating the mechanoceptors within the joint. This study focus on improving instability which is otherwise present in normal healthy individuals by improving the proprioception in the ankle.

Proprioception training has been in use and in practice since a very long time and has been proven effective in improving stability on long term basis but no study has proved the effectiveness of proprioception training on ankle instability in normal healthy individuals on immediate basis. The novelty of this study is to focus on helping normal healthy individuals to improve their ankle instability using proprioceptive training.

This study focuses on creating awareness among young healthy individuals on the basis of ankle instability and effect of proprioceptive training. This study helps the individual or the subjects to have immediate effect of proprioceptive training on ankle instability which continued for a prolong period of time can prevent injuries around the ankle.

The assessment of ankle injuries for this study was done using Y balance test and single leg stance time. Both these outcome measure are highly reliable and sensitive.

This study proves the significance of proprioceptive training on ankle injuries and thereby improving function of the ankle.

Previous studies found that ankle injuries is a common complain in subjects and proprioceptive training has been proved effective in such cases. Studies have also proven that ankle injuries is present in normal healthy individuals as well but no study has been done to prove the immediate effect of proprioceptive training on ankle injuries in normal healthy individuals.

Therefore this study concludes that ankle injuries present in normal healthy individuals must be treated in order to prevent injuries around the ankle joint using proprioceptive training.

6. CONCLUSION

The present study was aimed to check the effect of proprioceptive training with use of Y – Balance test and Single leg stance time test who have ankle instability in normal healthy individuals. Based on the analysis and result it can be concluded that, proprioceptive training are effective in increase stability of ankle joint by improving ankle proprioception among healthy individual who have ankle instability.

So here, we reject the null hypothesis and accept alternative hypothesis that, there is highly significant effect of proprioceptive training in Anterior Y-Balance test and SLSB test with eyes closed on normal healthy individual who have ankle instability.

7. Limitation of the Study

- All the subjects did not continue proprioception training after study interventions
- After completion of post intervention outcome measurement follow up was not taken.

8. Future Recommendation

- Study can be done with large sample size.
- Long term protocol should be form and intervention duration should be increase.
- Subjects divided into two groups to check the accurate effect of proprioceptive training on normal healthy individual.

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