EFFECT OF INCLINED BOARD PLYOMETRIC TRAINING ON JUMP PERFORMANCE IN YOUNG ELITE ATHLETES

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ABSTRACT: Context*: Plyometric exercises such as jumping, hopping, skipping, and bounding are executed with the goal of increasing dynamic muscular performance. Plyometric training is popular among individuals involved in dynamic sports, Much less information is available on the inclined plyometric training , where jumping high is important for success*
Aims*: To compare the Effect of inclined plyometric training and plane surface plyometric training.*
Setting: *The study has been carried over in SIMATS,Chennai*
Study Design: *Randomized Control Trial*
Methodology*: All the subjects were randomly selected and assisgned into group A and B. After signing of consent form they were evaluated and then were given 4 weeks inclined board plyometric training protocol in Group A (experimental) and Group B received Conventional exercises and later were reassessed.*
Materials: *Stop watch, Measuring tape, Goniometer, Inclined board, Chalk powder.*
Statistical analysis used*: Analysis was done using paired "t" test and unpaired "t" test. Intergroup significance was calculated by using unpaired "t" test and intra group significance was calculated by paired "t" test.*
Results*: 40 subjects completed the study. Comparison of pre and post Of SJT, SLHTT, THT in Group A was found to be statistically significant and that of Group B SJT, SLHTT, THT was found to be statistically significant. Comparison of VJT was found statistically insignificant between group – A & group – B (p>0.05).*
Conclusion*: This Study concludes that inclined board plyometric training has an effect on the jump performance of the athletes and a significant improvement was seen on Static jump test, Single leg hop time test and Triple hop test.*

Key Words: *Inclined board plyometrics, Optimum length tension relationship, Jump performance*

INTRODUCTION

POWER is the king of the sporting world. Plyometrics are a type of exercise designed to produce fast and powerful movements. They are generally used by athletes to improve performance in sports, especially those that involve speed, quickness and power.[1]

Two forms of plyometrics have been evolved. The first version of plyometrics was created by Yuri Verkhoshansky where he defined it as shock method. In this the athlete would drop down from a height and experience a "shock" on landing. This in turn would bring about a forced, involuntary eccentric contraction which would then immediately get switched to concentric contraction as the athlete jumped upward. The landing and takeoff time would be executed in an extremely short period of time, the range of 0.1 - 0.2 seconds.[2]

The second version of plyometrics, seen to a very great extent in the United States, relates to doing any and all forms of jumps regardless of execution time. Such jumps cannot be considered truly plyometric since the intensity of execution is much less and the time required for transitioning from the eccentric to the concentric contraction is much greater. Speed and strength are integral components of fitness found in varying degrees in all athletic movements. Simple combination of speed and strength is power.[2]

The ankle joint proposes of 15 to 25 degrees of dorsiflexion and 30 to 50 degrees of plantar flexion. In such a case when the movement is done on an inclined surface, the plantar and the dorsiflexion both are altered. This improves the range of motion of the ankle joint and helps in the jump performance of the athlete.

All plyometric movements involve **three** phases. The first phase is the pre-stretch or eccentric muscle action. Here, elastic energy is generated and stored. The second phase is the time between the end of the pre-stretch and the start of the concentric muscle action. This brief transition period from stretching to contracting is known as the **amortization** phase. The shorter this phase is, the more powerful the subsequent muscle contraction will be. The third and final phase is the actual muscle contraction. In

practice, this is the movement the athletes desires the powerful jump or throw. This sequence of three phases is called the **stretch-shortening cycle**. In fact, plyometrics could also be called stretch-shortening cycle exercises.[3]

Simple way to demonstrate the effect of the stretch-shortening cycle is to perform two vertical jumps. During the first vertical jump the athlete bends the knees and hips (eccentric muscle action or pre-stretch) and holds the semi-squat position for 3-5 seconds before jumping up vertically (concentric contraction) as high as possible. The 3-5 second delay increases the amortization phase. On the second jump the athlete bends the knees and hips to the same degree but immediately jumps up without a delay. This keeps the amortization phase to a minimum and makes best use of the stored elastic energy. The second jump will be higher.[3-4]

Modifications in the joint range of motion when performing a vertical jump could alter the range of muscle or tendon length during the movement. The behavior of the medial gastronemius (MGAS) fascicles has been described as a "catapult action'' Particularly, the medial gastronemius fascicle length decreases at the instant of initial contact, it remains relatively constant during the braking phase followed by a decline during propulsion Simultaneously, the ankle is initially in semi neutral position and then it is plantar flexed. However, it is known that isometric medial gastronemius force production is affected by muscle length and, in turn, by the angle of the ankle joint. Thus, the position of the ankle joint is of great importance for force production.[4]

The need for the generation of higher joint power output during performance of dynamic activities leads to force – length relationship of the plantar flexors during consecutive stretch shortening cycles of hopping.[5]

During jumping, medial gastronemius produces a large amount of force at a slow velocity because its length remains close to optimum range. However, the amount of force produced by the medial gastronemius could be much greater if jumping technique can be modified such that the muscle works at a length range near to its maximal force potential.[5]

METHOD

Participants

A total of 25 subjects who fulfill Criteria, were participated in this study. Subjects were recruited from SIMATS,Chennai . All subjects met the following inclusion criteria: 1) Athletes with the age group of 15yrs and above. 2) Athletes who have completed at least 1 full year of competitive athletics. 3) Subjects with good flexibility and strength of lower limbs. 4) Subjects who have been involved in any professional active outdoor sporting activities involving running, jumping and speed movements. Subjects were excluded with following exclusion criteria: 1) Lower limb and Spine fractures and deformities. 2) Tightness and contractures of muscles n tendons of lower limbs. 3) Any intrinsic complains by the athlete that limits the athletic performance. All subjects were required to sign and written informed consent document approved by the ethical committee at College of Physiotherapy, SIMATS,chennai.

Study Design

Forty subjects were randomly allocated to two groups by the investigator who was involved in data collection, treatment implication, and data analysis. 46 subjects were targeted, out of which 40 were included for the study purpose. Subjects in group A received inclined board plyometric training exercises. While, subject in group B did their conventional training on plane surface. Both the groups received this protocol for a period of one month, with a frequency of 4 times in a week. Baseline assessments were done after randomization, at the start of the protocol and at the end of 4 weeks. For each subject, all assessment sessions were performed at the same time of day

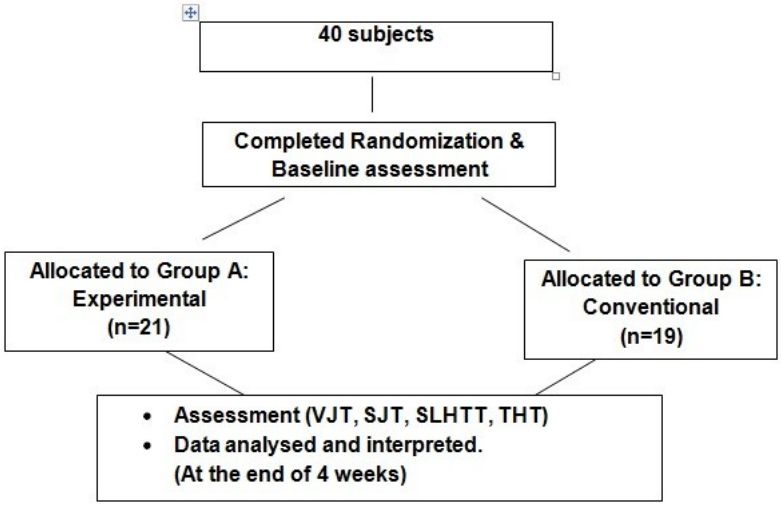


Fig 1. Study design and flow of the participants through each stages of the trial.

Assessment

VJT (Vertical jump test), SJT (Static jump test), SLHTT (Single leg hop time test) and THT (Triple hop test) assessed at baseline & at the end of 4 weeks.

Rehabilitation program

The rehabilitation program consisted of 16 sessions, each 1 hour long, 4 times weekly for 4 weeks. All treatment sessions occurred approximately at the same time of day on the same 4 days of the week throughout the study. Intervention was conducted in group and not in an individual format. The physical therapist was involved in performing the intervention as well as conducting the assessments. Duration - 4 weeks of training, 4 times per week i.e. 16 sessions per patient, an exercise was terminated, on patients demand if they feel tired or fatigue or any complains. Appropriate rest pause between each exercise was given. Total treatment duration 15 to 20 minutes. Inclined board plyometric training was given to Group A and Group B was given the same exercises on the plane surface.

Outcome Measure

VJT & SJT

The vertical jump test was conducted by placing a measuring tape vertically and the subjects were asked to jump against it. The static jump test and the vertical jump test were performed and recorded at the same time. The tests were done by asking the subjects to stand opposite to the vertical measuring tape. Then they were asked to squat for 5 seconds and jump as high as possible and touch the tape. Chalk powder was applied to each subject before they jumped and touched the tape. A person was asked to sit on a high seated chair beside the measuring tape and record the jump height. Two jumps were performed together consecutively. The first test was the static jump test which was done by squatting for 5 seconds and jumping while the second test was done immediately by jumping again as high as possible after landing from the static jump test. These tests were to measure the power and strength of the lower limbs.

SLHTT

In this test the time in seconds was noted while the subject performed three trials of single leg hop jump. Quickness was tested in this test.

THT

In this test the horizontal distance was measured by the measuring tape as the subjects finished three trials of continuous three hops without a break. The distance at the end of the third hop was measured in every trial.

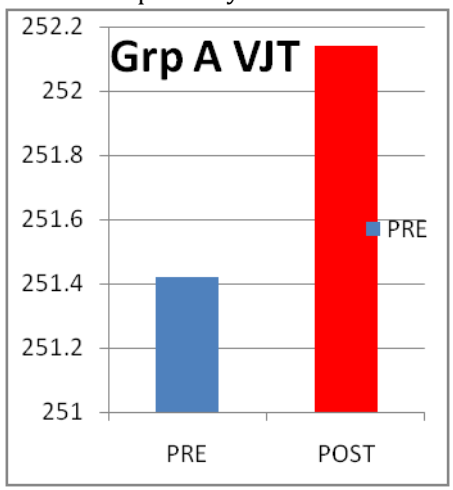
STATISTICAL ANALYSIS

Data was analysed by using Primer software and normality distribution done by Epi Info 7 software.

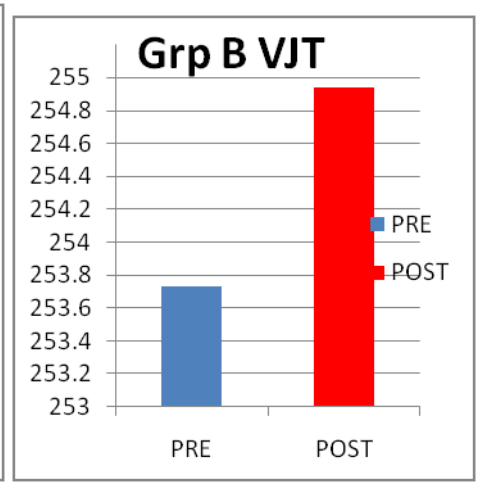
The Test of Significance such as "t" test between the groups was used after verifying the Bartlett's Test for Inequality of Population Variances was not significant. In case of Paired Values the Pittman's Test was used For Equality of Variances Before using the Paired "t" test. The statistical analysis was done using paired "t" test and unpaired "t" test. Inter group significance was calculated by using unpaired "t" test and intra group significance was calculated by paired "t" test. Data analysis was done and four test, (Vertical jump test, Static jump test, Single leg hop time test and Triple hop test) were recorded and tabulated.

The finding of present study clinically supports our alternative hypothesis that inclined board plyometric training (Group A) is effective in comparison to place surface exercise training. Our results reveal significant improvements in SJT, SLHTT and THT in both groups. No significant differences between groups were found in VJT and the between group difference was not significant statistically.

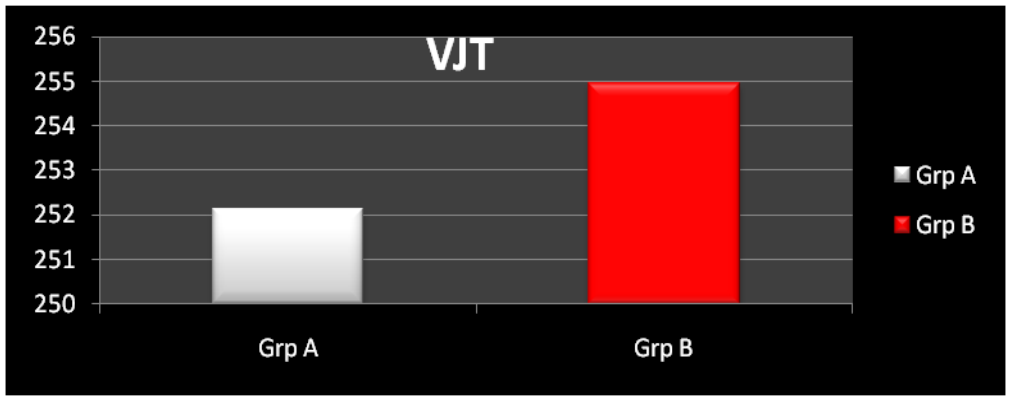
Following are the graphs representing distribution of inter group and intra group comparison of VJT, SJT, SLHTT and THT score respectively.



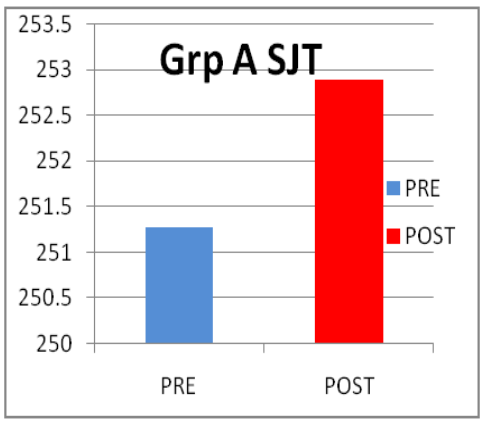
Graph:1 Comparison of pre and post findings of vertical jump test in group-A



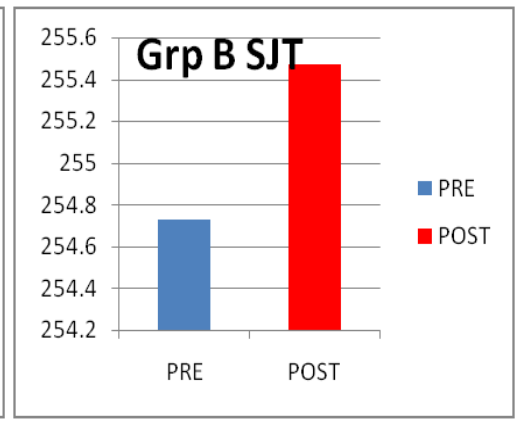
Graph:2 Comparison of pre & post findings of vertical jump test in groupB



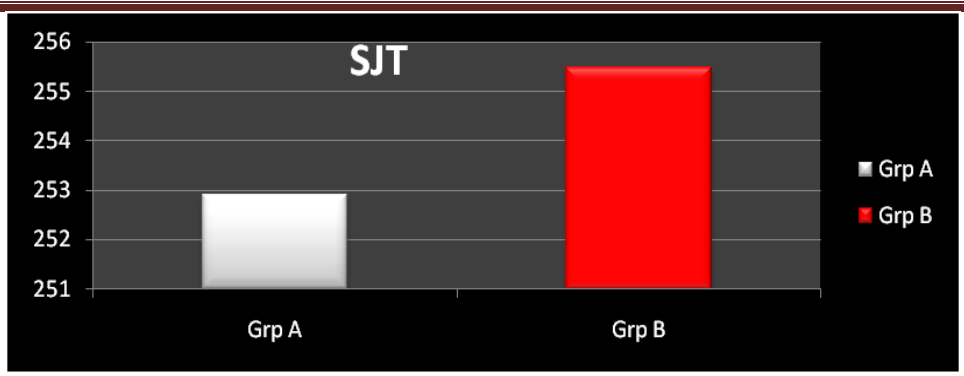
Graph:3.Comparison between post findings of vertical jump test of group A & B



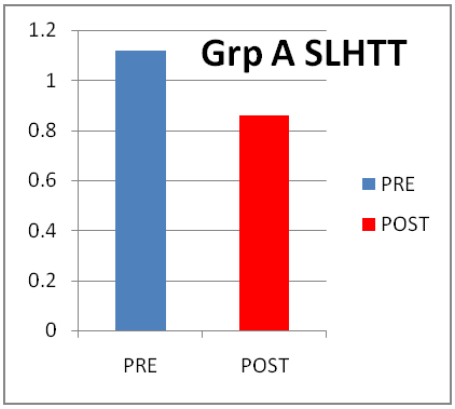
Graph:4 Comparison of pre and post findings of static jump test in group-A



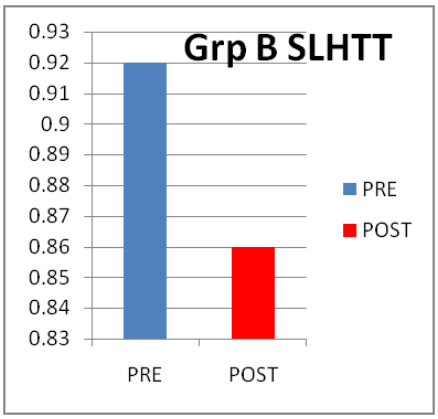
Graph:5 Comparison of pre & post findings of static jump test in group -B



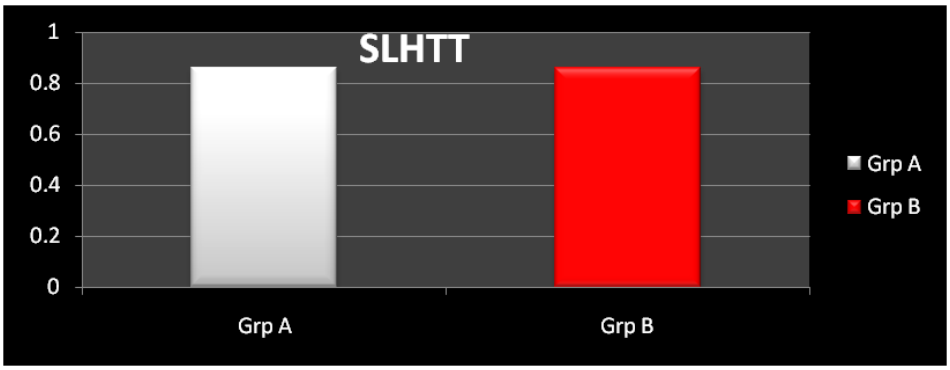
Graph:6 Comparison between post findings of static jump test of group A & B



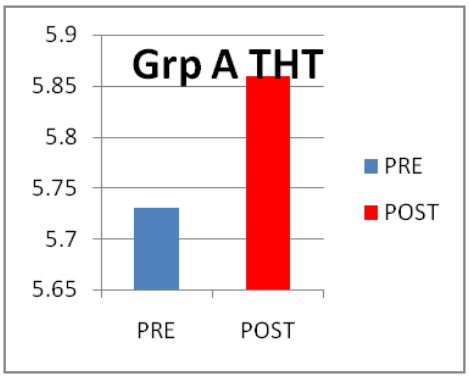
Graph:7 Comparison of pre and post findings of SLHT test in group-A



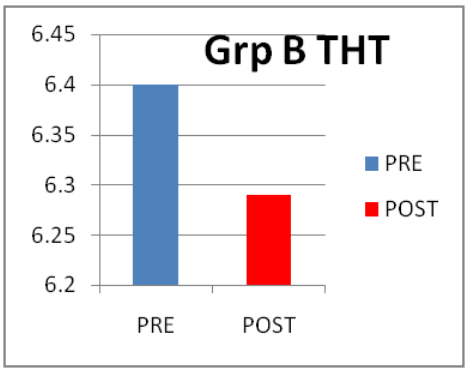
Graph:8 Comparison of pre & post findings of SLHT test in group -B



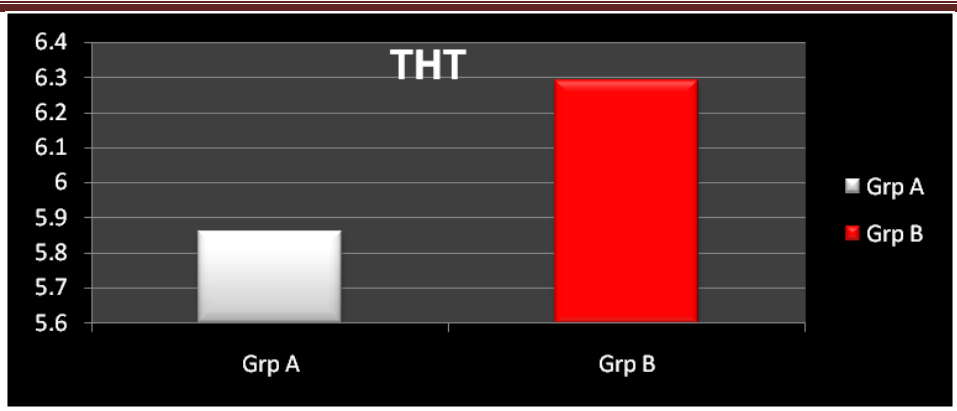
Graph:9 Comparison between post findings of SLHT test of group A & B



Graph:10 Comparison of pre and post findings of triple hop test in group-A



Graph:11 Comparison of pre & post findings of triple hop test in group -B



Graph:12 Comparison between post findings of triple hop test of group A & B

RESULT

40 subjects completed the study. Comparison of pre and post Of SJT, SLHTT, THT in Group A was found to be statistically significant and that of Group B SJT, SLHTT, THT was found to be statistically significant. Comparison of VJT was found statistically insignificant between group – A & group – B ($p>0.05$).

DISCUSSION

This study was an attempt to investigate the effect of inclined board plyometric exercise training on the jump performance on young elite athletes. The subjects selected in the study were athletes involved in sporting activity for more than 1 year male as well as female players, between 15-25 years. The subjects had attained the maturity level, as this has been suggested as a prerequisite to be considered prior to the administration of the plyometrics, that the participant has reached a basic maturation level.[6]

Terese L.Chmielewski et al (2006) studied Plyometric exercises in the rehabilitation of athletes and suggested that, in Plyometrics there is loading of the joints, and the tissues has to tolerate high forces for the same reason, the athletes having any kind of acute inflammation or pain, immediate postoperative status, and joint instability were excluded from the study. [6]

Much research has been focused on the development of vertical jump performance. Although various training methods, including heavy-resistance training, explosive type resistance training, electro stimulation training and vibration training, have been effectively used for the enhancement of vertical jump performance, most coaches and researchers seem to agree that plyometric training is a method of choice when aiming to improve vertical jump ability and leg muscle power.

Kannas et al compared groups of 10 athletes (all young males but no training history given) performing plyometric drills on an incline (15 degrees) or flat surface. Athletes performed 8 sets of 10 consecutive jumps on 4 days a week and for 4 weeks. The incline group showed significant improvements in fast depth jump performance (17% from a 20cm drop, 14% from 40cm) with activity of the gastronemius during the propulsion phase also increased during these jumps. While the incline group demonstrated a tendency for slight increases in squat, countermovement and slow depth jump performances, these were not significant.[7]

During a plyometric movement, the muscles undergo a very rapid switch from the eccentric phase to the concentric phase. This stretch-shortening cycle decreases the time of the amortization phase that in turn allows for greater than normal power production. The muscles stored elastic energy and stretch reflex response are essentially exploited in this manner, permitting more work to be done by the muscle during the concentric phase of movement. Training programs that have utilized plyometric exercises have been shown to positively affect performance in power-related movements such as jumping and speed. In the present study, improvements were seen in vertical jump height and vertical jump power. Better improvement can be seen on inclined plyometric training in addition to the above changes as the length of the achilles tendon increases due to dorsiflexion and considering the length-tension relationship, more force production can be observed.[8]

The increase in power following a plyometric training program could be due in part to increases in muscle fiber size. Improvements in muscle force production have been associated with increases in muscle fiber size. Study has shown that plyometric training can result in significant increases in both Type I and Type II muscle fiber area. The potential increase in muscle fiber size could account for the observed increases in body mass within the groups as well since there were no changes in percent body fat.[8]

Improved muscle performance due to a plyometric training program may also be due in part to increased motor unit functioning. Previous studies have indicated that neuromuscular adaptations such as increased inhibition of antagonist muscles as well as better activation and co-contraction of synergistic muscles may account for the improvements in power output.[8]

Yuri Verkhoshansky 2012 stated that performance during stretch shortening cycle exercise is influenced by the visco elastic properties of the muscle tendon units. During stretching of an activated muscle, mechanical energy is absorbed in the tendon structure (tendon & aponeurosis) and this energy can be subsequently re-utilized if shortening of the muscle immediately follows the stretching.[10] Bosco and Komi 1982 found that increases in vertical jump ability following a Countermovement jump or Drop jump could be attributed to a combination of the utilization of elastic energy and the stretch reflex potentiation of the muscle activation. They concluded that the elastic phenomenon is probably of primary importance in this increase.[9]

Hence during inclined plyometrics, there is an increase in the angle of dorsiflexion.

Due to this increase, the length of the gastrosoleus also increases. This further alters the torque of the muscle in comparison to the ankle in neutral of plane surface. This alteration of the length and torque of the muscle causes an improvement in the force production rendering improved jump performance.

CONCLUSION

Thus we conclude that inclined board plyometric training has an effect on the jump performance of the athletes and a significant improvement was seen on Static jump test, Single leg hop time test and Triple hop test.

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