

Comparison of Effect of Proprioceptive Training and Core Muscle Strengthening on the Balance Ability of Adolescent Taekwondo Athletes

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ABSTRACT

Background: Taekwondo is unique by the predominant use of powerful kicking techniques. Balance is the ability to maintain the condition of equilibrium in the body. In sports, both static and dynamic balances are related to performance enhancement. Proprioceptive training has improved the balance of healthy adults and the balance capacity of athletes and strengthening the core muscles would improve spinal movement and stability, and greatly help to improve athletic performance. there is no study done on the comparison of proprioceptive training and core muscle strengthening to improve the balance ability of adolescent Taekwondo athletes. The study used outcome measures such as Y-Balance Test and Single Leg Hop Test. Aim: To compare the effect of proprioceptive training and core strengthening on balance ability of adolescent Taekwondo athletes.

Objectives: To assess and compare the effect of proprioceptive training, Core muscle strengthening, Conventional exercises on balance ability of adolescent Taekwondo athletes using Y-balance test and Single leg hop test.

Material and Methods: A total of 45 adolescent Taekwondo players were selected as per the inclusion and exclusion criteria. All subjects were made to perform Y balance test and Single leg hop test. The subjects were randomly allocated in three groups i.e. Control group, Proprioception training group and core muscle strengthening group. Control group received conventional rehabilitation and two experimental group received Proprioceptive training and core muscle strengthening respectively. After six weeks, all subjects were made to perform Y balance test and Single leg hop test.

Result: The study result show that there is significant improvement in Y-balance and Single leg hop test scores of proprioceptive training and core Muscle strengthening group.

Conclusion: Proprioceptive training have significant difference than core strengthening in the result of posterolateral, posteromedial direction of Y-balance test while core muscle strengthening has significant difference than proprioceptive training in the result of Triple Hop distance, 6-meter timed hop of single leg hop test.

Keywords: Taekwondo, balance, proprioceptive training, core muscle strengthening

INTRODUCTION

Taekwondo, a Korean martial art form was traditionally used for self-defense during warfare and has been developed for

over 20 centuries in Korea. The term 'Taekwondo' literally translates as "tae-" to hit using the foot, "-kwon-" to hit using the fist, and "-do" referring to the art, thus

directly translating into “the art of kicking and punching”. Being one of many martial art forms, Taekwondo is unique by the predominant use of powerful kicking techniques. In more recent times, Taekwondo has transformed from a Korean self-defense skill set during warfare to a recognized international sport. It is a popular organized activity (particularly in Korea). [1]

Traditional Taekwondo is an art refined over generations that engages students in a process whereby they work to improve themselves cognitively (e.g. building capacity to focus), physically (e.g., building physical flexibility, fitness, strength, and precision in motor movements), emotionally (e.g., learning to meditate, controlling negative emotions), and socially (e.g., practicing respect toward others and individual responsibility). [2] Balance is the ability to maintain the condition of equilibrium in the body. In sports activities, balance plays an important role in maintaining posture and conducting given tasks, owing to a close relation between balance and motor performance capacity. Balance can be applied to a static condition while standing on a base of support with minimum movement, and also to a dynamic situation while maintaining a stable posture and performing techniques. Thus, in sports, both static and dynamic balances are related to performance enhancement. Furthermore, the ability to adjust the body weight into a motion without losing balance in the process of releasing the force at the target point is important for the purpose of competition. Various studies on proprioceptive training programs aiming to improve awareness of body aspects such as posture, movement, and change of balance have been reported. Proprioception is defined as the sense or ability to comprehend the position and speed of movement or weight, as well as the resistance of the body. Proprioceptive training has improved the balance of healthy adults and the balance capacity of athletes. In addition, it has been reported that this

training modality produces effective results in five weeks. [3]

In the case of Taekwondo players, strengthening the core muscles would improve spinal movement and stability, and greatly help to improve athletic performance. The core muscles generate all the power and mobility of the human body, as well as maintaining balance every time we move, and that the movements and stability of the trunk can be maximized by repeatedly stretching and strengthening the core muscles. [4]

The study is going to use outcome measures such as Y-Balance Test and Single Leg Hop Test.

The Y Balance Test (YBT) is a commercially available device for measuring balance that uses 3 (anterior, posteromedial and posterolateral) of the 8 SEBT directions and has been advocated as a method for assessing dynamic balance. For clinical use and screening purposes, the test needs to capture the greatest amount of information in the shortest amount of time. Thus, the anterior, posteromedial, and posterolateral directions appear to be important to identify individuals with chronic ankle instability and those at greater risk of lower extremity injury. The Y Balance Test™ was developed to address some of the limitations of the traditional SEBT testing methods. A reach indicator, standard reach height from the ground, well defined pass/fail criteria, and the ability of the reach indicator to remain over the tape measure after performance improve the reproducibility of the reach measurement. These features also allow the rater to focus more attention on observing the subject, and, therefore, better assess the subject's movement quality. [5] The multiple single-leg hop-stabilization test is a functional test which may offer a method of evaluating the dynamic attributes of balance. This type of functional test is important because it challenges athletes in a way which reflects the forces and directions of movement that are integral to sport. [6]

There are studies done where the effect of lower limb muscle strengthening along with the proprioception training on the balance ability of Taekwondo Poomsae athletes. Also, studies are done where the difference in foot pressure was studied after core muscle strengthening. However, there is no study done on the comparison of proprioceptive training and core muscle strengthening to improve the balance ability of adolescent Taekwondo athletes.

Thus, the study is an attempt to check and compare the effect of proprioceptive training and core muscle strengthening in adolescent Taekwondo athletes.

MATERIALS AND METHODS

This study was single blinded randomized control trial. This study involved 45 adolescent taekwondo athletes chosen by simple random sampling technique from Taekwondo academy, Mumbai after permission of ethical committee and subjects who were willing to participate in the study and of age group 11-20 years, training for 1-1.5 hrs daily for 1-1.5 years were included in this study and subjects who were medically not fit and with any musculoskeletal, neurological and cardiovascular disease were excluded from the study. Consent was taken. Material required for study was Swiss ball, Tilt board, Thera disc, Medicine ball, Timer, Chalk, Duct tape, Measuring tape, Pen, Book.



Fig.1: Materials used in the study.

All subjects were made to perform Y-balance test and Single Leg Hop Test. Subjects were randomly allocated in three groups I.e. Proprioception training group, Core muscle strengthening group and Control group, 15 in each group. Control group received conventional rehabilitation which included flexibility exercises, jumping jacks, high knees, skipping ropes, squats, lunges.

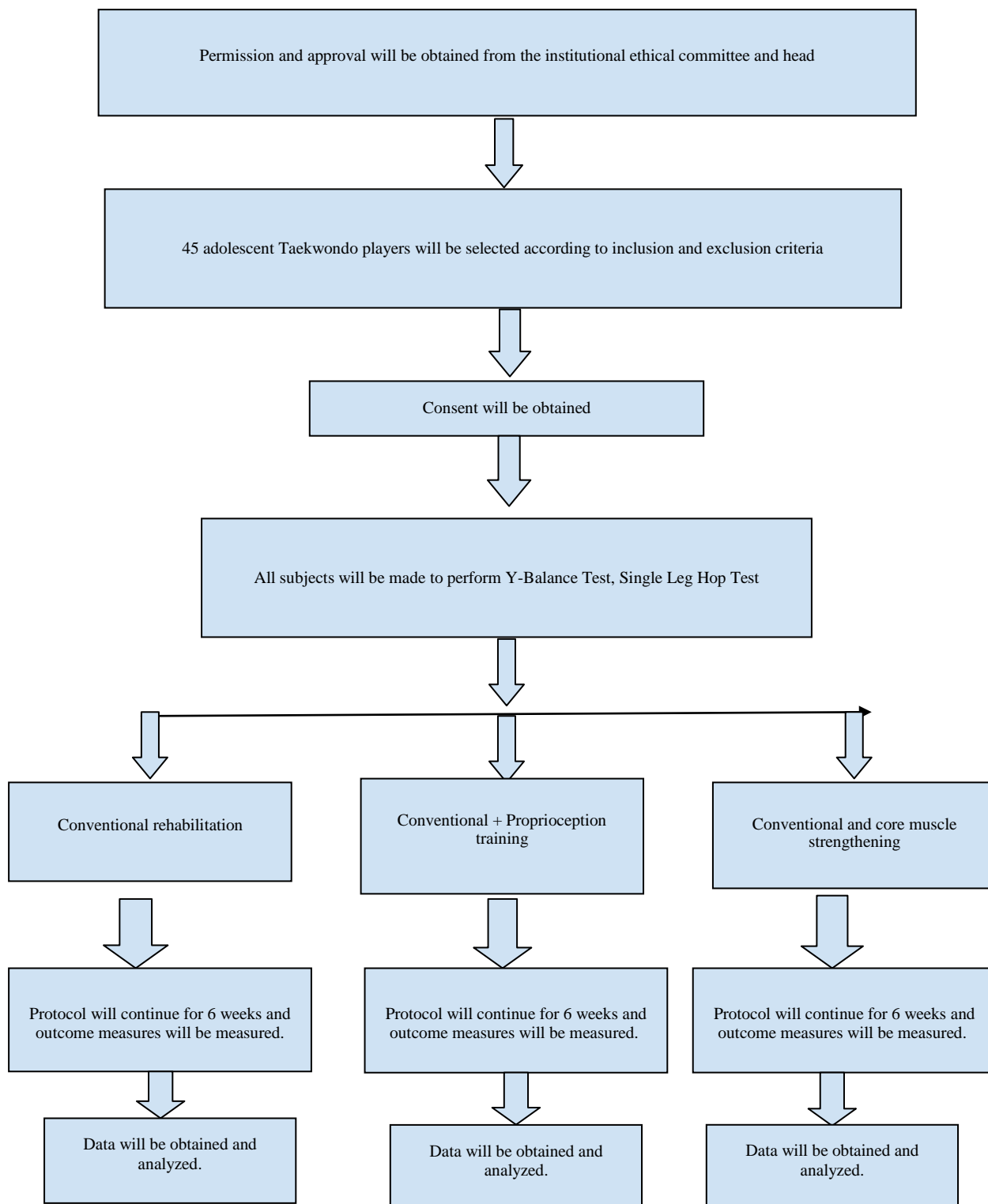
Proprioception training group received following exercise in 3 set of 60 secs, 20 secs interval break between two sets for 3 sessions per week over 6 weeks.

1. One leg standing on tilt board
2. One leg standing on tilt board with catch and throw
3. One leg standing on tilt board with catch and throw against the wall
4. One leg standing on tilt board with catch and throw in pair
5. One leg standing on tilt board holding a medicine ball overhead
6. High knee walking on thera-discs holding a medicine ball

Core muscle strengthening group received following exercise in 3 set of 10 repetitions, 1 min interval break between two sets for 3 sessions per week over 6 weeks.

1. Contralateral limb extension in prone lying
2. Side plank
3. Side plank with hip dips
4. Contralateral hip-knee flexion and shoulder flexion on swiss ball
5. Back extension with upper body out of the plinth
6. Abdominal curls on swiss ball

Post intervention subjects performed Y-balance test and Single Leg Hop Test.

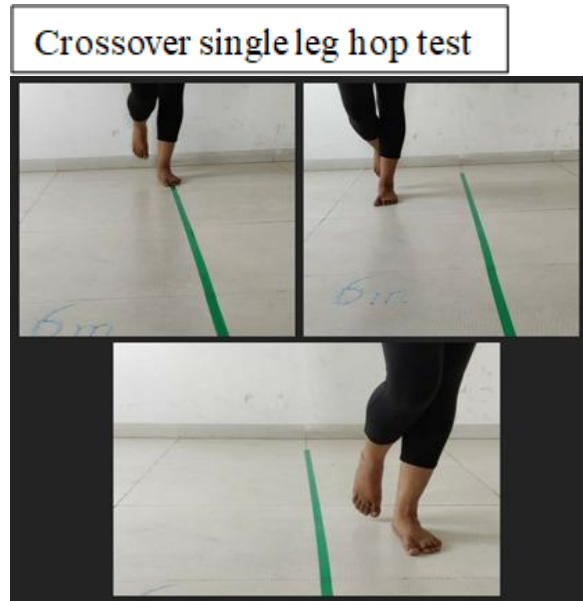
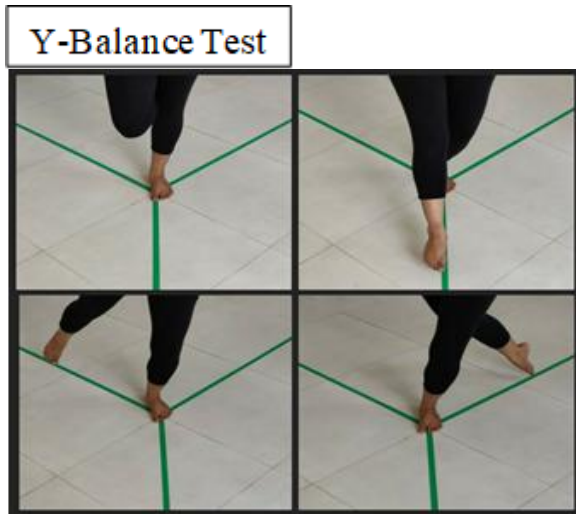


Y-balance test:

A y-shaped figure was drawn on the ground with tapes. Subject was asked to stand barefoot in the middle of the Y shape figure. Subject was asked to stand on the non-dominant leg and reach each of the three direction- anterior, posteromedial and posterolateral and then return to the starting

position, performed with three trials. The maximum reach for leg in each direction was measured. The absolute reach distance was calculated. Subject can touch down during the test or place his/her foot on top of the reach indicator. If subject's leg touches the ground or he loses his balance then the

test was aborted there and not counted in the results.



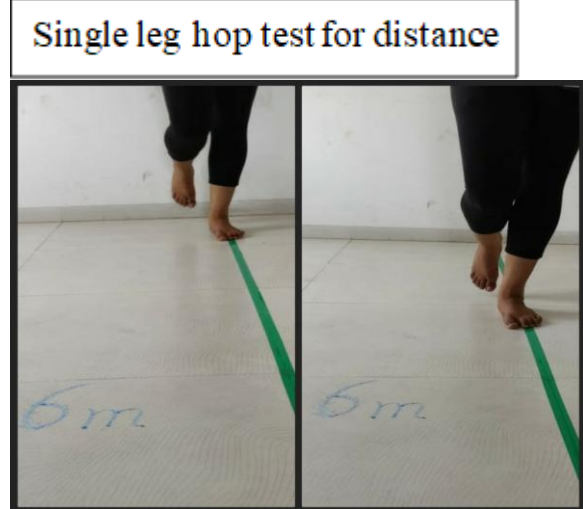
Single leg hop test:

A measuring tape was placed on the ground. Subject was asked to stand on the non-dominant at the starting point of the measuring tape.

There are 4 components of this test:

1. Single leg hop distance
2. Single leg triple hop distance
3. Crossover single leg hop distance
4. 6-meter timed hop

If subject was unable to maintain balance or cannot land on one leg then the test was aborted there and not counted in the results.



RESULT

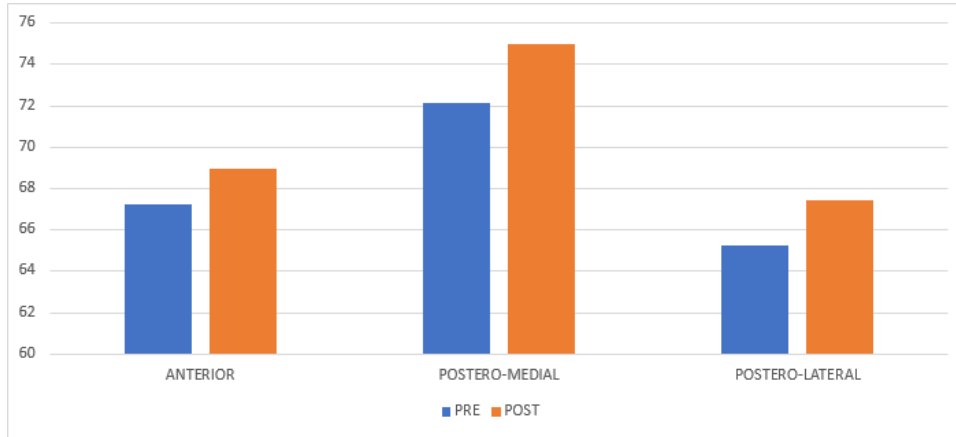
The demographic data of the subjects are presented in table.

Table 1. Descriptive Analysis

SR.NO.			GENDER	TOTAL	MEAN	S.D.
1.	AGE	CONTROL GROUP			12	±1.31
		PROPRIOCEPTION TRAINING GROUP			11.6	±0.74
		CORE MUSCLE STRENGTHENING GROUP			12	±1
2.	GENDER	CONTROL GROUP	MALE	8		
			FEMALE	7		
		PROPRIOCEPTION TRAINING GROUP	MALE	7		
			FEMALE	8		
		CORE MUSCLE STRENGTHENING GROUP	MALE	7		
			FEMALE	8		
3.	YEARS OF TRAINING	CONTROL GROUP			2.73	±0.78
		PROPRIOCEPTION TRAINING GROUP			2.666666667	±0.49
		CORE MUSCLE STRENGTHENING GROUP			2.766666667	±0.73
4.	HOURS OF TRAINING	CONTROL GROUP			1.266666667	±0.26
		PROPRIOCEPTION TRAINING GROUP			1.266666667	±0.26
		CORE MUSCLE STRENGTHENING GROUP			1.3	±0.25

Table 2. Measures of Y-Balance test Parameters in Control group (Pre test Vs Post test)

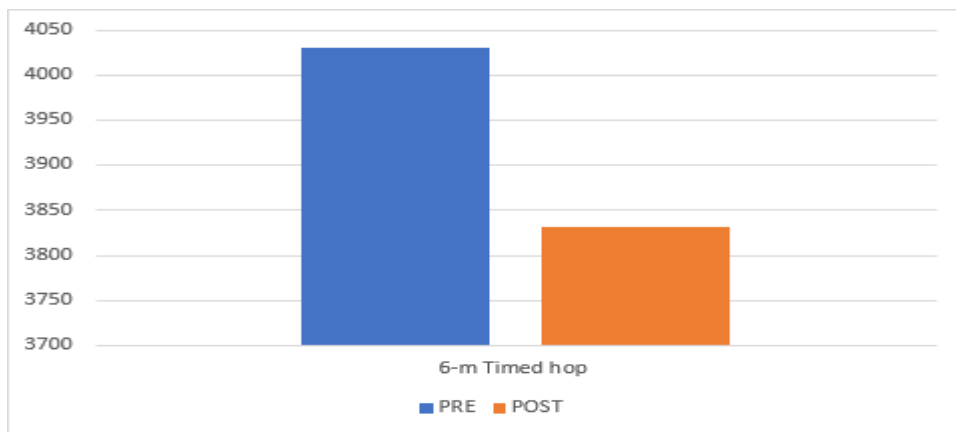
Parameters	Control Group		
Y-balance Test	Test	P-value	Significance
Anterior direction	Paired T- test	<0.0001	Yes
Posteromedial Direction	Paired T- test	<0.0001	Yes
Posterolateral direction	Paired T- test	<0.0001	Yes



Graph 1- Graph shows pre and post test data of Y-balance test of control group.

Table 3- Measures of Single leg hop test parameters in Control group (Pre vs Post test)

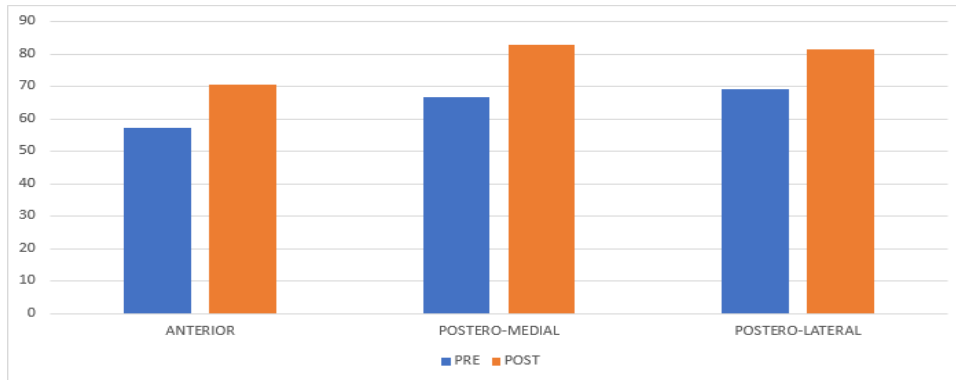
Parameters	Control Group		
Single leg hop test	Test	P-value	Significance
Single leg hop distance	Paired T- test	<0.0001	Yes
Triple Hop distance	Paired T- test	<0.0001	Yes
Cross over hop distance	Paired T- test	<0.0001	Yes
6m Timed hop	Wilcoxin test	0.0001	Yes



Graph 2- Graph shows pre and post test data of Single leg hop test of control group.

Table 4- Measures of Y balance test parameters in Proprioception training group (Pre vs Post test)

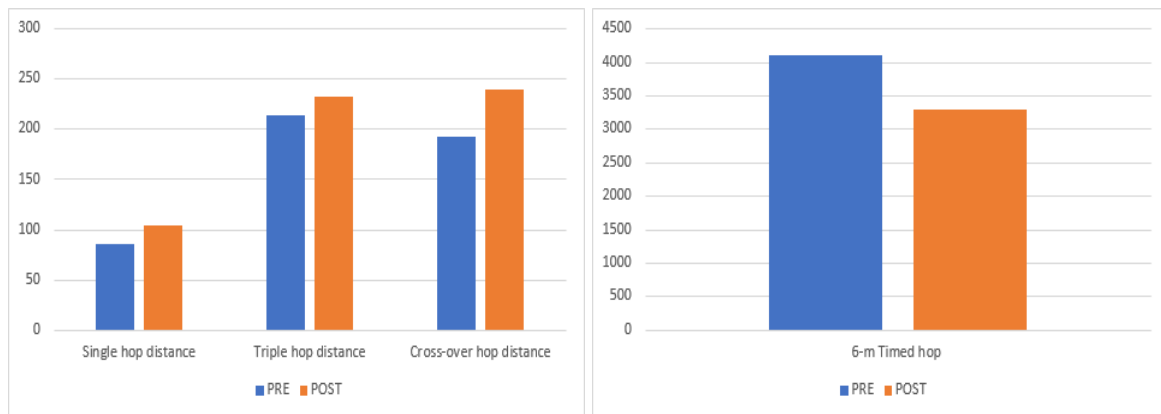
Parameters	Proprioception training Group		
	Test	P-value	Significance
Y-balance Test	Test		
Anterior direction	Paired T- test	0.0001	Yes
Posteromedial Direction	Paired T- test	0.0003	Yes
Posterolateral direction	Wilcoxin test	0.0001	Yes



Graph 3- Graph shows pre and post test data of Y-balance test of Proprioception training group.

Table 5- Measures of Single leg hop test parameters in Proprioception training group (Pre vs Post test)

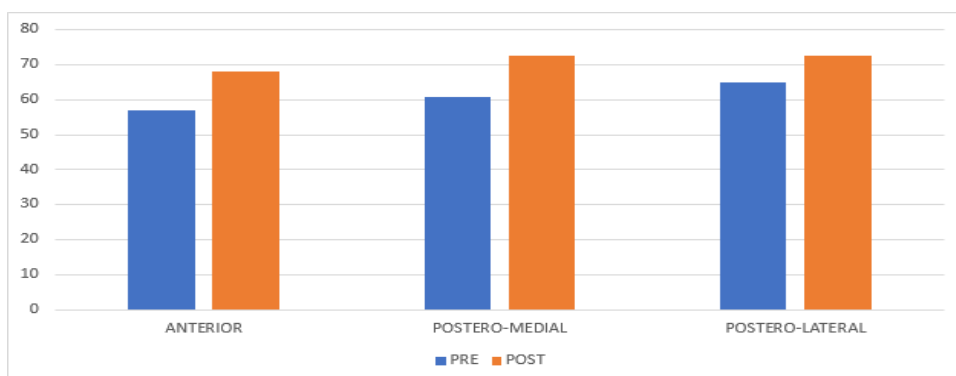
Parameters	Proprioception training Group		
	Test	P-value	Significance
Single leg hop test	Test		
Single leg hop distance	Paired T- test	0.0001	Yes
Triple Hop distance	Wilcoxin test	0.0001	Yes
Cross over hop distance	Paired T- test	0.0137	Yes
6m Timed hop	Wilcoxin test	0.0001	Yes



Graph 4-Graph shows pre and post test data of Single leg hop test of Proprioception training group.

Table 6- Measures of Y balance test parameters in Core muscle strengthening group (Pre vs Post test)

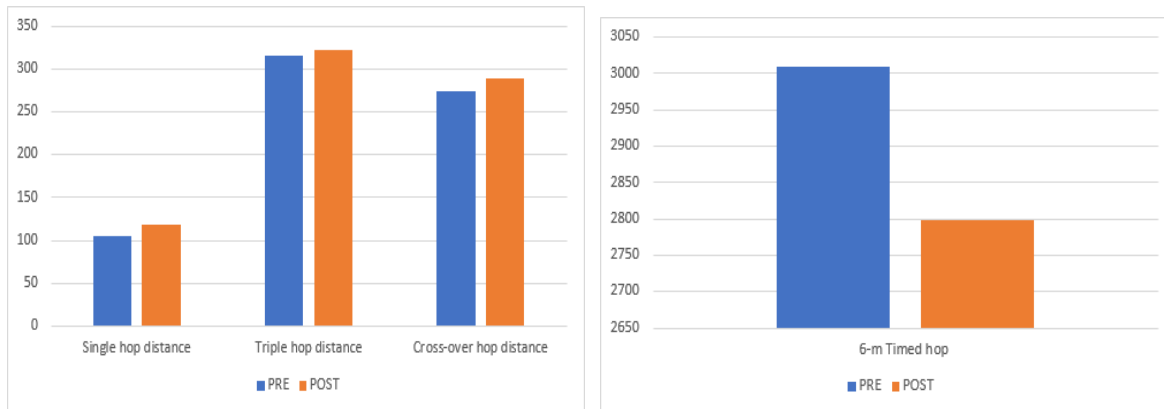
Parameters	Core muscle strengthening Group		
	Test	P-value	Significance
Y-balance Test	Test		
Anterior direction	Paired T- test	<0.0001	Yes
Posteromedial Direction	Wilcoxin Test	0.0001	Yes
Posterolateral direction	Paired T-test	<0.0001	Yes



Graph 5- Graph shows pre and post test data of Y-balance test of Core strengthening group.

Table 7- Measures of Single leg hop test parameters in Core muscle strengthening group (Pre vs Post test)

Parameters	Core muscle strengthening Group		
Single leg hop test	Test	P-value	Significance
Single leg hop distance	Paired T- test	<0.0001	Yes
Triple Hop distance	Paired T- test	<0.0001	Yes
Cross over hop distance	Paired T- test	0.0012	Yes
6m Timed hop	Paired T- test	0.0004	Yes



Graph 6- Graph shows pre and post test data of Single leg hop test of Core strengthening group.

Table 8. Measures of Y- balance test Parameters of Control vs Proprioception training vs Core muscle strengthening group

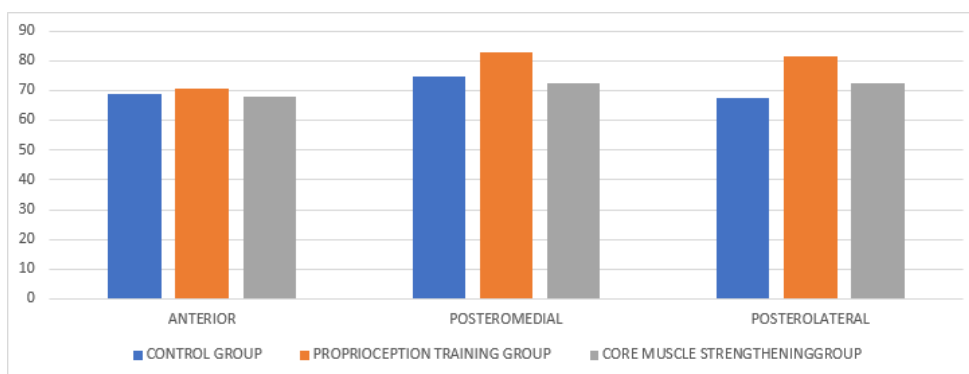
Parameters	Control vs Proprioception training vs core muscle strengthening group		
Y-balance test	Test	P VALUE	SIGNIFICANCE
Anterior	ANOVA	0.637636	NO

Posteromedial direction

A one way between groups ANOVA was conducted to compare the effect of interventions on the balance ability in posteromedial direction of Y-balance test. There was a significant effect of interventions on balance in posteromedial direction at the $p < 0.5$ for the three interventional groups [F (4,42) = 4.597729, P= 0.03525]. Post hoc comparisons using the Tukey HSD test indicated that the proprioception training and core muscle strengthening groups differed significantly at $P < .05$; control group was not significantly different than other groups, lying somewhere in the middle.

Posterolateral direction

A one way between groups ANOVA was conducted to compare the effect of interventions on the balance ability in posterolateral direction of Y-balance test. There was a significant effect of interventions on balance in posterolateral direction at the $p < 0.5$ for the three interventional groups. [F (2,42) = 6.48025, P= 0.03525]. Post hoc comparisons using the Tukey HSD test indicated that the control and proprioception training groups differed significantly at $P < .05$; core muscle strengthening group was not significantly different than other groups, lying somewhere in the middle.



Graph 7- Above table and graph shows between group comparison data of Y-balance test.

Table 9. Measures of Single leg hop test Parameters of Control vs Proprioception training vs Core strengthening group

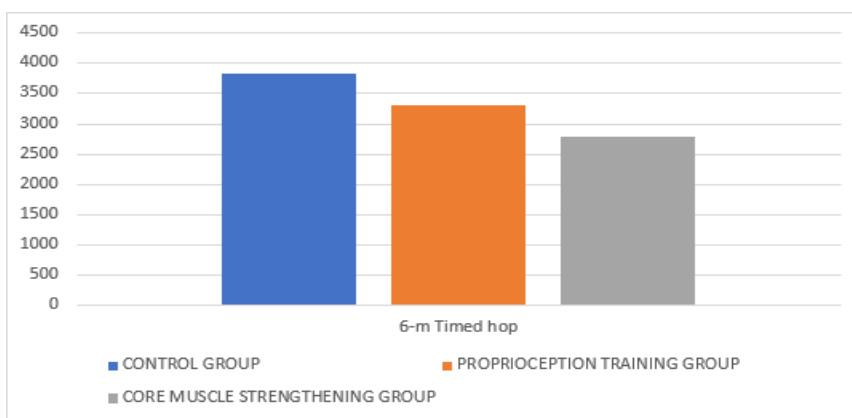
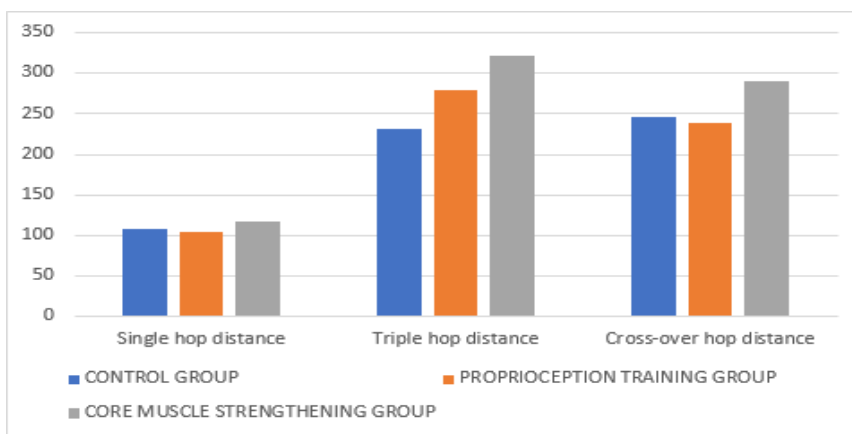
Parameters	Control vs Proprioception training vs core muscle strengthening group		
Single leg hop test	Test	P VALUE	SIGNIFICANCE
Single leg hop distance	ANOVA	0.165878	NO
Cross over hop distance	ANOVA	0.128709	NO

Triple hop distance

A Chi-square test of independence was performed to examine the relation between interventions and triple leg distance. Improvement in Balance ability for the triple jump distance was observed more in core muscle strengthening than control group (4.48% versus 3.23%, $P < 0.001$, Chi square test) than in proprioception training group than control group. (3.65% versus 3.03%, $P < 0.003$, chi square test).

6-meter timed hop

A chi-square test of independence was performed to examine the relation between interventions and timed hop. Improvement in Balance ability for the timed hop was observed more in core muscle strengthening than control group (94.29% versus 38.95%, $P < 0.001$, Chi square test) than in proprioception training group than control group. (43.21% versus 50.10%, $P < 0.003$, chi square test).



Graph 8- Graph shows between group comparison data of Single leg hop test.

DISCUSSION

Several studies have studied the effect of proprioceptive training on the balance ability of taekwondo players, effect of core muscle strengthening on the balance ability of taekwondo players, to our knowledge comparison wasn't done

between two interventions and their effect on the balance ability of adolescent taekwondo players. The study results show that there is improvement in balance ability of adolescent taekwondo players by proprioceptive training and core strengthening.

Y- balance test

The YBT is a functional test that requires strength, flexibility, neuromuscular control, stability, range of movement, balance, and proprioception. This test is a good solution for functional testing because of its speed, efficiency, portability, consistency, and objectivity. It can be performed on multiple surfaces. [7]

Anterior direction

In the present study, the intra group analysis showed significant results for all the groups- control, proprioception training and core muscle strengthening ($P < 0.0001$). However, the inter group analysis for anterior direction did not show significant results as per table 8.

Posteromedial direction and posterolateral direction

In the present study, the intra group analysis for posteromedial direction showed significant results for all the groups- Control ($P < 0.0001$), Proprioception training ($P < 0.0003$) and core muscle strengthening ($P < 0.0001$) as well as for posterolateral direction Control, Proprioception training and core muscle strengthening ($P < 0.0001$). The inter group analysis for both the direction showed significant result in core muscle strengthening and proprioception training group ($P < .05$). It could be due to various reasons.

One of the reasons of Significant result in the proprioception training group is, In the Posteromedial and posterolateral directions, visual awareness is reduced and this places an increased demand on somatosensory feedback strategies. Proprioceptive training focuses on the use of somatosensory signals such as proprioceptive or tactile afferents in the absence of information from other modalities such as vision. [8] Reason of significant result in core muscle strengthening training group is, core musculature is responsible for optimizing the functioning/performance of lower extremity and improved balance. [9]

strengthening in the core muscles provides a better stability for the lower limb movements allowing the occurrence of a smooth and stable movement. [10] it explained by the specific role of the trunk as a linkage between upper and lower extremities. Particularly during every-day or sports-related rotational torso movements, trunk muscles generate torque along a diagonal proximal to distal path to enhance extremity force production. Konin and colleagues referred to this as the so-called serape (i.e., “shawl-like”) effect. According to Young et al, muscles belonging to the global system (e.g., erector spinae, rectus abdominis, internal/external obliques, latissimus dorsi) primarily generate torque in a serape-like manner during rotational movements (e.g., throwing). Moreover, the trunk acts as a kinetic link that facilitates the transfer of torques and angular momenta between upper and lower extremities during the execution of whole-body movements. [11]

Single leg hop test

Single leg hop test is used to assess participant's lower extremity muscular strength and ability to perform tasks that challenge knee stability [12] and can detect the contribution of muscle strength asymmetries to the ability to generate power. [13]

Single leg hop distance and cross over hop distance

In the present study, the intra group analysis for single leg hop distance showed significant results for all the groups- Control ($P < 0.0001$), Proprioception training ($P < 0.0001$) and core muscle strengthening ($P < 0.0001$) as well as for Cross over hop distance direction Control ($P < 0.0001$), Proprioception training ($P < 0.0137$) and core muscle strengthening ($P < 0.0001$). However, the inter group analysis for single leg hop distance and cross over hop distance did not show significant results as per table 9.

Triple hop distance

In the present study, the intra group analysis for triple hop distance showed significant results for all the groups- Control ($P < 0.0001$), Proprioception training ($P < 0.0001$) and core muscle strengthening ($P < 0.0001$). The inter group analysis for triple hop distance showed significant result in core muscle strengthening ($P < 0.0001$) and proprioception training group ($P < 0.0003$), compared to control group.

6-meter timed hop

In the present study, the intra group analysis for 6-meter timed hop showed significant results for all the groups- Control ($P < 0.0001$), Proprioception training ($P < 0.0001$) and core muscle strengthening ($P < 0.0004$). The inter group analysis 6-meter timed hop showed significant result in core muscle strengthening ($P < 0.0001$) and proprioception training group ($PP < 0.0003$). Reason of significant result in core muscle strengthening training group is,

It has been proved before that stability of the core musculature is responsible for optimizing the functioning/performance of lower extremity and improved balance. Lower limb muscle strength is related to core endurance.^[9] Strengthening in the core muscles provides a better stability for the lower limb movements allowing the occurrence of a smooth and stable movement. Strengthening the core could have resulted in a smaller displacement in the mediolateral center of pressure and also, in the center of mass. This means that, the motion at the level of the trunk and hip is properly controlled, resulting in the significant dynamic balance improvement.^[10]

Reason of significant result in Proprioception training group is, single leg hop test used to assess their participant's lower extremity muscular strength and ability to perform tasks that challenge knee stability.^[12] Knee stability can be improved by proprioceptive training as, Proprioceptive training combines static and dynamic aspects to include passive motion

sense, active motion sense, limb position sense, and sense of heaviness, which provide feedback to the neuromuscular system. This feedback is performed by stimulating muscle spindles, Golgi tendon organs, and various joint afferents (Pacianian corpuscles, Ruffini endings, and free nerve endings)^[14] which are around the human knee that are responsible for sensation the joint position.^[15]

CONCLUSION

Proprioceptive training has significant difference than core muscle strengthening in the result of posterolateral, posteromedial direction of Y-balance test while core Muscle strengthening have significant difference than proprioceptive training in the result of Triple Hop distance, 6-meter timed hop of single leg hop test.

Competing Interest:

The author declares no conflicts of work.

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