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Original Research Article

Effect of Upper Extremity Proprioceptive Training on Speed, Grip Strength and Functional Performance in Tennis Players

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ABSTRACT

Background: Tennis is a well-known and globally popular sport, played by millions of people of all ages and skill levels. It is enjoyed both recreationally and competitively. The sport is known for its physical, mental, and social benefits, making it a great choice for lifelong participation. The sport demands precise movement, grip strength, and kinetic chain efficiency for optimal performance and injury prevention. Shoulder stability, scapular motion, and proprioception are crucial, as imbalances can lead to injuries. Proprioceptive training enhances motor control, balance, and coordination, improving performance and injury prevention by stimulating neuromuscular responses essential for dynamic equilibrium during play.

Methodology: 40 tennis players were selected according to the inclusion and exclusion criteria. Assessment of the outcome measures was done pre and post 12 sessions. Outcome measures used were grip strength using hand held dynamometer, functional performance using Closed kinetic chain upper extremity stability test, serve speed via Radar gun and upper limb proprioception using Active angle reproduction test. Proprioceptive training for upper limb was given to all the subjects.

Result: The pre and post values of the group showed statistically significant results in all outcome measures (p value <0.01)

Conclusion: There is statistically significant difference in grip strength, serve speed, upper limb proprioception and functional performance in tennis players.

KEY WORDS: Proprioceptive training, tennis players, grip strength, serve speed.

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INTRODUCTION

Tennis is popular worldwide sport played by millions of recreational players which is non-contact, high velocity sport [1]. Numerous physical component skills, such as power, speed, strength, accuracy, agility, and coordination, are necessary for a good tennis player [2]. Throughout the entire game, the physical element is used in quick, continuous, explosive movements. Sustaining high levels of technical and physical competence as well as psychological stability is therefore essential.

During tennis strokes and serves, the shoulder complex joints have an increased stress acting as a bridge that transfers power from the lower limbs and trunk to the playing arm. This kinetic chain is repeated numerous times during the game involving unilateral arm. In the cocking phase, the racquet is moved away from the body, using a combination of movements such as humeral abduction, shoulder external rotation, and lumbar spine hyperextension to generate speed and power. Scapular motion is essential for preserving the glenohumeral joint's concentric articulation during each phase. During the early to late cocking phase, the scapula is crucial for maintaining the stability of the glenohumeral joint [3]. Study showed that prevalence of scapular dyskinesia in Elite tennis players came out to be 43% which can alter scapulohumeral rhythm and is associated with shoulder injuries.

Proprioception refers to the body's ability to detect its own position and orientation within space. Proprioception plays a significant role in sports and contributes greatly to the performance of athletes. In addition to regaining the joint's physiological function, proprioceptive training aims at developing every level of motor skills necessary to sustain the body's dynamic equilibrium while exercising. Therefore, it suggests that the overhead athlete's performance is dependent upon having adequate proprioceptive and neuromuscular control [4].

The shoulder being the most mobile joint has to compromise stability over mobility to generate sufficient level of force required to produce an effective serve. It is well documented that a decreased sense of proprioception is related to shoulder injuries such as shoulder instability, impingement, rotator cuff dysfunctions. Studies have found that the repetitive overhead action while playing racket sports causes fatigue of scapular muscle and thereby reducing the glenohumeral proprioception up to 78% [5]. Therefore, proper proprioceptive and neuromuscular control is crucial for athlete's performance. However, there is lack of information on proprioception training for upper extremity in tennis players for improving their performance and for preventing injuries. Hence, this study is aimed to assess the effects of upper extremity proprioceptive training in improving the performance of tennis players.

AIM: To assess the effect of upper extremity proprioceptive training on serve speed, grip strength, proprioception and functional performance in tennis players.

OBJECTIVE

1. To assess the effect of upper extremity proprioceptive training on serve speed.
2. To assess the effect of upper extremity proprioceptive training on grip strength.
3. To assess the effect of upper extremity proprioceptive training on upper extremity functional performance.
4. To assess the effect of upper extremity proprioceptive training on upper extremity proprioception.

METHODOLOGY

Study Design: Interventional Study

Study Type: Experimental Study

Sampling Method: Convenience Sampling

Place Of Study: Sports Club in and around the city

Sampling Calculation: 40

Study Population: Tennis Players

Inclusion Criteria:

1. Age- 18-30 years
2. Male and Female tennis players, who are practicing and playing tennis for one year.
3. Actively participating in tennis for at least 1 hours/day and 3 days/week

Exclusion Criteria:

1. Players with any history of fractures and surgeries within past 1 year.
2. History of upper limb injuries in the previous 6 months.
3. Any history of Neurologic and Cardiovascular problems.

Outcome Measures

1. Serve speed using Radar Gun
2. Grip strength using Hand Grip Dynamometer
3. Closed Kinetic Chain Upper Extremity Stability test (CKCUEST)
4. Active angle reproduction test

MATERIALS USED

1. Instrumental tools: Bubble inclinometer, Radar gun, Hand grip Dynamometer.
2. Physical tools: Stopwatch, Pen, Proforma, Phone camera, Consent Form, Measuring tape

Procedure: Ethical committee was taken from the Institutional Committee approval. CTRI registration was done (CTRI/2025/01/079247). A consent form was taken from the selected subjects who fulfil the inclusion and exclusion criteria were selected. Subjects were considered as a single group. Intervention of 12 sessions was given, outcome measures were assessed pre and post completion of intervention period and data analysis was done.

Table 1: Protocol.

Week		Exercises	Frequency
Week 1	1.	Quadruped to kneeling	10 reps* 2 sets
	2.	Elbow plank	10 sec hold*2 sets
	3.	Knee pushup	10 reps* 2 sets
	4.	Quadruped with arm lift	10 reps* 2 sets
Week 2	1.	Beast position	10 sec hold*2 sets
	2.	Alternate arm and leg lift	10 reps* 2 sets
	3.	Elbow plank with balance cushion	10 sec hold*2 sets
	4.	Thread a needle with disc	10 reps* 2 sets
Week 3	1.	Beast position with disc	10 sec hold*2 sets
	2.	Side plank	10 sec hold*2 sets
	3.	Hand plank	10 sec hold*2 sets
	4.	Alternate arm and leg lift with disc	10 reps* 2 sets
	5.	Knee pushup with disc	10 reps* 2 sets
Week 4	1.	Downward dog with disc	10 sec hold*2 sets
	2.	Hand plank with knee to chest with disc	10 reps* 2 sets
	3.	Side plank with disc	10 sec hold*2 sets

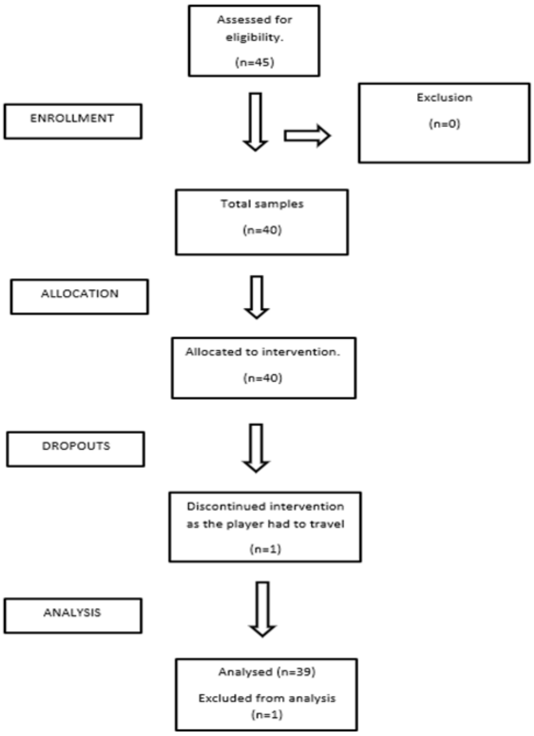


Figure 1: Consort diagram

RESULTS

The data analysis was done using the Statistical Package for Social Science version 29 (SPSS 29). The intra group data was analyzed using a 'Paired t- test' for changes in post intervention group from pre- intervention values.

The following table shows the baseline data of the subjects analysed for the study:

Table 2: Demographic data.

Demographic Data	Mean With Standard Deviation
Age (In Years)	23.79 (±3.03)
Bmi (In Kg/M^2)	24.93 (± 2.90)
Gender (Male: Female)	26:13:00

Table 3: Pre and post serve speed.

	Pre	Post	P Value
Grip Strength	73.97 (± 23.32)	85.13(± 25.45)	P<0.01

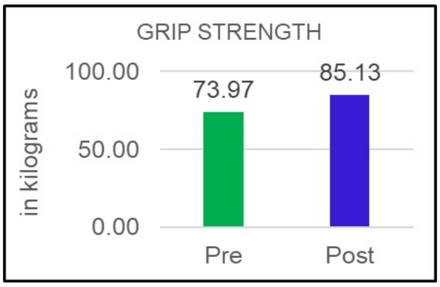
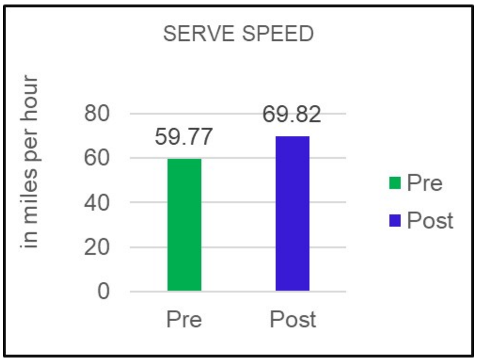


Figure 2: Grip strength

Inference: As p <0.01, there is statistically significant differences between pre and post mean value of grip strength.

Table 4: Pre and post CKCUEST score.

	Pre	Post	P Value
Serve Speed	59.77 (± 11.77)	69.82 (± 12.84)	P<0.01



Inference: As p <0.01, there is statistically significant differences between pre and post mean value of serve speed.

Table 5: Pre and post CKCUEST score.

	Pre	Post	P Value
CKCUEST Score	27.95 (± 3.43)	33.28 (± 4.26)	P<0.01

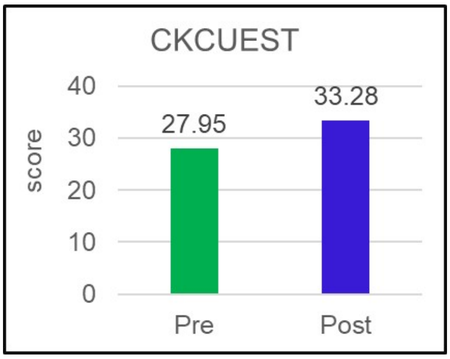


Figure 4: CKCUEST score

Inference: As p <0.01, there is statistically significant differences between pre and post mean value of CKCUEST score.

Table 6: Pre and post mean proprioception error.

Mean Proprioception Error	Pre	Post	P Value
30° Flexion	6.56 (± 2.79)	4.26 (± 2.65)	P<0.01
60° Flexion	5.44 (± 2.62)	3.26 (± 2.12)	P<0.01
30°Abduction	5.18 (± 2.07)	3.00 (± 2.16)	P<0.01
60° Abduction	4.77 (± 1.97)	2.77 (± 1.84)	P<0.01

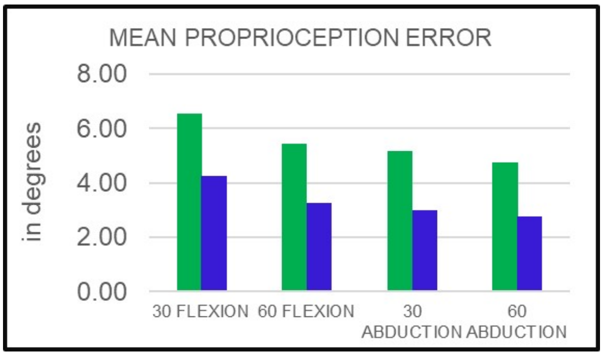


Figure 5: Mean proprioception error.

Inference: As p <0.01, there is a statistically significant difference between the pre- and post-mean value of the mean proprioception angle error.

DISCUSSION

All the tennis players who participated in the study received proprioceptive training for their upper limbs. The intervention included weight-bearing exercises, in which some exercises were performed with a balance cushion for two sets each. The purpose of this study was to investigate the effect of proprioceptive exercises on grip strength, serve speed, and performance in tennis players. It has been hypothesized that proprioception helps with motor programming for neuromuscular control, which is necessary for precise motions, muscle responses, and promotes dynamic joint stability.

In the study, there is a significant improvement in the CKCUEST score and grip strength following the intervention. As stated by Danny Pincivero in the article "The role of proprioception in the management and rehabilitation of athletic injuries", the purpose of dynamic stabilization exercises is to promote muscle co-activation [6].

It is also believed that closed-chain exercises performed in weight-bearing positions in the upper extremities co-activate the scapular and glenohumeral stabilizers, thereby enhancing the dynamic stability of the shoulder joint.

Manadlidis and O'Brien et al. discovered a statistically significant and positive correlation between isokinetic peak torque and work assessments of the shoulder stabilizing muscles, as well as isometric hand grip strength. The association has been hypothesized due to the need for a stable proximal shoulder girdle to allow for optimal activation of the distal muscles, which can be attributed to improved grip strength [7].

In the study, a significant improvement in service speed was observed post-intervention. This can be attributed to the increased grip strength in tennis players who perform proprioceptive exercises. Koulla Parpa et al. discovered a strong positive correlation between grip strength and serve velocity in tennis, suggesting that stronger grip strength generally results in a faster serve. A player with greater hand strength can generate more power during the serve motion, resulting in a quicker ball speed [8].

The mean proprioception angle error shows a statistically significant difference in pre- and post-values. A decrease in mean proprioception angle error following proprioceptive training in tennis players suggests that joint position sense (JPS) accuracy in the shoulder has improved. This advancement indicates that the players have become increasingly aware of the precise alignment of their shoulder joints, which is necessary for performing all the complex motions that are an essential component of tennis.

Limitations: The intervention was not compared to a conventional training program

Future Scope Of Study: A comparative study can be done by adding another group that would perform conventional training

CONCLUSION

There is statistically significant difference seen in grip strength, closed kinetic chain upper extremity stability test, serve speed and mean proprioception angle error. Therefore, the proprioceptive training plays a significant role in grip strength and serve speed and functional performance.

ABBREVIATIONS

CKCUEST- Close kinetic chain upper extremity stability test

AUTHOR'S CONTRIBUTION

Hemakshi Jain: Contributed towards selection of topic, Research Process, Research Design, Data Collection, Manuscript Drafting.

Poonam Parulekar: Research Design, Statistical Research Analysis, Discussion and Editing.

Ali Irani: Research Design, Discussion

Conflicts of interest: None

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