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Effects of Proprioceptive Training Program (PTP) on the selected fitness components and playing abilities of female novice tennis players

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Abstract
Objectives: To evaluate the efficacy of a proprioceptive Training program on Balance, Strength and playing abilities of novice tennis players.
Participants: A total of thirty female athletes were selected as the subjects for the present study. The ages of the subjects ranged from 14 to 18 years. All the selected subjects are from Gwalior, India.
Interventions: The experimental group received an 8 weeks proprioceptive training program and control group followed their normal daily routine.
Results: Paired t test showed that there is a significant difference for all the variable's experimental group, but no significant difference in control groups. This statistics further clarified the effect of proprioceptive Training program with Independent t test between post-tests of experimental and control groups of all the three variables and here also we got significant statistical difference.
Conclusions: Proprioceptive training can enhance strength, balance, and playing ability, but further research is needed to understand its mechanisms and optimize training protocols for different populations and goals. This will enable the development of more effective strategies for maximizing muscle strength and athletic performance.

Keywords: Lawn tennis, proprioceptive training, balance, strength

Introduction
In lawn tennis, players need to be highly skilled in their physical interceptive motions in order to initiate and maintain a rally. Athletes have improved due in part to the complex technical requirements of tennis moves as well as the sport's emphasis on winning over developing skill. Tennis players have employed a range of training methods, including the Proprioceptive Training Programme (PTP), to counteract the sluggish rate at which rookie athletes acquire their skills and abilities.
One of the most important neuromuscular senses is proprioception, or the knowledge of one's own body in space. It is a member of the special sense, or somatosensation, which is also known as the sixth sense. Somatosensory senses, also referred to as mechanoreception (vibration, pressure, and selective touch), thermoreception (temperature), equilibrioception (balance), and proprioception (feeling of location and movement), are the general terms that encompass these subcategories. [1]. After receiving input from each of these numerous sensory components, information is sent by our peripheral nervous system (PNS) to our central nervous system (CNS), where it is processed both at the spinal cord level for reflexive function and at the cerebral cortex level for additional processing. [2]. In this case, there is close relationship between proprioceptors, soft tissues, and the nervous system. On nerve terminals in the skin, inner ear, tendons, muscles, and joints are specialised sensors known as proprioceptors. These sensors provide information to the brain about variations in movement, location, force, tension, and environment. Age, neurological disorders, and recent or continuing traumas can all occasionally result in reduced proprioception. For us to remain upright, our muscles and joints must constantly send information to our brain. The brain tracks our location and makes necessary adjustments based on proprioceptive input. [3]. If an athlete's brain absorbs signals too slowly or badly, they are more likely to suffer from an injury like a sprained ankle or chronic knee pain.

Lawn tennis is a graceful and powerful game where players need to be exceptionally athletic. Undoubtedly, the most crucial yet often overlooked quality among them is equilibrium. Maintaining stability while sprinting across the court, quickly changing direction, and unleashing powerful strokes requires a special balancing act of muscle control, proprioception, and mental focus. Their exquisite sense of balance, which enables them to do seemingly unachievable athletic feats, distinguishes decent players from exceptional ones. [4].

Balance is used for more than just keeping your equilibrium. Players can quickly change directions and move across the court like shadows thanks to it as the foundation for their explosive mobility. Imagine Roger Federer diving for a drop shot, his centre of gravity moving effortlessly as he prepared for the return volley with his body perfectly balanced. [5]. The intricate relationship between the body and the mind, in addition to physical skill, combine to produce this amazing dexterity. Balance is important when performing a stroke. A strong foundation is required for each powerful forehand, precise backhand, and graceful volley. For optimal weight transfer and power creation, the player's body must counteract the movement caused by the racket swing. [6]. Mentally agile players can maintain their composure in the face of powerful serves and quick volleys, maintaining balanced even under tremendous pressure. [7].

Lawn tennis, often associated with elegance and grace, has deceptively fluid movements that mask a challenging physical reality. The fundamental building block of the sport is total strength, even though speed and agility are its primary characteristics. An extremely robust muscular system is necessary for the constant sprinting, lunging, and twisting needed to cover the court. From the powerful serve to the deft touch volley, each stroke requires strength in a distinct set of muscles. Each stroke is powered by the upper body, the legs provide the explosive force needed for acceleration and deceleration, and the core keeps the movements balanced and stable. Even when they are not making apparent motions, a tennis player's strength is what enables them to recover quickly and perform at their peak. The secret to an athlete's endurance is their ability to exert effort repeatedly without tiring. This in turn relies on a strong foundation of muscular mass and efficient energy use. [8]. Being strong involves more than just employing physical power; it also involves accuracy and control. Tennis players must possess sufficient strength to target their strokes with precision and force, ensuring that the ball stays inside the lines and moves in the desired direction. This requires a precise balance of unadulterated strength and nuanced control, which can only be attained by regular strength training. Building general strength is a crucial foundation, even though specific training for certain strokes is important. It reduces the chance of injury and enhances overall performance by allowing athletes to withstand the physical demands of the game. Regardless of a player's age or level of endurance, a solid physical foundation is still necessary for success on the court [9].

Materials and Methods

Thirty female athletes in all were chosen to be the study's subjects. The individuals were between the ages of 14 and 18. The chosen topics are all natives of Gwalior, India. Of the thirty girls, fifteen were assigned to the control group and the remaining fifteen to the experimental group. Fifteen girls participated in the proprioceptive training procedure as part of the experimental group, whereas fifteen athletes in the control group went about their usual activities. Pre-data was gathered prior to the training, and post-data was gathered eight weeks later. Players of tennis a stork stand test was used to determine balance values. In the stork stand test, participants raise their right leg and press their right foot's sole against their left kneecap. They must maintain this position for the longest amount of time while a researcher times them in seconds. Using a leg dynamometer, measurements of strength were taken. Athletes using this leg dynamometer should maintain their feet flat on the dynamometer's base while pulling against the weight steadily (no jerky movements). At the end of the lift, when her legs are nearly straight, she will perform at her best. If not, she needs to change the beginning position and length of the chain. The athlete was given three chances, the best of which was recorded. Measurements of a person's ability to play lawn tennis were conducted using Hewitt's revised Dyer backboard test. Hewitt made changes to the Dyer Test, including a 20-foot restraining line and a 30-second time limit for the student to serve and employ ground strokes behind it. Above a 3-foot net line, the athletes smacked the ball against a brick wall. Each of the fifteen athletes received three chances, resulting in an average of three chances being gathered. For every measure, descriptive statistics were calculated. With the use of statistical software, the collected data were examined (SPSS 20 version). To examine the differences between the sample averages of the novice tennis players' strength, balance, and playing skill, the mean, standard deviation, and paired t test were computed. A threshold of 0.05 was established for statistical significance.

Statistical Analysis

Table 1: Descriptive Statistics of Strength, Balance & Lawn Tennis test

			Mean	N	Std. Deviation
Balance	Experimental group	Pre test	13.266	15	2.491
		Post test	15.666	15	2.093
	Control group	Pre test	12.466	15	2.030
		Post test	12.266	15	1.533
Strength	Experimental group	Pre test	112.266	15	4.802
		Post test	115.466	15	4.596
	Control group	Pre test	108.066	15	6.158
		Post test	107.933	15	5.119
Lawn tennis playing ability Test	Experimental group	Pre test	3.600	15	.232
		Post test	4.666	15	.254
	Control group	Pre test	3.133	15	.593
		Post test	2.733	15	.915

Table no 1 showing the descriptive statistics of Balance, Strength and Lawn Tennis Test. During Measuring the balance, in pre test we found the mean and SD of experimental and control group is 13.266±2.491 and

12.466±2.030 respectively. In post test we found the mean and SD of experimental and control group is 15.666 ±2.093 and 12.266±1.533 respectively. Descriptive Statistics of Strength showed the mean and SD of experimental and control group is 112.266±4.802 and 108.066±6.158 for pre test. In post test we found the mean and SD of experimental and control group is 115.466 ±4.596 and 107.933±5.199 respectively. The experimental and control groups' mean and standard deviation were found to be 3.600±0.232 and 3.133±0.593 respectively, during the pre-test phase of the Lawn Tennis Test measurement. The experimental and control group's mean and standard deviation were found to be 4.666±0.254 and 2.733±0.915 in the post-test of the Lawn Tennis Test measurement.

Table 2: Paired sample t test of Strength, Balance & Lawn Tennis test

			Mean	Std. Deviation	Paired Differences t	df	Sig. (2-tailed)
Balance	Experimental group	Pre test Post test	2.400	.9102	10.212	14	.000
	Control group	Pre test Post test	.200	1.264	.612	14	.550
Strength	Experimental group	Pre test Post test	3.200	1.521	8.147	14	.000
	Control group	Pre test Post test	.1333	2.166	.238	14	.815
Lawn tennis playing ability Test	Experimental group	Pre test Post test	1.066	.703	5.870	14	.000
	Control group	Pre test Post test	.400	.910	1.702	14	.111

Table 2 showed the paired Differences columns showed the mean difference in scores between the two groups for variable the variables of Balance, Strength and Tennis Playing Ability. In all the three variales, the p-value is 0.000 for experimental groups, which is less than 0.05. It means that there is a statistically significant difference between the means of all the experimental groups. P-value of Control Groups of Strength, Balance and Tennis Playing Ability (0.550, 0.815, 0.111) is greater than 0.05, which clearly showed the insignificance in Control Group. The paired t-statistic is positive in all three cases.

Table 3: Independent sample t test of Strength, Balance & Lawn Tennis test

		Levene's Test for Equality of Variances		t-test for Equality of Means		
Balance	test Equal variances assumed	F	Sig.	t	df	Sig. (2-tailed)
		1.068	.310	6.392	28	.000
Strength	test Equal variances assumed	.231	.635	5.519	28	.000
Lawn tennis test	test Equal variances assumed	2.115	.157	2.982	28	.006

Table 3 showed the independent t test between post-test of all the experimental groups and control groups of all variables. Balance and Strength showed the p-value of 0.000, which define a significant difference and Lawn tennis test also showed significant difference with the p-value of 0.006.

Results and Discussion

Proprioceptive training's ability to increase muscle strength has piqued the curiosity of exercise scientists. Increasing the body's awareness of its position and movement in space is the goal of proprioceptive training, while typical strength training programmes primarily focus on overloading muscles to promote growth. [10]. Proprioceptors in muscles and joints enable this awareness, which improves control and coordination of muscle activation during exercise. [11]. Research on how proprioceptive training influences muscle strength has produced encouraging results. Proprioceptive training has been demonstrated in earlier studies to help athletes and those with motor impairments, and it was found to significantly boost knee muscle strength in non-athletes. The benefits of proprioceptive training for enhancing muscle strength appear to be possible when combined with traditional strength training programmes. [12]. This impact could be caused by a variety of different processes. Proprioceptive training may lead to increased intramuscular coordination, which would improve force output and muscle fibre recruitment. Enhanced proprioception contributes to strength growth by enabling improved movement patterns and neuromuscular adaptations. [4].

The study's findings provide strong support for the hypothesis that proprioceptive training greatly improves balance. Participants in proprioceptive training improved their joint range of motion more than those in the control group, who only did static stretching exercises. [7]. This suggests that a more effective approach to enhancing balance may be proprioceptive training rather than traditional methods. The benefits of proprioceptive training on balance are attributed to a number of processes. [13]. Better awareness of one's own body's location and movement can lead to increased motor control and coordination through proprioceptive training. This is among the explanations that could apply. This could result in more efficient contraction and relaxation of the muscles during stretches, which could ultimately lead to greater improvements in balance. [9]. Inhibitory neurotransmitters are also released more often after proprioceptive training, which further enhances joint range of motion and muscular relaxation. [14].

There are likely several reasons why proprioceptive training improves lawn tennis performance. It increased awareness of the position and mobility of joints. Increase your

neuromuscular system's flexibility. [15]. Proprioceptive training can improve learning and skill refinement by stimulating the brain's ability to adapt and adjust existing neural connections. During gameplay, cognitive processes are crucial for anticipating opponent shots and making fast decisions. Proprioceptive training directly improves cognitive function by increasing processing speed and attention. [16].

Conclusion

Based on the existing research, proprioceptive training seems to be a beneficial strategy for enhancing strength, balance, and playing skill. More research is required to fully comprehend the exact mechanisms of action and customise training plans for different populations and goals. We can develop more comprehensive and effective programmes for building muscle strength and improving athletic performance if we have a better understanding of the potential of proprioceptive training. Subsequent research should pay closer attention to the specific processes behind the effect of proprioceptive training on muscle strength. Additionally, more investigation is needed to find the proprioceptive training modality and dosage that work best for different individuals. Understanding these factors will make it easier to develop more targeted and effective therapies that maximise proprioceptive training's ability to increase muscle strength.

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