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Research Protocol

Physiotherapy Section

Effect of Myokinetic Chain Training on Agility, Endurance, Reaction Time and Grip Strength in Recreational Tennis Players: A Research Protocol for A Randomised Controlled Trial

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ABSTRACT

Introduction: The kinetic chain is an integrated, multisegmented, sequential joint-motion and muscle-activation mechanism that results in dynamic upper-extremity dominating actions like throwing, kicking, and serving. Efficient kinetic chain function supports force generation, transfer, and movement control during sports-specific activities.

Need of the study: Recreational tennis players have been deliberately chosen as they represent the largest segment of the global tennis-playing community, yet remain underrepresented in sports science research. This protocol is among the first to simultaneously examine the effects of a structured myokinetic chain training program on agility, endurance, Reaction Time (RT), and grip strength in this population. Previous studies have largely focused on elite athletes or have investigated these performance parameters in isolation. By applying the concept of myokinetic chain training- which emphasises proximal-to-distal sequential activation- to non elite players, this study introduces a novel clinical and scientific perspective. Such an approach has the potential to bridge the gap between sports rehabilitation and performance enhancement, offering meaningful insights for recreational athletes.

Aim: To evaluate the effect of 6-week kinetic chain training on endurance, RT, grip strength, and agility in recreational tennis players.

Materials and Methods: A randomised parallel-group study will be conducted between February 2026 and April 2027 at the Sports Complex of Maharishi Markandeshwar (Deemed to be University), Haryana, India. The study will recruit 50 recreational tennis players aged 18-26 years through random sampling. Participants will be randomly allocated into two groups: Group A will undergo kinetic chain training, while Group B will receive conventional training. The primary outcome measures will include RT and agility, while secondary outcomes will consist of endurance and grip strength. For between-group comparisons, the independent t-test will be applied to normally distributed variables, and the Mann-Whitney U-test will be used for non-normally distributed variables. As multiple outcome measures will be analysed, a Bonferroni correction will be applied to reduce the risk of Type I error from multiple comparisons. A p-value of <0.05 will be considered statistically significant.

Keywords: Agility, Hand strength, Performance, Reaction time, Stroke, Tennis

INTRODUCTION

Tennis is popular worldwide. From adolescence to old age, this ‘sport of life’ gives significant social and health benefits. Tennis generates positive attitudes by encouraging physical exercise in a unique atmosphere and rewarding successful strokes for youngsters, non professionals and professionals. Players must use their technical, tactical, motor, and intellectual skills during tennis [1]. Rapid acceleration, deceleration, direction changes, and explosive jumping are examples of physiological and motor components that can be linked to moving around the court with ease, reaching the ball on time and hit it precisely in response to opponents’ moves [2]. In addition to technical skills, physical abilities, including agility, RT, endurance, and grip strength, are necessary for effective performance [3,4].

Biomechanically, tennis strokes are not the result of isolated muscle activity; they arise from the coordinated movement and transmission of force across many segments. The tennis stroke creation is a proximal-to-distal sequence, whereby the lower limbs, trunk, shoulder girdle, arm, and hand contribute progressively to effective movement and stroke formation [5]. Core stability is important for athletic performance, facilitating efficient force generation, transmission, and regulation throughout the kinetic chain, especially in high-velocity sports [6].

The tennis serve is influenced by several anatomical lines that work together, including the front arm lines, front functional line, spiral lines, lateral lines, and deep front line. These lines enhance various aspects such as rotational control, stability, reach, shot precision, racquet grip, power generation, and trunk force transfer. The front functional line is critical for transferring power through the thorax, while the front arm lines are essential for holding and manoeuvring the racquet. Additionally, the spiral and lateral lines play a role in maintaining rotational control, stability, and reach. The deep front line is crucial for core stability, which significantly impacts the power and precision of the shot [5].

The existing research on tennis has primarily focused on general conditioning, isolated strengthening, stretching, or therapeutic intervention, despite the importance of integrated force transmission and kinetic chain function [3,7,8]. There is a lack of evidence supporting a structured myokinetic chain training program specifically tailored for tennis players. This gap in research is notable, as these performance measures are crucial components of tennis-specific performance. Limited studies have examined agility, RT, endurance, and grip strength together.

REVIEW OF LITERATURE

Kinetic chain exercises stimulate one or more muscular groups. Closed-chain exercises stimulate more muscle groups than openchain exercises, although neither can effectively activate multiple muscles at once. A combination of techniques that combine both types may effectively target more muscle units throughout the kinetic chain [8].

According to Kibler WB et al., core stability is essential for athletic function because it facilitates appropriate force production, transfer, and control across the entire kinetic chain. Their study highlighted the coordinated involvement of the lower limbs, trunk, and upper limbs in effective upper-extremity athletic movements and noted that injury to one segment could lead to reduced performance and increased mechanical stress on another segment. They concluded that the complete kinetic chain should be the focus of rehabilitation and performance training, rather than only the affected area [6].

The kinetic chain concept in overhead athletes was further explained by Ellenbecker TS and Aoki R who found that rapid energy transmission between body parts is essential for effective movement. They pointed out that impairments in proximal control, trunk rotation, or lower-limb movement can negatively impact upper-limb movement. They concluded that kinetic chain-based evaluation and training are clinically applicable for enhancing performance and lowering overload in overhead sports, such as actions connected to tennis [7].

Chang CC et al., compared the effectiveness of a four-week kinetic exercise intervention and conventional training for volleyball players with scapular dyskinesis and shoulder pain. Participants were randomly assigned to either the kinetic or the conventional training groups using block randomisation, ensuring gender stratification. Treatments were given three times a week for four weeks, and during this time, a three-dimensional kinematic analysis was performed. The results showed that both therapies were particularly beneficial for restoring upper trunk rotation and improving spiking clarity [9].

"The effect of active myokinetic chain release and stretching on physical performance in young racquet sport players" was studied by Das A et al., They noted that biomotor skills and physical performance improved after the intervention, highlighting the importance of agility, endurance, speed, balance, and coordination in racquet sports. Although their study focused on release therapy rather than planned exercise training, the authors concluded that chain-oriented interventions might enhance physical performance in racquet athletes. The significance of myokinetic chain-based techniques in racquet sport populations and the necessity for additional tennis-specific exercises make this study more relevant [10]. Chain-based training may enhance agility, RT, endurance, grip strength, coordinated segmental activation, core stability, force transfer, and stroke-related control. The present study protocol aims to investigate the effects of myokinetic chain training on agility, endurance, RT, and grip strength in tennis players.

Primary objective: To evaluate the effect of 6-week kinetic chain training on RT and agility in recreational tennis players.

Secondary objective: To evaluate the effect of 6-week kinetic chain training on endurance and grip strength in recreational tennis players

Null Hypothesis (H_0): A kinetic chain-based training protocol does not produce significant improvements in endurance, RT, agility, or grip strength among recreational tennis players.

Alternative Hypothesis (H_a): A kinetic chain-based training protocol produces significant improvements in endurance, RT, agility, and grip strength among recreational tennis players.

MATERIALS AND METHODS

A randomised parallel-group trial will be conducted at the Sports Complex of Maharishi Markandeshwar (Deemed to be University), Mullana, Ambala, Haryana, India from February 2026 to April 2027. The study is registered with the Clinical Trial Registry of India (CTRI/2026/02/104888) and approved by the Student Project Committee (SPC) of MMIPR, MM(DU), Mullana, Ambala (Approval No. SPC-PA-07). Written informed consent will be obtained from all participants before enrolment. Participants will be assured that there will be no adverse health consequences, and the confidentiality of personal data will be strictly maintained.

Inclusion criteria:

1. Male and female recreational tennis players aged 18-26 years who provide informed consent;
2. Minimum of six months' tennis experience;
3. Free from injuries or health issues at the time of participation.

Exclusion criteria:

1. History of surgery within the past six months;
2. Presence of cardiovascular, musculoskeletal, or other systemic disease;
3. Concurrent treatment or supplement use;
4. Inability to hold the dynamometer, or occurrence of cramping, discomfort, or pain during assessment tests.

Sample size calculation: The required sample size per group was estimated using the formula for two independent groups based on Cohen's standardised effect size:

$n=2\cdot(Z1\text{-}\alpha/2+Z1\text{-}\beta)^2/d^2$

Where:

- n =sample size per group;
- Z1-α/2 =Z value for significance level (1.96 for α=0.05);
- Z1-β=Z value for desired power (0.84 for 80% power);
- d =Cohen's standardised effect size=0.8 [11].

Although Bokil C et al., employed proprioceptive training rather than myokinetic chain training, both interventions share a common neurophysiological basis- enhancement of sensorimotor integration and neuromuscular response pathways that underpin RT in tennis players [11]. In the absence of a published RCT on myokinetic chain training reporting pre–post RT data in tennis players, study by Bokil C et al., was considered the closest available evidence base, as it involved, the same population (recreational tennis players), the same outcome variable (simple RT via ruler drop test), and a comparable age group (18-26 years).

$n=2*(1.96+0.84)^2 0.80$

$n=2*(2.80)^2/0.64$

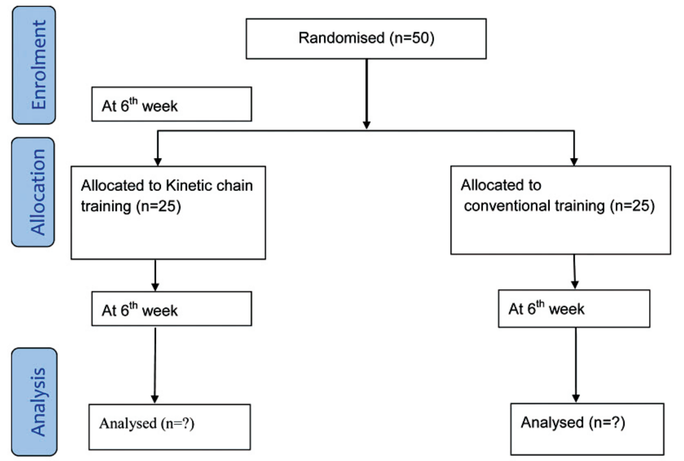
$n=2*7.84/0.64$

$n=15.68/0.64=24.5\approx25$

Thus, the required sample size is 25 participants per group, yielding a total sample size of 50 participants.

Participants will be randomised into either the experimental or control groups with a 1:1 allocation ratio. To ensure allocation concealment, will use sequentially numbered, opaque, and sealed envelopes prepared by an independent third party who is not involved in participant recruitment or screening. Each envelope will contain the group assignment and will be opened sequentially by the recruiting coordinator only after the individual has completed all baseline tests and has been confirmed as eligible for participation [Table/Fig-1].

Due to the nature of the exercise interventions, complete participant blinding is not feasible, as participants are necessarily aware of the training programme they are receiving. However, a single-blind design will be implemented: the outcome assessors responsible for all pre- and post intervention measurements (RT, agility, endurance, grip strength) will be blinded to group allocation throughout the study. The assessors will have no access to the randomisation list or group assignment envelopes. Participants will be instructed not to disclose their group allocation to the assessors at any time during the study period.



[Table/Fig-1]: CONSORT flow chart.

First, the players will warm up for 10-15 minutes. After that, preoutcome measurements of endurance, RT, agility, and grip strength will be taken at zero and six weeks for recreational tennis players. The players will be divided into two groups: Group A and Group B. In Group A, myokinetic chain exercises training will be performed for six weeks [Table/Fig-2] [12-18], while Group B will follow conventional training as discussed in [Table/Fig-3]. In Group B, conventional training will include stationary drills, wall practice, forehand serves, clockwise and counter clockwise spins cross passes, multiball practice, and attacks [19]. The total duration of this training protocol will be a maximum of 50 minutes. At the end of six weeks, the postoutcome measures will be taken again to evaluate the players' progress.

Primary outcomes:

T-test: The t-test will be used to assess the agility of the player. The players will start their test with both feet positioned behind the starting point A. When the whistle blows, the player starts running from point A to cone B, which is 9.14 m (10 yards) away. The player will run to the left 4.57m (5 yards) and touch the cone C with their left hand, followed by running to the right 9.14 m and touching the cone D with their right hand. Then they ran 4.57 m to the left and touched the cone B with their left hand. From cone B, the players run backward, crossing the finish line at point A. A total of three test trials will be done, and the timings will be recorded in seconds [20].

Ruler drop test: The ruler drop test will be used to evaluate RT. The subject will be seated parallel to a table, leaning on it with their elbow bent at a 90° angle. The 60 cm long ruler will be held vertically by the researcher, who positioned the zero point between the thumb and index finger. The researcher will explain the protocol to the participants. When the word "ready" is said, the participant will be told to gaze at his or her hand and that the ruler might fall at any moment. As soon as they see the ruler fall, the players have to attempt to pick it up as fast as they can. A total of three trials will be taken [21].

S. No.	Exercise	Description	Duration
1.	PNF D1-D2 Flexion/ Extension of upper extremity with TheraBand	**D1 Flexion-Adduction-External Rotation** Shoulder: flexion-adduction-external rotation Scapula: anterior elevation Elbow: accommodates for goals Wrist: radial deviation and supination Fingers: flexion and adduction **D1 Extension-Abduction-Internal rotation** Shoulder: extension-abduction-internal rotation Scapula: posterior depression Elbow: accommodates for goals Wrist: ulnar deviation and pronation Fingers: extension and abduction **D2 Flexion-Abduction-External Rotation** Shoulder: flexion-abduction-external rotation Scapula: Posterior elevation Elbow: Accommodates for goals Wrist: Radial deviation and supination Fingers: Extension **D2 Extension-Adduction-Internal rotation** Shoulder: extension-adduction-internal rotation Scapula: anterior depression Elbow: accommodates for goals Wrist: ulnar deviation and pronation Fingers: flexion and adduction	2 sets/10 repetitions (30 sec of rest in between)
2.	Medicine ball rotational throw	The subjects will be informed to stand sideways (i.e., alternating both the left and the right foot and shoulder pulled forward), and facing the wall to which the ball is to be thrown, holding a medicine ball at the belly button in both hands. To begin, the subjects performed a counter movement at the height of the waist, and then the ball was forcefully thrown in a straight path by an explosively executed hip and trunk rotation.	2 sets/15 repetitions
3.	Split squat	Participants will be instructed to step forward into a split stance with the dominant limb, then complete each repetition by lowering the body until the front thigh was parallel to the floor. Once they reached the lowest position, they will be instructed to immediately rise upward and return to the split standing starting position.	2 sets/10 repetitions (30 sec rest in between sets)
4.	Forward lunge	Participants will be instructed to stand, feet shoulder-width apart. Participants lunged forward and must lower the thigh to be parallel with the ground and then return to the starting position.	6 sets/10 repetitions
5.	Jump squat	The participants will be instructed to stand, lower themselves to a self-selected knee flexion, and immediately jump. Arms will be placed on the hips. The participants were instructed to avoid any knee flexion before landing.	3 sets/10 repetitions

[Table/Fig-2]: Myokinetic chain exercise training in Group A [12-18].

S. No.	Conventional training component	Description	Duration
1	Stationary stroke drills	Forehand and backhand stroke practice from a fixed position to reinforce basic stroke control.	8 minutes
2	Wall practice	Repeated forehand and backhand hitting against the wall at comfortable intensity.	8 minutes
3	Forehand serve practice	Repeated serve practice focusing on comfortable technique and consistency.	8 minutes
4	Clockwise and counter-clockwise movement drills	Court movement drills in both directions at moderate intensity.	8 minutes
5	Cross-pass drills	Forehand and backhand cross-court passing drills with controlled footwork.	8 minutes
6	Multiball practice and attack drills	Repeated ball feeding with controlled attacking strokes according to participant tolerance.	10 minutes

[Table/Fig-3]: Training plan for Group B (conventional tennis training).

Secondary outcomes:

Plank test: The core endurance will be assessed using the plank test. In the prone plank test, the participant stayed prone while using their forearms and toes to maintain their body weight. Players had to lie on their side with their foot and elbow supporting them for the side plank test. Both sides will be subjected to the side plank test. During the test, players will be instructed to maintain a neutral pelvis and spine and to breathe properly. When the subject is unable to maintain their position, the test will be stopped. Every holding time will be recorded using a stopwatch [22].

Handheld dynamometer: To evaluate grip strength, Jamar handheld dynamometer will be utilised. The player will hold the dynamometer while taking the test. The American Society of Hand Therapists (ASHT) position will be used, which consists of the subject sitting upright, shoulder adducted and neutrally rotated, elbow flexed at a 90° angle, forearm neutral, and wrist extension ranging from 0° to 30°. The player will be directed to squeeze the dynamometer as hard as possible for a minimum of five seconds. The player will be given three trials, and the average record will be calculated [23].

The selected outcome measures are feasible, low-cost, field-based and previously used in sports or athletic populations. Although the tennis-specific RT and agility tests are valuable, their implementation requires additional equipment, visual stimulus systems, and testing resources that are not currently available at the institute. Therefore, validated general sports performance tests are selected to examine the RT, agility, endurance, and grip strength in a standardised manner.

STATISTICAL ANALYSIS

Data will be analysed using Statistical Package for the Social Sciences (SPSS) version 26.0 (SPSS Inc., Chicago, IL, USA). The normality of continuous variables will be assessed using the Shapiro-Wilk test. For variables following a normal distribution, descriptive statistics will be presented as mean ± Standard Deviation (SD); for non normally distributed variables, the median and Interquartile Range (IQR) will be reported. Between-group comparisons will be performed using the independent samples t-test for normally distributed data and the Mann-Whitney U test for non normally distributed data. Intragroup (within-group) comparisons will be conducted to assess pre-post changes within each intervention arm. For normally distributed data, the paired samples t-test will be applied; for non normally distributed data, the Wilcoxon signed-rank test will be used. All statistical tests will be two-tailed, with significance set at p-value ≤0.05. Given the analysis of multiple outcome measures, a Bonferroni correction will be applied to control for type I error. With four outcome measures, the adjusted significance threshold for outcome-specific comparisons will be set at p-value ≤0.0125.

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