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The effect of active myokinetic chain release and stretching on physical performance amongst young racquet sports players

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Abstract
Introduction. **Muscle imbalance is frequently observed according to research findings. Muscles that have been shortened for a lengthy period become tight. Modalities, posture changes, and releases can all be used to treat this condition. Muscle soreness is a myogenic condition that results from deep releases. A joint's range of motion is reduced and pain is experienced as a result of adhesions and inflammation caused by the rupture of taut bands because of excessive pressure.** Aim of Study. **The aim was to examine the effects of active myokinetic chain release therapy (AMRT) and stretching on physical performance amongst adolescent racquet sport players with misalignment of fascial tissue.** Material and Methods. **Eighty racquet sports players having muscle imbalance as tested by the Bunkie test were randomly divided into two groups receiving AMRT and stretching, respectively. They were tested for different biomotor abilities, targeting lower back and hamstring flexibility, agility as well as endurance, with functional ability, speed of the racquet, pulse rate, and oxygen saturation used to assess physical performance.** Results. **AMRT resulted in better results in improving the biomotor abilities as compared to stretching in different biomotor abilities, but there was a significant change from pre- to post-assessment.** Conclusions. **While AMRT can increase biomotor and physical performance in elite athletes, there is no key procedure to apply this intervention to any player, yet this appears to be a very easy and adequate protocol for the athletic population to generate the immediate effect.**

KEYWORDS: stretching, Bunkie test, racquet players, active myokinetic chain release therapy, biomotor abilities.

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Introduction

Sports are an important part of our daily lives because they help us improve and maintain our physical, physiological, psychological, and social health [19]. Racquet sports players must be able to move and change directions quickly, speed up and slow down quickly while running, keep their balance and coordination, generate the right amount of force for each stroke, and do all of this repeatedly to do well in a game or tournament [11, 17]. To coordinate all the events, the primary factors in racquet sports are flexibility, endurance, muscle strength, speed, balance, and coordination, more precisely agility, response time, and cognition [8]. Young tennis players who are exceedingly active are more likely to acquire a harmful maladaptation in strength and flexibility in the area subject to repetitive tensile overload. The timing of the tournament or gameplay influences the improvement of maladaptation [14]. Maladaptation causes changes in joint biomechanics and force coupling of the muscles around the joint, as well as a reduction in force generation and a risk factor for injury [9]. On average, young players who participate in tennis or other sports sustain several injuries, which are directly related to the frequency, with which these individuals participate in the games [14].

The many components responsible for human body movement include muscles, tendons, bones, nerves and arteries, among other things. Similarly, fascia is an important component that covers all the body's components responsible for movement and other work in a web-like structure [26]. According to evidence from the literature, fasciae can aid in venous return, dispersion of tensional stress at the site where a muscle, ligament, or tendon inserts into a bone [3], explaining the etiology of pain [16], and smooth interaction between muscles of the limb. Fascia is an important component in the maintenance of human posture and mobility. Finally, some research suggests that the continuity of the fascial system has a function in proprioception and conveys the organ sensations throughout the body [3, 16]. Trainers, coaches, and physiotherapists constantly encounter new challenges and use their knowledge to develop new exercise protocols aimed at improving performance and reducing injury and its risk factors in the sports population, as modern-day athletes are subjected to intense training programs to achieve an optimal level of performance in the competitive era of sport [5].

Different isometric tests are used to assess the balance and endurance kinetic muscle chains, but these are mostly isolated. Therefore, to assess the weak or wrong muscle activation and imbalance of muscle a simple, less expensive isometric test called "the Bunkie test" was developed over a period of 12 years by a South--African physiotherapist working with elite athletes [5, 7]. Repetitive movements in sports cause the fascia to shorten and thicken around the overused muscle and lengthen in another area of the body. The main goal of the Bunkie test was to find the obvious restriction of the kinetic chain along the fascial lines [23].

Among the several release techniques that have been examined to determine the advantageous effect of improving the effect of muscle soreness the active myokinetic chain release technique (AMRT) is one of the most commonly used in clinical practice [1, 28]. The purpose of the technique is to ease the pain and tightness and help the muscle to return to its normal position. The application of AMRT has provided a better improvement in increasing flexibility and the range of motion immediately after the treatment [1, 28]. Although AMRT is commonly used in clinical practice by physiotherapists, its effect on the sports population has not been scientifically studied. This new therapeutic strategy has been introduced to the sports population.

Aim of Study

The purpose of the study was to assess the misalignment and muscle imbalance using the Bunkie test so that the athletes could correct misalignment, activate the right muscle for the specific movement under the supervision of a physiotherapist, and examine the effect of AMRT on physical performance and specific biomotor abilities in adolescent racquet sport players.

Material and Methods

The inclusion criteria were 14-20 years old, regularly practising racquet sports, having at least one year of experience, no major injuries interfering with their game, and an incorrect kinetic chain diagnosed by the Bunkie test. Players with unstable pathology, severe neurological deficits, continuous neurological pain, cardiac or metabolic diseases that prevent them from testing, and players who successfully completed all five positions in the Bunkie test and those on any dietary supplements during the testing were excluded. The method of double-blinded randomization was used to allocate players into two groups. The present study used a quasi-experimental design with two experimental groups (the active myokinetic release group and the active stretching group).

Sampling

The calculation of the sample size was carried out using the G*Power version 3.1.9.7 program using A priori 't' test (means: difference between two independent means, two groups), with an α error of 0.05, power ($1 - \beta$ error) of 0.80, effect size of 0.5, resulting in a total of 128 participants. However, this was rounded to 150 considering the dropouts.

Procedure

After the clearance of the study by the ethical committee of the university (MRIIRS/FAHS/DEC/2021-S16 dated 12th April), the players were screened from different sports academies in Delhi and Faridabad (India). All the testing was conducted during the non-competitive phase of the season, and the academies continued with their normal training season around the time of testing. The nature, importance, and beneficial effect of the study were clearly explained to the players and coaches. Written consent was taken from the players, who volunteered themselves for the study and fulfilled the inclusion and exclusion criteria.

About 150 players were screened. These players were checked for their eligibility for enrolment based on the inclusion and exclusion criteria. The Bunkie test was performed to test fascial alignment as one of the inclusion criteria (Figure 1).

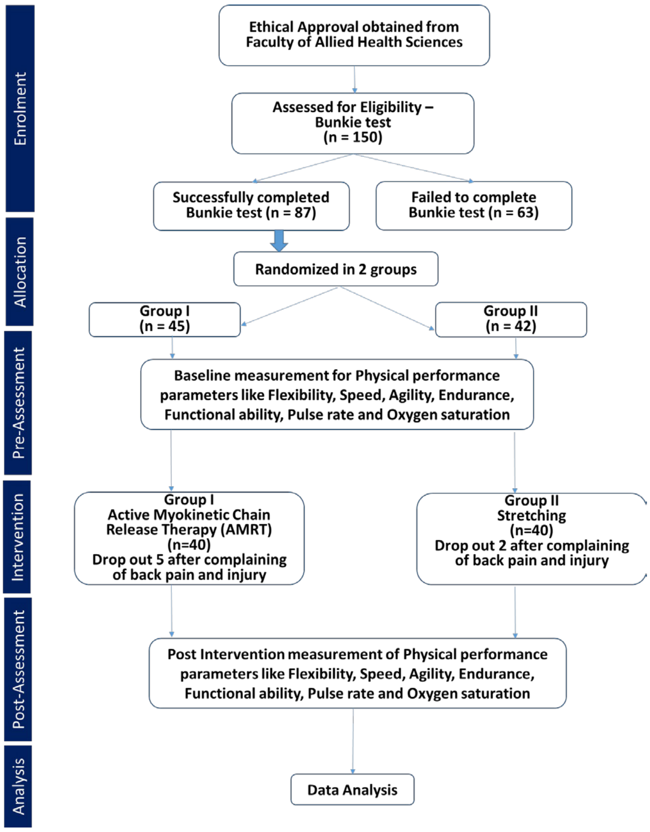

Figure 1. Flow chart of the study

The Bunkie test

The Bunkie test was demonstrated and clearly explained to all the players. The Bunkie test is comprised of five positions or functional lines, each performed on the left and right sides of the body, totaling ten positions. Postures included the posterior power line (PPL), anterior power line (APL), posterior stabilizing line (PSL), lateral stabilizing line (LSL), and medial stabilizing line (MSL). Each position is completed on a 30 cm high bench with the upper extremities resting on a mat placed on the floor below them. The athletes were allowed to try each position to familiarize themselves for 5 seconds, but no longer to avoid fatigue. Subjects were instructed to hold each position for 40 seconds, which is the duration required for elite athletes. Since this test is aimed to identify fascia restrictions in specific lines rather than measuring strength, therefore they were instructed to express the moment when they first felt any straining, cramping, pain or tension while holding a position [5]. These symptoms indicated that the fascia in that specific line was "locked-long", causing restrictions in the fascia and malalignments of the myofascia. The duration that the participant could hold each position without symptoms was recorded.

Intervention

Group I

Group 'A' received myokinetic therapy targeted at releasing muscles of the superficial back line, i.e., gastrocnemius, hamstrings, thoracolumbar fascia, and erector spinae. The release was applied passively by sustained pressure for 8-10 seconds. A gentle stretching force was applied to take up the slack until the muscle was released. The patient was next asked to apply a weak opposite force in the stretched position to improve the release. This protocol consisted of three sets with 2 minutes of rest for six sessions. Each session was given on alternate days. Each muscle group was released on the same day and during each session.

Group II

Group 'B' performed self-stretching of the gastrocnemius, hamstrings, thoracolumbar fascia, and erector spinae. The subjects used their own body weight without any extra help from the physiotherapist. Subjects were instructed to perform three sets of stretches for all the muscles. Each stretch was held for 20 seconds, alternating the left and right limbs. The subjects were next instructed in the self-stretching exercise of the erector spinae muscle and thoracolumbar fascia. Each session was given on alternate days. Each muscle group was released on the same day and during each session.

Testing, assessment, and evaluation

The assessment was done to assess the selected biomotor abilities using the sit and reach test (lower back and hamstring flexibility), half kneeling rotation of trunk in back (HKRTB), half kneeling rotation of trunk in front (HKRTF), sitting trunk rotation (STR) (for trunk flexibility), T-test (for agility), progressive aerobic cardiovascular endurance run test (for endurance), single limb timed side hop test (functional ability), speed of the racquet by speed gun (speed), pulse rate and oxygen saturation (using a pulse oximeter).

It was ensured that the Bunkie test was performed on the first day and the biomotor abilities were tested on the second day to avoid fatigue. All testing sessions were conducted in the mornings and players were tested individually. One researcher was present as an overseer during the testing. Testing started after a 10-minute dynamic warm-up routine. A 10- to 15-minute break separated the various tests.

Sit and reach test

The players sat on a rubber mattress with their legs extended and feet at the right angle to the floor, approximately hip-wide against each other. The rubber mattress was marked with a plus sign. The center of the plus sign was mounted with “0”. The line parallel to the leg and opposite to the player was mounted with 1, 2, 3, etc. in inches and the line towards the players with -1, -2, -3, etc. in inches. The feet were placed at the base of the horizontal line of the plus sign. Then players were instructed to extend their arms slowly forwards as far as they could by placing one hand upon another along the measuring line. With palms down, the player reached forward, slinging hands along the measuring scale as far as possible without bending the knee of the extended leg. The score was obtained according to the best distance covered by the middle finger with three attempts for each player.

Test for trunk rotation flexibility

The HKRTB, the HKRTF, and the STR were used to measure flexibility of trunk rotation. For the HKRTB, the participant was asked to place the left knee down on the ground and the right foot directly in front of the left knee [21]. A baseball bat was positioned behind the back and held in place by asking the participant to lock their arms around the bat while keeping their hands on their stomach. This position keeps the scapula in a retracted position, removing any range of motion that may occur from scapular movement. The examiner stood to the right of the participant and positioned the stationary arm of the goniometer parallel to the upper back. The participant was then asked to rotate as far to the right as possible without discomfort. As the participant rotated, the movable arm was aligned parallel to the upper back, and the angle between the stationary and moving arms was recorded. The test was repeated with the position of the legs switched to measure rotation to the left.

The HKRTF was performed in the same manner as the HKRTB, except that the bat was placed across the chest instead of behind the back [21]. This test allows movement of the scapula over the rib cage and measurement of the rotation flexibility achieved by scapular and spine movement. The test was repeated with the position of the legs switched to measure rotation to the left.

For the STR, the participant was asked to sit in a chair with their feet together and touching the ground, their body in an erect upright posture, and their arms across their chest [24]. They were then instructed to rotate to the right as far as possible without discomfort. A goniometer was used to measure the amount of rotation with the same alignment as the HKRTB and HKRTF. The test was repeated with rotation to the left.

For all flexibility measures, an average of three trials was used for analysis.

Agility T-test

T-test was performed by using the four cones placed in the shape of a “T”, where the second cone was kept at a distance of 9.14 meters and the other two cones were kept at a distance of 4.57 meters from the second cone. The time from the crossing of the first cone at the start to the ending of the same cone on the return was measured using a stopwatch. The players were instructed to sprint forward 9.14 meters from the starting cone and touch the tip with their right hand, then side sprint to the left and touch the third cone with their left hand, and finally side sprint 9.14 meters to the right and touch the fourth cone with their right hand, then side sprint to the second cone and touch it with their left hand, and finally return to the first cone with a backward sprint. Three attempts were made for each player, out of which the best one was taken [22]. Trials were found to be unsuccessful if the player failed to touch the cone, had their leg crossed during a side sprint, or did not face forward during each attempt. One minute of recovery was given between each attempt.

Pacer/beep test

Players were instructed to run between two lines 20 meters apart, reaching each line in synch with the corresponding beep. According to the improvement of running speed, the beep interval decreases slowly as the testing progresses. Players can withdraw themselves from the test when fatigued, or after missing the line once, unable to attempt the line on the next beep, or being eliminated by the experimenter after attempting to reach the line, but missing two beeps consecutively. The score was calculated by adding the number of attempts, shuttle type, and level completed [18].

Single legged timed side hop test

With the adherence tape, three boxes of 46 × 46 cm in length and width were secured to the floor. The players were encouraged to side hop to the next box as fast as possible by maintaining their balance and the time was noted down with the help of a stopwatch, which represented the score. A score of zero was obtained if the player was unable to cross the lines, double bounce between the hops, or was not able to hold the balance during landing [6].

Speed of racquet

The speed of the racquet was measured using a velocity speed gun or radar gun [25]. Serving and smashing speeds were measured in tennis and badminton players, respectively.

Oxygen saturation and pulse rate

Both oxygen saturation and pulse rate were measured with a pulse oximeter at a basal level [20]. The players were instructed not to do any vigorous physical activity and to breathe gently before measuring. All the measurements were made in a calm and quiet place.

Statistical analysis

All statistical analyses were carried out using the SPSS version 21. The normality distribution of all variables was verified using the Shapiro–Wilk test. An independent test was used to examine the difference between groups for demographic characteristics and outcome measures at baseline. A 2 × 2 mixed model ANOVA was used to consider within subjects' effects (baseline and post-intervention values) and the between subjects' effect (AMRT and stretching groups) to determine the main effects (time and group effect) and the time × group interaction. If baseline values showed a significant difference, then 2 × 2 ANCOVA was applied to find the main effects (time and group effect) and the time × group interaction using baseline values as covariates. Partial eta square was performed to check the ratio of variance explained in the dependent variable by a predictor while controlling the other predictors. All the descriptive data are presented as means and standard deviations. A p-value of ≤0.05 was taken as the significant level for all variables.

Results

A total of 150 players were screened in the study. Sixty-three players were excluded based on the successful completion of the Bunkie test during the study, and 7 players [group 1 (n = 5) and group II (n = 2)] who had severe back pain while performing biomotor tests were also excluded. Therefore, 80 players who successfully completed the Bunkie test (taking less than 40 seconds

Table 1. Baseline demographic characteristics of participants in group I and II represented as Mean ± SD

Independent variables	Group I (AMRT) (n = 40)	Group II (stretching) (n = 40)	p-value
Age (years)	17.97 ± 2.04	18.12 ± 1.38	0.720
Height (meter)	1.66 ± 0.04	1.64 ± 0.07	0.178
Weight (kg)	50.76 ± 4.40	52.34 ± 2.75	0.094
BMI (kg/m²)	18.20 ± 1.31	19.33 ± 1.57	0.004*
Sleeping duration (hours)	9.24 ± 0.68	9.16 ± 0.80	0.661
Hydration status (litres/day)	3.14 ± 0.90	4.31 ± 0.99	0.001*
Training duration (hours/week)	11.10 ± 2.88	12.88 ± 2.26	0.01*
Playing since (years)	2.36 ± 0.73	1.98 ± 0.86	0.072
Pulse rate	93.24 ± 9.36	92.31 ± 8.11	0.68
Oxygen saturation (%)	98.03 ± 2.24	92.16 ± 3.47	<0.001*
Sit and reach test	16.8 ± 0.87	16.63 ± 1.5	0.585
Trunk rotation	87.29 ± 4.97	85.94 ± 5.06	0.3
Agility	12.82 ± 1.1	13.61 ± 1.34	0.015*
Speed of racquet	227 ± 28.83	197.16 ± 30.66	<0.001*
Endurance	5.8 ± 0.62	5.24 ± 0.77	0.003*
Functional ability (left limb)	2.87 ± 0.5	3.24 ± 0.8	0.033*
Functional ability (right limb)	2.61 ± 0.52	3.15 ± 0.6	0.001*

Note: AMRT – active myokinetic chain release therapy, BMI – body mass index, SD – standard deviation
* signifies the level of significance p < 0.05

to perform five positions or functional lines) were included in the study. Among the demographic variables, three variables were found to be significantly different between group I and group II, i.e., BMI ($p \leq 0.004$), hydration status ($p \leq 0.001$), and training duration ($p = 0.01$) (Table 1).
The variables with no significant difference between the two groups at the baseline were flexibility (sit and reach test and trunk rotation) and pulse rate. A univariate test was used to determine the time effect and the time × group interaction, and a multivariate test was used to identify the group effect in these two variables. The variables with significant differences between the two groups at the baseline were agility, speed, endurance, functional ability (left and right) and the percentage of oxygen saturation. Box's test of equality of covariance matrices was applied to analyze the time effect, time × variable covariate interaction and time × group interaction. From the result of analyses of variances (ANOVA) it was found that flexibility using the sit and reach test and trunk rotation,

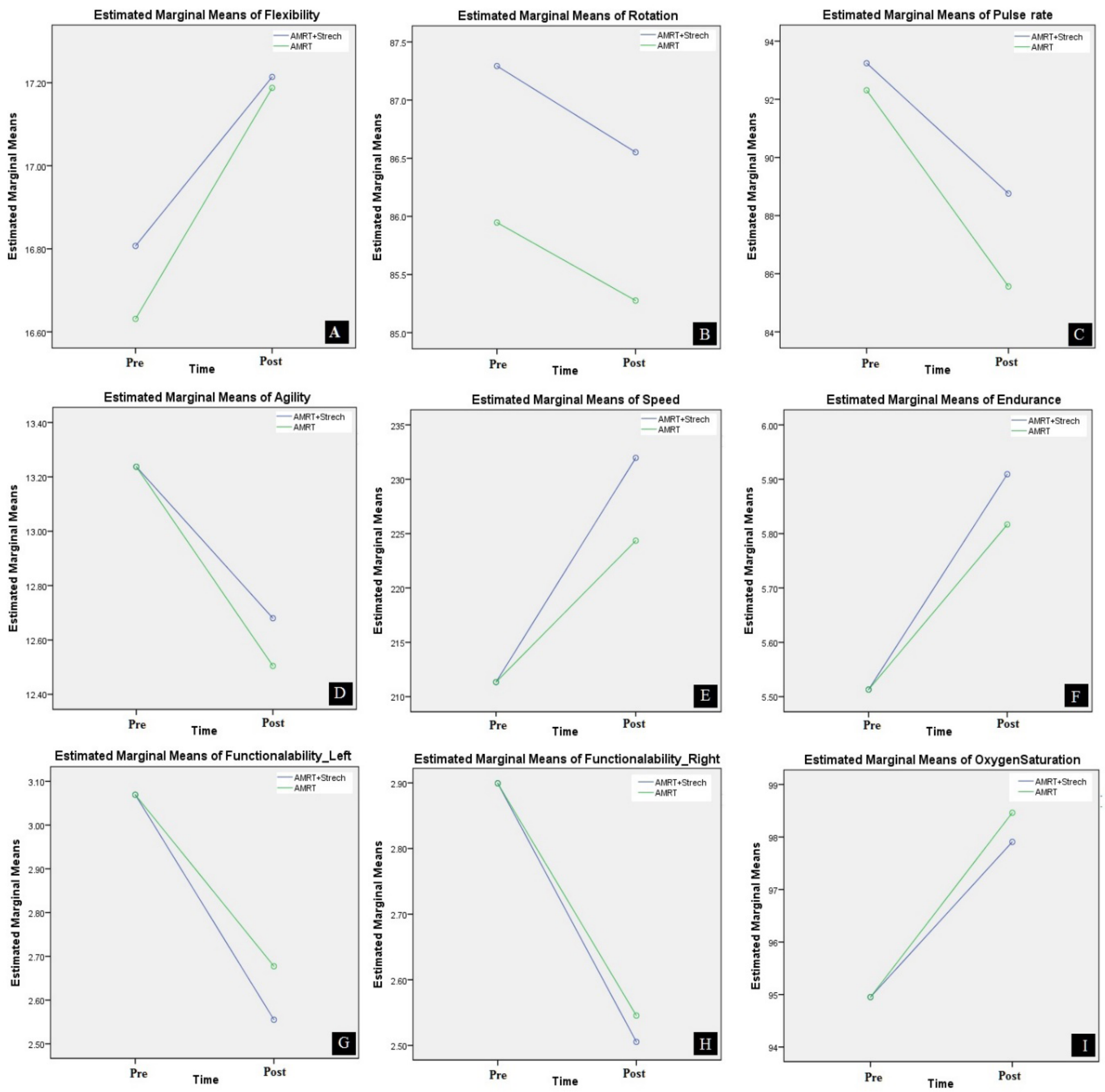

Figure 2. ANOVA plot of the mean (A) flexibility, (B) rotation, (C) pulse rate; ANCOVA plot of the mean (D) agility, (E) speed, (F) endurance, (G) functional ability (left), (H) functional ability (right), (I) oxygen saturation percentage – score for group I (active myokinetic chain release therapy) and group II (stretching)

and pulse rate showed significant changes in time ($p < 0.001$), whereas the group and time × group interaction was not found to be significant (Table 2).

Table 2. Results of the 2 × 2 mixed model analyses of variance (ANOVA) for flexibility and pulse rate

Outcome measures	Source	F-value	Partial eta	p-value
Flexibility				
sit and reach test	time (T)	96.18	0.62	<0.001*
	group (G)	0.109	0.002	0.743
	time × group	2.313	0.038	0.134
trunk rotation	time (T)	52.14	0.469	<0.001*
	group (G)	1.016	0.017	0.317
	time × group	0.131	0.002	0.719
Pulse rate	time (T)	44.11	0.428	<0.001*
	group (G)	1.265	0.021	0.265
	time × group	1.80	0.03	0.185

* $p < 0.05$

Results of ANCOVA revealed that agility ($p = 0.05$), speed ($p = 007$), endurance ($p = 0.011$), functional ability on the left limb ($p = 0.021$), functional ability on the right limb ($p = 0.001$) and oxygen saturation ($p < 0.001$) were found to be significant for the time effect, whereas the group effect and the time × group interaction were not significant for all outcome measures (Table 3).

Table 3. A summary of analyses of covariance (ANCOVA) for agility, speed, endurance, functional ability left and right and oxygen saturation percentage

Outcome measures	Source	F-value	Partial eta square	p-value
Agility	time	3.956	0.064	0.05*
	group	0.92	0.016	0.342
	time × group	0.92	0.016	0.342
Speed	time	7.726	0.118	0.007*
	group	2.274	0.038	0.137
	time × group	2.274	0.038	0.137
Endurance	time	6.906	0.106	0.011*
	group	0.836	0.014	0.364
	time × group	0.836	0.014	0.364
Functional ability (left)	time	5.607	0.088	0.021*
	group	1.952	0.033	0.168
	time × group	1.952	0.033	0.168
Functional ability (right)	time	13.564	0.19	0.001*
	group	0.138	0.002	0.711
	time × group	0.138	0.002	0.711
Oxygen saturation percentage	time	52.967	0.477	<0.001*
	group	0.443	0.008	0.508
	time × group	0.443	0.008	0.508

* $p < 0.05$

The plot of the mean "flexibility, rotation, pulse rate, agility, speed, endurance, functional ability (left), functional ability (right), oxygen saturation percentage" score for group I (AMRT) and group II (stretching) is plotted in a line graph, as shown in Figure 2.

Discussion

AMRT is a popular method to potentially increase the compliance and extensibility of the fascia and reduce muscle stiffness [30]. AMRT has been associated with positive linkage with physical performance, increasing the range of motion and athletic performance. The study was designed to check the effect of AMRT among adolescent racquet sports players, taking various physical performances of the players into consideration. The study has revealed the importance of muscle functioning in the kinetic chain and not in isolation, as well as the influence of malfunction in these chains on the biomotor abilities and other functional parameters. The correction of these kinetic chains is absolutely necessary to improve the biomotor abilities as well as the functional parameters. Stretching exercises alleviate the pain and have been found to be useful in decreasing joint stiffness and increasing the range of motion. The lengthening of connective tissue, which makes muscles more flexible when they break or become inflamed, is also a major physiological effect that makes people more likely to use stretching to shorten muscles [29]. To this end, the findings of this study have improved our understanding of the functions of muscles in the kinetic chain as well as given a practical tool for therapists, coaches, and players to improve the physical performance of athletes.

The outcome variables such as flexibility (lower back and hamstrings measured by the sit and reach test and trunk rotation measured by the trunk rotation test) show their significance with respect to time in both groups. Both groups saw a considerable increase in pulse rate and agility with time. The speed and endurance are important factors for racquet sport players. The functional ability of the lower limb for both the left and right side show its significant result with respect to time. Figure 2 shows that the effect of time on the percentage of oxygen saturation was important.

Despite an increase in the baseline values for the sit and reach test, the impact of AMRT appears to be more significant than that recorded in the stretching group. Further, the average pre- to post-measurement for flexibility appears to be greater following AMRT as compared to stretching, suggesting that there is a main effect of time as well. The findings of the means of trunk rotation in the stretching and AMRT groups hardly showed any significant difference. However, the effect of these techniques indicated decreased rotation, which was significant in group II receiving stretching as compared to group I receiving AMRT. In addition, the pre- to post-measurement of rotation following stretching was higher than AMRT, suggesting that there is a main effect of time (pre-post).

A recent study explained that ART was given to a patient with chronic muscular neck pain and the therapy was effective in muscle soreness and pain where the release was given to lengthen the area [15]. This study concluded that the release given towards the painful area improves both the range of motion (flexibility) and alleviates pain, but the release opposite to the painful area improves only the range of motion, not the pain.

When the muscle is worked for a longer period or due to the overuse of the muscle in the athletic population, both the muscle and the fascia become shortened. As the fascia is shortened, the muscle spindle and muscle fibers get close to the shortened area, because of which the myofascial system becomes strong and non--breakable [2, 4, 27]. In this study, the intervention that is the release was given towards the lengthened area to break the adhesion, which was formed in the shortened area and improved the blood circulation in the weak area.

The results of this study confirmed that there is a clinical significance between pulse rate and time and intervention. The effects of both AMRT and stretching techniques have shown significant impact in relation to the time of exposure, but this was not significant between AMRT and stretching. All the other variables, including agility, speed, endurance, functional ability (left and right), and oxygen saturation percentage improved in the stretching and AMRT groups. For the main effect of pre- to post--measurement there was no significant difference in agility, while there was a significant difference in speed, endurance, functional ability (left and right), and oxygen saturation percentage (Figure 2).

Several studies have looked into the benefits of reducing muscle soreness. The myokinetic active release technique is widely used in clinical practice. The patient is asked to actively move the tissue from a shortened to an extended position, breaking the adhesion produced. It helps relieve pain and tightness while repositioning the muscles. ART has improved flexibility and the range of motion shortly after treatment [1, 28].

Nowadays, various soft tissue release techniques such as e.g. self-myofascial release using a foam roller, or manual myofascial release using different methods of application are practiced [10, 13]. Myokinetic chain active release therapy is used for treatment purposes, which ultimately helps in adhesion break, increases the blood flow and lymphatic drainage, resulting in increased flexibility of the soft tissues, while it also improves the range of motion and muscle strength. Active myokinetic strain release is a technique that involves the application of deep tension over the tenderness and instructs the players to actively move the tissue from the shortened to the lengthened position, which results in breaking the adhesion [12]. Although this study did not result in any significant changes in racquet players with muscle imbalance, in the future this AMRT may be applied to diseased, disabled, and recreational athletes. In addition, this technique may be assessed in other games at different levels.

Conclusion

While computing the effectiveness of AMRT on the physical performances of adolescent racquet sports athletes, it is concluded that although AMRT has better results than stretching, this difference is not significant. The active myokinetic release technique has been used by physiotherapists for the treatment of tenderness/stiffness at various joints. From the practical point of view, we can suggest that the active myokinetic technique is effective in the release of the myofascia and, in turn, improves the sports specific parameters of racquet sports players. Stretching also impacts and improves the adhesions, increases the blood flow and lymphatic drainage, resulting in an increase in soft tissue extensibility and improves range of motion and muscle strength. The myokinetic active release technique is the application of deep tension over the tenderness and asking the patient to actively move the tissue from the shortened to the lengthened position, thereby breaking the adhesion. Both these techniques can be treatment of choice in young racquet sports players to improve their sports performance.

The subjects were not divided based on their experience, level of play or gender, as that could impact the results. The history of past training was also not collected in this research. The long-term effect was not studied.

Conflict of Interests

The authors declare no conflict of interest.

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