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Effect of Mental Imagery Skill Training Program on Soccer Passing and Control Skills in Collegiate-Level Players: A Randomized Controlled Trial

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Abstract Mental imagery is used to re-create a sporting scenario in the mind to enhance sporting technique and performance. Less research has been done on internal and external imagery both in combination. The aim of this study was to see the effect of mental imagery in enhancing soccer passing and control skills in male collegiate-level players. The study evaluated 60 male collegiate soccer athletes, allocated into imagery and control groups. Both the groups were tested for their passing and control skills using Loughborough soccer passing test (LSPT) and McDonald Soccer skill test, followed by mental imagery intervention for a period of 3 weeks for the experimental group. Post-intervention LSPT and McDonald soccer test scores were taken again for both the groups. Within group statistical analysis of data was done using Wilcoxon signed rank test for the two means pre- and post-intervention and between groups using Mann-Whitney U test. Results showed that there was a notable improvement in the LSPT and McDonald soccer test score measured pre and post imagery. Mental imagery can be a beneficial technique in improving skill-specific training in collegiate-level athletes, for maintaining focus on skillsets, strength and power post-injury and surgery, during detraining and return to sport.

Keywords Imagery, Soccer, Return to Sport, Sports Medicine, Neuroscience

1. Introduction

Mental Imagery (MI) is a psychological tool used to create mental representation of a task or a situation, without actually doing the task and without any sensory stimuli [1,2]. In sports, imagery engages multisensorial pathways to recreate a sporting scenario in our minds to improve sport performance. Mental imagery in sports is used at the time of training, competition, injury, detraining, etc. [3-8]. There are several theories and models of imagery that explain how imagery helps in improving athletes performance [9]. For example, the psychoneuromuscular theory suggests that motor cortex of the brain gets accessed with the help of motor imagery,

which leads to neuromuscular activation and eventually helps in performance of a motor task. Imagery training helps in gaining motor expertise which leads to neural reorganizations of networks in the brain which are activity-dependent and eventually help in controlling both real and imaginary performances [10]. Another theory called the theory of functional equivalence, proposes that when a person performs a particular task, or when he/she images themselves performing the same task, similar areas of the brain get activated. For example, when an athlete images himself hitting a tennis ball, the same areas of brain get activated when he actually hits a tennis ball. Imagery strengthens neural activity which leads to improved execution of the desired skill, hence achieving sporting success. Apart from improved motor output of a sport skill, other physiological responses like heart rate, muscle activity, ventilation frequency, which are significant parameters experienced when an actual situation is happening, also increase during mental imagery [11]. Further classification can be made in MI as internal and external. Kinaesthetic imagery is a synonym used for internal imagery [12]. Here, the athlete imagines himself from a first-person perspective. Keeping themselves as the frame of reference, focus is kept on the simulated scenario. Internal imagery is most commonly delivered in the form of an audio script. It is experienced from within where the athlete feels as if he/she is performing the movement. It includes not just visual but also kinaesthetic and spatial components of the action. Internal imagery is distinguished from external imagery in which the latter one, the athlete takes the view of a spectator, watching a particular scenario [13]. Here, mode of delivery is mainly visual and the athlete sees from a third-person perspective and watches the movement being performed by someone else or even themselves in front of them in a video [14,15]. Sports can be put into two categories i.e., closed and open. In a closed sport, external factors like the environment, opponent players presence, referee, etc. don't influence the athletes performance. Hence every move or skill to be executed can be pre-planned. For xample, sports like javelin throw, shooting, springboard diving, are all closed sports. Even in sports like basketball, the free-throw component of it, is a closed element of the game. But in open sports like football, hockey, etc., the environment keeps changing and nothing can be predicted. Most of the team sports are open while most of the individual games are considered a part of closed sports [16]. Previous literature has suggested the benefits of visualization, for athletes involved in closed sports. The field of open sports with a highly demanding constantly changing environment, has made it crucial for athletes to resort to or utilize various other strategies including cognitive and psychological techniques to achieve success in their sport. In an open sport like soccer, passing and control is a technique that needs accuracy and precision on the ball. It requires the athlete to use multiple senses, and target the correct person, in a precise manner and at the right time. Mental imagery may prove to be a beneficial tool for improving the athletes passing and control skill in all kinds of scenarios where they aim to pass [17]. Mental Imagery studies have been used in the past for return to sport post- injury and during rehabilitation. Most of the imagery studies mainly focus on elite level players but no study has been used for collegiate level players in the Indian setup till date. Very few studies have researched on open sport wherein the environment keeps changing. A combination of external and internal imagery is also less researched. Therefore, the research question was: What is the effect of mental imagery skill training program on soccer passing and control skills in male collegiate level soccer players?

2. Materials and Methods

2.1. Design

A randomized controlled trial was conducted in which 60 male collegiate level soccer players who are a part of the college team, take part in intercollegiate competitions (based on Tegner activity level scale- level 9). The participants were randomized using block randomization and the assessor was blinded. Participants were recruited from ABSMARI, a teaching institute, Odisha, India between May 20, 2023 to May 30, 2023. Participants were assessed pre- and post-intervention (baseline and after 3 weeks) using LSPT and McDonald soccer skill test.

Ethical approval was received from IEC of ABSMARI and the registration number was ABSMARI/IRB/01/2023.

The study was approved and registered under Clinical Trials Registry India (CTRI) in May 2023 (CTRI Number: CTRI/2023/05/052323).

2.2. Participants

Research Recruitment Process:

Inclusion criteria comprised male collegiate level soccer players who are a part of the college team, taking part in competitions (based on Tegner activity level scale-level 9), between the age bracket of 18-25 years and those who playing/practicing soccer for a minimum 5 of hours/ week for a minimum of 1 year. Exclusion criteria consisted of goalkeepers, athletes having any recent injury, fracture, open wounds over the past 6 months (using Nordic questionnaire) and athletes with pre-existing neurological conditions affecting cognition. Formula used for calculation of sample size was $2K (SD)^2 / d^2$, where K is 10.5, SD (Standard Deviation) is 6.2 and d (Standard error measurement (SEM)) is 2.2. According to the selection criteria, a total of 60 male collegiate soccer players were selected. The study procedure was explained to all the athletes and informed consent was taken, followed by

demographic data of the subjects. There was a random allocation of the subjects into two groups, which were experimental and control. The experimental group had 32 players (mean age = 18.150.36) while the control group had 28 players (mean age = 18.160.81).

2.3. Intervention

Pre-intervention outcome measures scores that were taken for both the groups using LSPT and McDonald soccer skill test. The control group underwent regular football skills training while the experimental group underwent mental imagery training which comprised of external (videotape) as well as internal (audio script) imagery intervention for about 10-15 minutes for 3 weeks and 4 sessions/week (total 12 sessions). The sessions were administered as a part of their warm-up. 4 subjects from the control group were unable to continue and hence had to drop out of the study. Post-intervention outcome measure scores were taken again for both the groups using the same outcome measures followed by data analysis for the subjects who completed the study (per protocol analysis).

2.4. Flow of Participants throughout the Study

Figure 1 shows the participants' flow throughout the trial. 60 participants were screened for inclusion. All 60 participants were assigned into 2 groups using block randomization. Experimental (mental imagery) group and control group had 30 participants each.

All 60 participants were assessed for the primary (LSPT) and secondary outcome (McDonald soccer skill test) measures following which the experimental group underwent mental imagery (MI) along with regular football skill training and control group underwent only regular football skill training for 3 weeks. MI session was administered for 10-15 minutes during the warm-up for the experimental group, 4 times a week, totalling 12 sessions. During the study, there was a drop-out of 4 players from the control group. After 3 weeks post-intervention, the same outcome measures were used for assessment of passing and control skills for both the groups. Per protocol analysis was done.

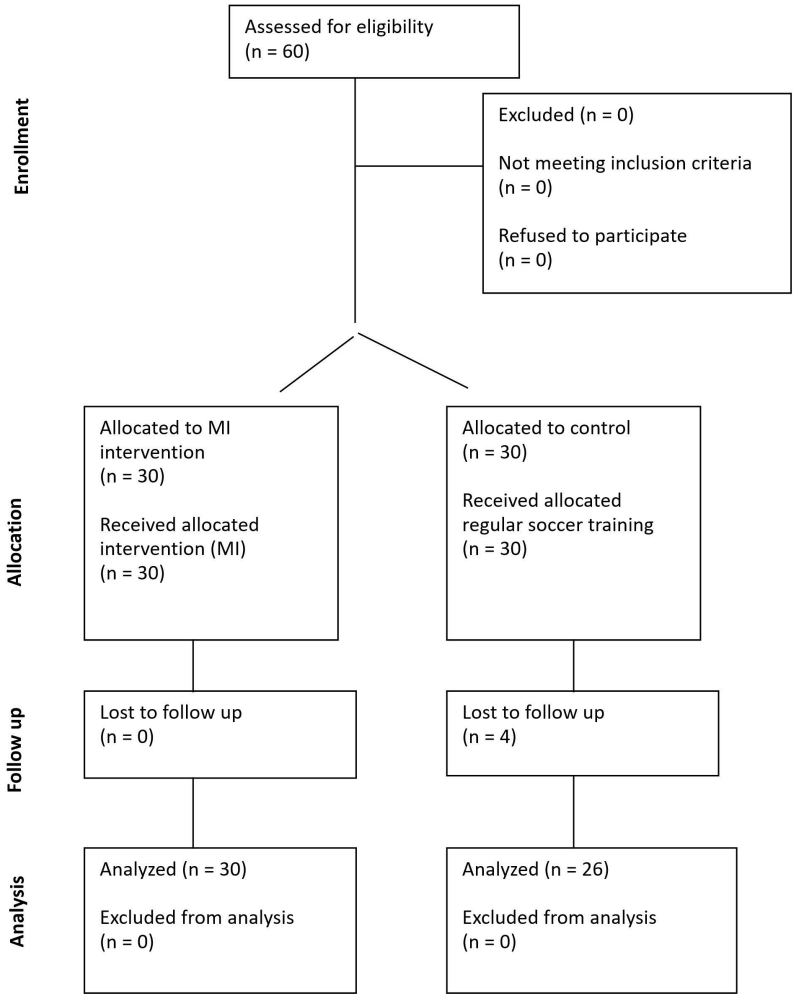

Figure 1. Consolidated Standards of Reporting Trials (CONSORT) diagram for the study

2.5. Outcome Measures

Primary Outcome

Loughborough Soccer Passing Test (LSPT) (Figure 2):

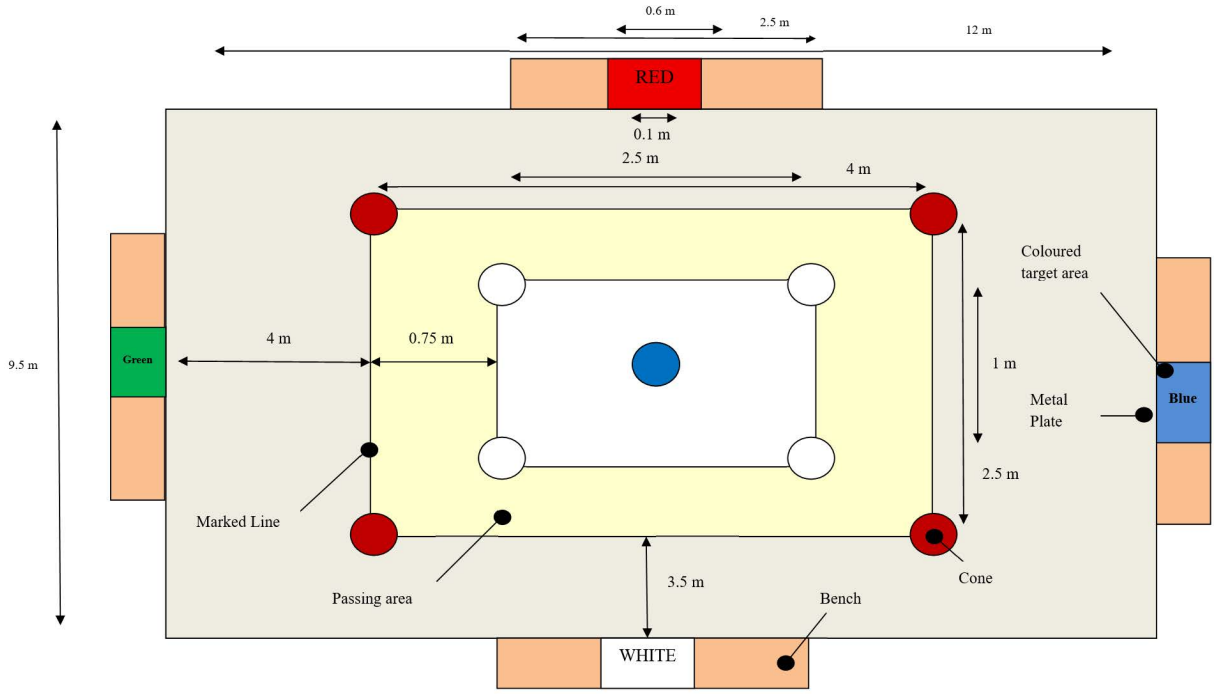

Figure 2. Loughborough Soccer Passing test (LSPT)

This outcome measure has a reliability of 0.73.

In this test, the player starts by standing with the football near the cone, placed in the middle of the test area. The moment the ball is moved by the player, out of the inner rectangle, the examiner starts timing the test. The colour of the next target (order of the passes) is called out by the second examiner. While completing the current pass, the next target is called out.

Players are required to perform 16 passes comprising 8 long and 8 short passes (on coloured card labelled gymnasium benches) within the designated passing zone (between the two rectangles in the middle area) as fast as they can with precision and accuracy. Penalty time scores would be added for any of the following faults the athlete made:

One second was subtracted from the total time if the ball struck the 10-cm strip in the center of the target; two seconds if the ball passed outside the allotted area, if the ball touched any cone and for ball handling; three seconds for missing the target area; and five seconds if the bench was entirely missed or passed to the incorrect bench [18].

Secondary Outcome

McDonald Soccer skill test (Figure 3):

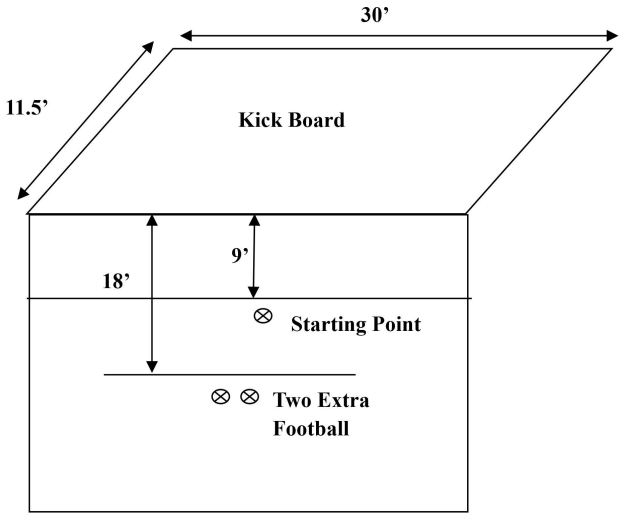

Figure 3. McDonald Soccer Skill Test

This test has a validity coefficient range from 0.63 to 0.94.

This test studies the basic soccer skills and how they can be measured so as to improve the technique and interest in players.

A 30 feet wide and 11 feet high kickboard is used for the test. 9 feet from the kickboard, the first restraining line is drawn, from where the athlete conducts the test. Second restraining line is drawn 18 feet from the kickboard, where two extra footballs are kept as substitutes. By keeping the ball under control and utilizing any kind of kick and ball control technique, the athlete is permitted to run and kick the ball as many times as possible in 30 seconds. If the ball doesn't rebound enough, the player can either retrieve the same ball or use their hands or feet to grab one of the additional balls that are held nine feet behind the restraining line [19].

2.6. Statistical Analysis

The statistical software SPSS 22.0 (SPSS Inc., Chicago, IL) was used to evaluate the data, and a significance level of $p<0.05$ was set. By utilizing the Kolomogorov-Smirnov test, normality was determined. The data did not follow a normal distribution, hence inferential statistics was done using Mann-Whitney U test for between groups analysis (experimental and control), and the Wilcoxon signed rank test was used for within group (before and post-intervention) analysis.

Table 1 shows Independent Samples Effect Sizes. The effect sizes were estimated using the denominator. The pooled standard deviation is used by Cohen's d. The pooled standard deviation plus a correction factor is used in hedges correction. The sample standard deviation of the control group, or the second group, is used by Glass's delta.

The experimental and control groups' effect size value for the LSPT outcome measure (pre-post difference) is 0.25110, which is small and suggests that there is little difference between the two groups in terms of LSPT; while for McDonald outcome measure (pre-post difference) is 1.91107, which is high and indicates a significant difference between the two groups with regard to McDonald skill test.

Baseline Characteristics

Chart 1 shows the demographic data of the participants: Mean age of the subjects was 18.5±0.36 years for the experimental group and 18.16±0.81 years for the control group.

Table 1. Independent Samples Effect Sizes

Independent Samples Effect Sizes					
				95% Confidence Interval	
		Standardizer[a]	Point Estimate	Lower	Upper
LSPT Diff	Cohen's d	.25110	.974	.410	1.530
	Hedges' correction	.25465	.960	.404	
	Glass's delta	.28240	.866	.274	1.443
McDiff	Cohen's d	1.91107	-1.390	-1.975	-.794
	Hedges' correction	1.93814	-1.371	-1.947	-.783
	Glass's delta	2.43614	-1.090	-1.697	-.467

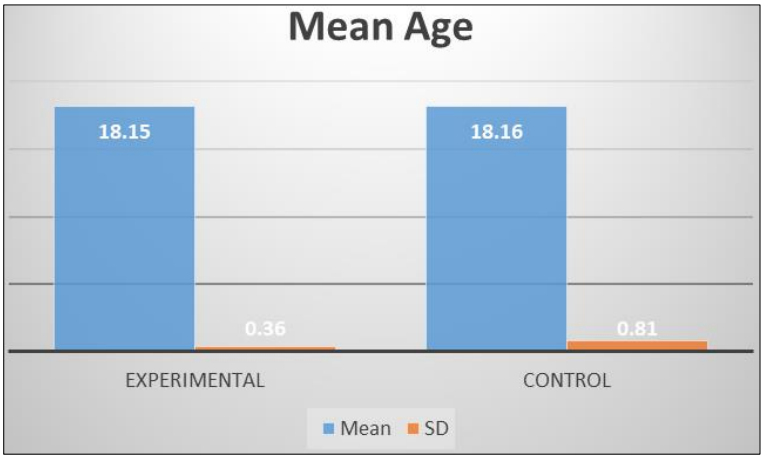

Chart 1. Mean age for both experimental and control groups

3. Results

Statistical difference ($p<0.05$) was found within the experimental group (pre and post-intervention) but not in the control group for both the outcome measures i.e., LSPT and McDonald soccer test is as expressed in charts 2 and 3.

Tables 2 and 3 show the inferential statistics for pre-post analysis of both the outcome measures in both groups, keeping $p<0.05$ as level of significance.

Statistical difference was also found between the experimental and control groups for the difference calculated between both the outcome measures (LSPT (pre-post) and McDonald soccer test (pre-post)) is as expressed in chart 4.

Hence there is a significant effect of mental imagery in enhancing passing and control skills in collegiate level soccer players.

Table 4 displays the statistics for difference between pre and post-intervention of both outcome measures for both Experimental (1) & Control groups (0).

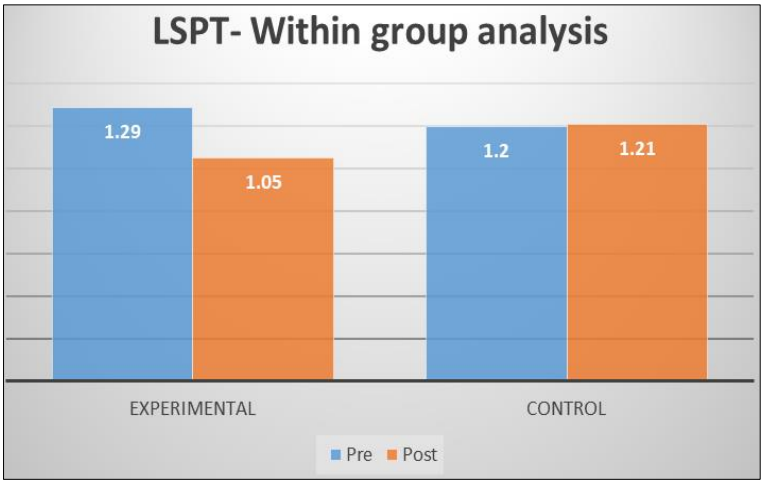

Chart 2. LSPT- Within group analysis (pre-post intervention) for both the groups

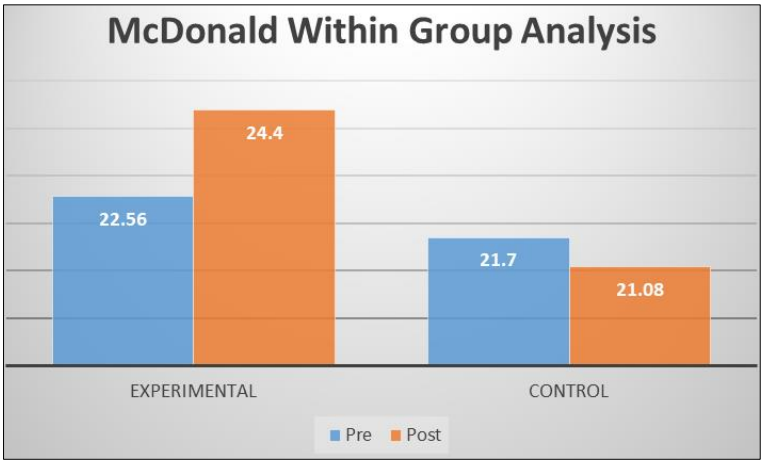

Chart 3. McDonald soccer skill test -Within group analysis of (pre and post-intervention) for both the groups

Table 2. LSPT- Between group analysis (pre-post intervention) for both the groups

Test Statistics[a]

	LSPT_Diff
Mann-Whitney U	119.500
Wilcoxon W	419.500
Z	-4.381
Asym. Sig. (2-tailed)	.000

a. Grouping Variables: Groups

Table 3. McDonald Soccer Skill Test- Between group analysis (pre-post intervention) for both the groups

Test Statistics[a]

	McDonald_Diff
Mann-Whitney U	85.000
Wilcoxon W	613.000
Z	-5.019
Asym. Sig. (2-tailed)	.000

a. Grouping Variables: Groups

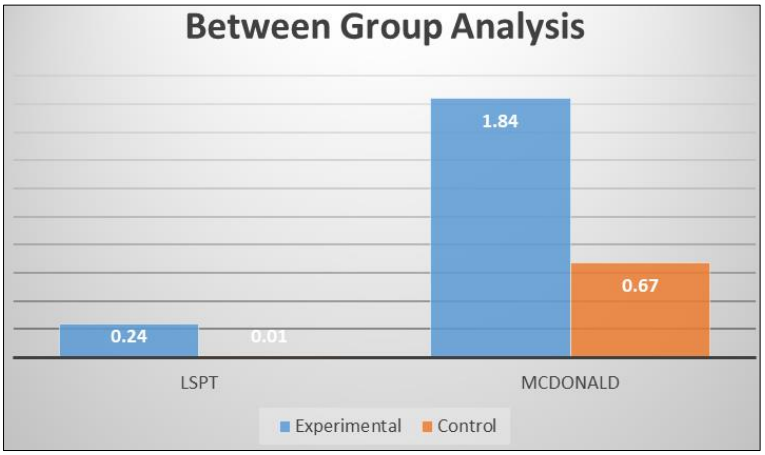

Chart 4. Between group analysis of Experimental and Control groups for both the outcome measures

Table 4. Statistics for Pre-Post Difference of both outcome measures for both Experimental (1) & Control groups (0)

Statistics				
Groups			LSPT_Diff	McDonald_Diff
.	N	Valid	0	0
		Missing	2	2
.00	N	Valid	24	24
		Missing	0	0
	Mean		-.0058	.7500
	Std. Error of Mean		.05764	.49728
	Median		-.0550	.5000
	Std. Deviation		.28240	2.43614
	Skewness		.663	.337
	Std. Error of Skewness		.472	.472
	Kurtosis		3.604	4.621
	Std. Error of Kurtosis		.918	.918
1.00	N	Valid	32	32
		Missing	0	0
	Mean		.2388	-1.9063
	Std. Error of Mean		.03979	.24740
	Median		.1650	-2.0000
	Std. Deviation		.22508	1.39952
	Skewness		1.215	-.780
	Std. Error of Skewness		.414	.414
	Kurtosis		1.460	.943
	Std. Error of Kurtosis		.809	.809

4. Discussion

This study comprised a total of 56 collegiate male athletes out of which 32 were allocated in the experimental group undergoing mental imagery (MI) along with regular football training and the rest 24 were allocated in the control group undergoing only regular football training. The baseline characteristics for both the groups are shown in chart 1 and statistics related to Pre-post difference in both outcome measures in both the groups are also shown in Table 4. The purpose of the study was to see the effect of mental imagery (MI) intervention in enhancing soccer passing and control skills. Findings indicate that mental imagery does help in improving passing and control skills in collegiate level soccer players, which was consistent with the main hypothesis of this study. These findings corroborate with various previous research studies which showed an improvement in motor performance using mental imagery training [10,14,16,17]. The first reason for achieving a significant improvement in the experimental group, pre and post-intervention as shown in chart 2, could be that a supervised session of imagery before the regular training in the form of a warm-up, helped the athletes to easily incorporate the technique in their regular training schedule without making any major changes [20]. Secondly, the utilization of both, video tape and audio script, i.e., a combined effect of external and internal form of imagery, might have reinforced the imagery, making stronger neural networks in the brain leading to more clarity in the execution of the skill. According to previous studies, giving external imagery (video tape) alone, proves to be more of a motivational factor and hence combining internal imagery (audio script) with external helps in gaining the cognitive benefits of MI [21-23]. The imagery script that was used for this study was in accordance with the PETTLEP model of imagery which is proven to be a beneficial format for athletes undergoing internal imagery training [11,24]. Sports psychology research has demonstrated the benefits of imagery in athletic performance on discrete/serial tasks which is similar to the results of this study [10,14,16,20,22]. The primary outcome measure, LSPT, is a test that measures passing accuracy, precision, along with taking time component (time to complete 16 passes) into consideration [22]. After a 3-week protocol of MI, comprising a total of 12 sessions (4 sessions/week), the experimental group athletes showed an improvement in the LSPTs component of passing and control precision, accuracy and the test completion time became shorter. While the control group athletes, who also underwent regular football skills training, without MI, took either the same time to complete the test as compared to their baseline values, or longer by a few seconds, as shown in chart 3. The precision and accuracy component of LSPT in the control group remained more or less near the baseline values. One of the reasons for the increased test completion time could be the low adherence towards the practice sessions. Few athletes from the control group dropped out of the study due to personal reasons. The secondary outcome measure was McDonald soccer passing test which tested the speed with which the athletes could kick maximum number of times on the wall from a designated distance [19]. Here as well, the experimental group athletes showed an increased number of kicks and speed post MI intervention, in comparison with the control group as depicted in chart 4, Tables 2 and 3. Few players in the control group were older in age by a few years while all the players in the experimental group were younger. According to a study done by Tohid Seif-Barghi et al, younger soccer players, use more cognitive specific and cognitive general imagery as compared to their older counterparts [17]. It is worth noting that this study comprised collegiate-level athletes, who have never undergone any kind of MI or sport psychology training before. According to previous studies, MI was found more beneficial in elite-level athletes as it would help them in improving the scope of fine-skilled movements which generally gives them the extra edge at elite-level competitions [18,20]. However there are studies which suggest that younger athletes have capabilities of being great imagers which is why they can engage in imagery more frequently and strongly as compared to older adult players, who are more interested in the motivational component of imagery than the cognitive aspect of it. A study done by Bianca A. Simonsmeier et al. counters this concept by saying that the higher expertise and experience level of an athlete, the greater the imagery ability of the athlete and hence the greater will be the effect of MI intervention in them as compared to novice players [20]. As far as the frequency of MI training and training duration is considered, different studies have mentioned different time periods for giving MI training, subject to the age, level of play and type of MI intervention given to the athletes. However, according to a review study done by Jesmy Jose et al., the duration of the MI intervention should not be less than 1 week as it may not show much improvement [25]. Along with positive effects of MI on skill development demonstrated in this study, there were a few limitations as well: There was a possibility of cross-contamination between control group and imagery group as both the groups belonged to the same study setting. Ability of the athletes to use imagery was not assessed pre and post-intervention using outcome measures like Movement Imagery Questionnaire-3 (MIQ-3) or Plymouth sensory imagery questionnaire (Psi-Q) which is an important factor considering individual differences [26]. This study involved only male athletes which limits generalizability of findings.

5. Conclusions

The study concludes that using mental imagery along

with regular football training helps in enhancing soccer passing and control skills in collegiate-level athletes. Therefore, imagery proves to be an important tool for maintaining focus on skillsets and hence can also be used to maintain strength and power post-injury and surgery, during detraining and return to sport.

Future studies can include feedback sessions, post every session of MI as it might help the athletes to process and reinforce the information even better. The athletes should be encouraged to make customized scripts based on their self-analysis on where they need to improve and which technique. Studies should also focus on novice players who demonstrate greater difficulty in performing synchronized movements.

Future research is needed to better understand the influences of Psychopathology within the chronic stress, burnout, perfectionism, competitive anxiety, poor sleep, negative attribution after failure, negative coping strategies, negative stress recovery strategies, career dissatisfaction, contemplating retirement.

Abbreviations

LSPT: Loughborough Soccer Passing Test
MI: Mental Imagery
CTRI: Clinical Trials Registry-India
PETTLEP: Physical Environment Task Timing Learning Emotion Perspective

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This study received no funding.

Conflicts of Interest

There authors declare no conflicts of interest.

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