DOI: 10.7860/JCDR/2021/49981.15367

Original Article

Physiotherapy Section

Effect of Distributed Versus Massed Practice on Reaction Time in Collegiate Volleyball Players: A Pilot Study

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ABSTRACT

Introduction: Reaction Time (RT) is the time taken by an individual to respond to external stimuli. It is one of the most important determinant ability in sports like Volleyball. Shorter RT leads to higher performance and success in Volleyball. Two types of training methods, massed and distributed practice have been used in researches to improve RT and other sports related skills in sports. In massed practice, there is persistent workout with hardly any rest periods even of minimal time period relative to the work interval while in distributed practice; it is interspersed with rest or other skill learning. There are mixed evidences on effectiveness of these practice methods which has led to the present study.

Aim: To find the effect of distributed practice and massed practice in terms of RT among collegiate volleyball players.

Materials and Methods: The study design was quasi-experimental pilot study that was conducted at the volleyball academy Gurugram, Haryana, India from September 2019 to December 2019. A total of 30 players, aged 18-22 years, from college volleyball team were invited to participate in the study. Subjects were randomly divided into two groups. Group A received massed practice (n=15), and group B received distributed practice (n=15) for 40 minutes, four days a week for four weeks. Players who were practicing daily for one hour were included in this study and they were excluded if they had any condition that limited their participation in the study or if they are suffering from any type of orthopaedic or neurological illness. RT was measured using Ruler Drop Test (RDT) and Red Light Green Light Test (RLGL). Data was analysed using Statistical Package for the Social Sciences (SPSS) version 20.0 for statistical analysis.

Results: The mean pre and post data of Group A, for RDT was 0.16 and 0.12 seconds, respectively; of Group B, it was 0.16 and 0.13. The mean pre and post data of Group A for RLGL was 0.42 and 0.38 seconds, respectively; Group B data for RLGL pre and post was 0.39 and 0.37 seconds, respectively. Both the groups showed significant improvement in scores of RDT (p-value for Group A=0.01, Group B=0.05) and RLGL (p-value for Group A=0.01, Group B=0.01) measured by the paired sample t-test ($p<0.05$). But there was no significant difference in between group analysis measured by independent sample t-test ($p>0.05$).

Conclusion: This study showed that both massed and distributed practice was helpful in improving RT of collegiate volleyball players. As there was no significant difference between the two groups, consequently which practice method is superior in improving RT in collegiate volleyball players could not be stated.

Keywords: Athletic performance, High performance, Red light green light test, Ruler drop, Sports, Success

INTRODUCTION

The RT is defined as the length of time taken for a person to respond to given stimuli or events. Sensory neurons transform a stimulus into an electrochemical signal, which proceeds the length of them, followed through neurons of the Central Nervous System (CNS), and at the end through the length of the motor neurons [1]. RT is of utmost importance in any sport which requires sustained attention. As in volleyball, players organise their movement patterns before performing their skills in advance and as the skills get more complex, so the RT should be well maintained for movement initiation [2]. Many pieces of research have been done on improving RT by various parameters and motor task practices [3]. Volleyball is a team sport that requires good communication and coordination among players. Volleyball, in terms of motor components, necessitates coordination, agility, and response time while playing, as well as a solid sense of lifting and hitting the ball. Volleyball players must have a high level of coordination, agility, and reaction ability to play the sport [4]. The RT is considered as one of the determinant abilities especially in the modalities that require immediate answers, like volleyball [5]. The players are excessively subjected to arousal in the competition environment and need to predict and respond quickly in a limited period of time. "The ability to quickly see the incoming ball or change one's position on the court decide whether a point is scored and, in the end, the game is won [6].

Few researchers have used two types of practice, massed and distributed for improving RT. In massed practice, there is persistent workout with hardly any rest periods even of minimal time period relative to the work interval while in distributed practice it is interspersed with rest or other skill learning [7]. There have been researches which have shown the importance of these practice condition on various parameters of athletic performance [8-10]. Among those one such research was done by Safari I et al., in which they used both massed and distributed practice to see the practice effect on hand-eye coordination towards the accuracy of forehand topspin in table tennis. In their work, distributed practice showed better results [11]. Another research by Al-Sayed Al-Mowafy A, was conducted to see the effect of massed and distributed practice on learning attacking serving in volleyball girl players. The result of their study proved that mix practice of both massed and distributed practice is effective than distributed or massed alone [12].

Ahmadvand R et al., in their research concluded that mass and distributed practice improved performance and learning of discrete simple and complex skills in volleyball players [13]. Due to mixed results in the literature regarding the effectiveness of distributed practice and massed practice in improving RT of volleyball players [14], so this study was aimed to investigate the effect of distributed practice and massed practice on RT of collegiate volleyball players. Authors hypothesised that distributed practice will be more effective in improving RT of volleyball players. In present study, auhors focused on changes in RT of volleyball players by two different training methods and also to find out which one is better than the other.

MATERIALS AND METHODS

This was a quasi-experimental pilot study that was conducted at the volleyball academy Gurugram from September 2019 to December 2019. The permission to conduct the study was obtained via Institutional Ethical Committee (IEC) approval number (SGTU/FOP/2020/24). A total number of 30 subjects were conveniently chosen from college volleyball team to participate in the study. The whole procedure was explained to the subjects and the informed consent was taken.

Inclusion and Exclusion criteria: A total 30 collegiate volleyball players both male and female, aged between 18-22 years, those who were practicing daily for one hour were included in the study. Participants were excluded if they have any condition that limits their participation in the study, if they don't practice the game on regular basis and if they were suffering from any type of orthopaedic or neurological illness.

Basement assessment of the players was taken by the RDT and RLGL test. After an assessment, the players were randomly allocated into two different groups, distributed group (n=15) and massed group (n=15). Each group received intervention for 40 minutes a day, four days a week for four weeks. Both the group followed the protocol and data was collected at the baseline and the post data was collected on the last day of 4th week.

Tests for Reaction Time (RT)

Red Light Green Light Test (RLGL): In a closed small room, each participant used a computerised program that measured their reflexes. This program worked as a "click-the-button" type test and recorded the time it took for the participant to click the button as soon as the light turned green. Each trial had five runs within it, and the computer took the time of each run and averaged it out [15].

Ruler Drop Test (RDT): A rule of 50-60 centimetres (cm) long was used. The person to be tested stands or sits near the edge of a table, resting their elbow on the table so that their wrist extends over the side. The researcher holds the ruler in the air between his thumb and index finger just above the subject's hand. Align the zero mark with the subject's fingers. The subject should indicate when they are ready. Without warning, release the ruler and let it drop-the subject must catch it as quickly as possible as soon as they see it fall. Distance was recorded in metres when the ruler falls. The RDT was repeated three times with each hand, taking the average score of each hand. The average of each hand and the average of both hands were used for the subsequent statistical analysis. The RT conversion (in seconds) is performed using the formula for a body in free fall under the influence of gravity ($d=½gt^2$) [16].

Massed Practice Group (Group A)

The group received 40 minutes of training which consisted of five minutes of warm-up, 30 minutes of practice and five minutes cool-down period. The tasks included in the group were: (a) Ball dribbling: Participant had to dribble the ball while walking; (b) Reverse counting: Participant had to say reverse counting from 500 while walking; (c) Juggling with balls: Participant had to juggle with two balls while walking; (d) Reverse spell: Participant had to spell back words given by the researcher during walking [Table/Fig-1]; (e) Side catch: Participant had to catch balls thrown by the researcher during walking. Each task was performed for six minutes that is, 30 minutes consecutively.

Distributed Practice Group (Group B)

The group received 40 minutes of training, which were divided into five minutes of warm-up, 30 minutes of distributed practice and five minutes of cool-down period. The tasks included in the group were: (a) Ball dribbling; (b) Reverse counting; (c) Juggling with balls; (d) Reverse spell; (e) Side catch [Table/Fig-2]. Every task performed by the individual was time dependent. Each task was performed for five minutes and a rest interval of one minute was given between every task. All the tasks were performed during walking.

[Table/Fig-1]: Reverse spell task during massed practice.
[Table/Fig-2]: Side catch task during distributed practice. (Images from left to right)

STATISTICAL ANALYSIS

Data was analysed using SPSS version 20.0 for statistical analysis. After the descriptive analysis of the data, the paired sample t-test was used for within the group analysis and an independent sample t-test was used for between the group analysis for RDT and RLGL. The level of significance was set at $p \leq 0.05$.

RESULTS

The general characteristics of the study participants are summarised in [Table/Fig-3]. Independent sample t-test showed that there was no significant differences between the demographics of the participants ($p>0.05$).

Variables	Group A (Mean±SD)	Group B (Mean±SD)	t value	p-value
Gender (Male/Female)	20/10	20/10	-	-
Age (years)	21±1.09	20±1.41	1.11	0.10
Height (cm)	162.87±4.52	172.72±9.90	1.80	0.29
Weight (kg)	54.8±4.87	56.6±4.67	0.53	0.60

[Table/Fig-3]: Demographics of participants.

Paired sample t-test within Group A showed significant differences in Ruler Drop Test (RDT) (p=0.01) and Red Light Green Light Test (RLGL) (p=0.01) [Table/Fig-4].

Variables	Mean±SD	t value	df	p-value
RDT (Pre)	0.16±0.02	3.87	4	0.01*
RDT (Post)	0.12±0.02			
RLGL (Pre)	0.42±0.34	4.67	4	0.01*
RLGL (Post)	0.38±0.21			

[Table/Fig-4]: RDT and RLGL of Massed Group (Group A).
*significant

Paired sample t-test showed significant differences in Ruler Drop Test (RDT) (p=0.05) and Red Light Green Light Test (RLGL) (p=0.01) in Group B [Table/Fig-5].

Variables	Mean±SD	t value	df	p-value
RDT (Pre)	0.16±0.02	2.77	4	0.05*
RDT (Post)	0.13±0.02			
RLGL (Pre)	0.39±0.20	5.44	4	0.01*
RLGL (Post)	0.37±0.13			

[Table/Fig-5]: RDT and RLGL of Distributed group (Group B).
*significant

[Table/Fig-6] shows mean difference in RDT between groups. Group A showed improvement of 0.04 sec and Group B had improvement of 0.03 sec in RDT. Independent sample t-test showed no significant differences between two groups in terms of Ruler Drop Test (RDT). p-value is 0.48 which was not significant ($p>0.05$).

The comparison of the RLGL between Group A and Group B is given in [Table/Fig-7] which shows mean difference in RLGL test between

Variables	RDT (Pre)	RDT (Post)	Mean difference	t value	p-value
Group A	0.16	0.12	0.04	-0.73	0.48
Group B	0.16	0.13	0.03		

[Table/Fig-6]: Comparison of Ruler Drop Test (RDT) between two groups.

two groups. Group A showed improvement of 0.04 seconds and Group B showed improvement of 0.02 seconds. Independent sample t-test showed no significant differences between two groups in terms of Red Light Green Light Test (RLGL). p-value is 0.19 which was not significant (p>0.05).

Variables	RLGL (Pre)	RLGL (Post)	Mean difference	t value	p-value
Group A	0.42	0.38	0.04	1.41	0.19
Group B	0.39	0.37	0.02		

[Table/Fig-7]: Comparison of Red Light Green Light Test (RLGL) between two groups.

DISCUSSION

The present findings of this study indicated that the both distributed and massed practice showed a significant improvement in RT of the volleyball players but there was no significant difference between post data of both groups. So, a better practice method could not be found. Authors compared the results of both the tests used for RT, there was a 0.01 sec difference in RT measured by RDT and 0.02 seconds difference when measured by RLGL (data not shown). Consequently, participants who were involved in massed practice showed more decrease in RT than the participants who were in distributed practice.

The findings of present study were in contradiction with outcomes of Edward AS. It proved that mass replications receive less process and coding variables in mass practice and hence it is less diversified [17]. Therefore, performance which is observed in mass practice is weaker as compared to distributed practice which is in contrast to present study findings. Similarly in a study conducted by Lee TD and Genovese ED further supported that mass practice does not accelerate learning and along with more mass practice, learning improvement will be less substantial [18].

Godwin MA and Schmidt RA in their study concluded that distributed practice enhances practice variability and this leads to stronger learning of the considered activity. They found that a complex discrete motor activity is benefitted more from distributed practice than mass practice [19]. This study was also in contrast with the findings of present study.

The RT is one of the important methods to study a person's central information processing speed and coordinated peripheral movement response. In distributed training, the strategy is to give practice sessions with rest intervals [20]. It gives the learner the time to think and review feedback to improve performance. It may take a longer time to learn a skill but it gives a longer effect on improving the performance of the player or the learner. In massed practice a skill is learned without a break, i.e., there is no rest period between the training session. If someone practices the same skill over and over, he or she would be able to build up "muscle memory" therefore the skill will become more automatic [21]. It shows rapid improvement in a short time but the effect of training also lasts for a shorter duration of time [22,23]. This could be the reason for improvement in massed practice group in present study because present study was of four weeks only which is a short time. Distributed practice showed improvement in RT because participants got an opportunity to recall a task after a while it has elapsed [24]. During these rest periods mental practice may take place.

Since distributed practice involves learning, Jarrard LE showed the role of hippocampus which been considered the central hub of most of learning [25,26]. It is also important for the consolidation of new memories, and learning of new things. It is believed that the effectiveness of distributed training appears to depend innumerably on one's working memory rather than one's ability to form persistent memories. He also concluded that the distribute style is innumerably successful when the skill and accomplishment result in extreme exhaustion, not only limited to physical and muscular exhaustion, rather involving cognitive and nervous depression [27].

Outcomes of the studies proved that mass practice is beneficial for learning and preservation of discrete motor skills. The result of present study was similar to a study done by Mustofa F et al., where they saw the effect of massed practice throwing and distributed practice on learning outcomes skills for the accuracy of top softball and found that massed practice is better than distributed practice [28]. Kuncoro B et al., conducted a study to find out effects of massed and distributed practice method on soccer players' dribbling skill where the result of their study concluded that distributed practice is more effective than the massed group [29]. This was in contrast with the findings of present study research. Another study in the 2020 by Nurcahya Y et al., also concluded that distributed practice method is superior to massed practice method in improving forehand drive skills in tennis which was also contradictory to the findings of present study result [30]. Therefore, precautions must be considered while utilising and generalising the findings since the research and findings are not profuse enough to be used to put forward certain guidance, with certainty, on the relationship between practice method and this classification of skills.

Outcomes proved that both practice methods help subjects enhance their performance but respecting the stronger effect of mass practice for simple skills and distributed practice for complex skills, coaches and instructors are suggested to follow this rule to improve learners' functions.

Limitation(s)

The present study was a preliminary investigation that involved a small sample size. Further studies that involve a higher sample size are needed to confirm these results. Furthermore, the duration of treatment was four weeks which might have been insufficient to promote an optimal response for gait for the participants.

CONCLUSION(S)

The study concluded that both massed and distributed groups showed significant improvement in RT. As both the training methods are found clinically and equally beneficial for improving the RT of volleyball players and so this can be included in rehabilitation protocol for the players to enhance the performance of the players.

Acknowledgement

Authors would like to thanks all the subjects who participated in the study.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 19, 2021
- Manual Googling: Jul 16, 2021
- iThenticate Software: Aug 20, 2021 (20%)

ETYMOLOGY: Author Origin

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Apr 17, 2021**
Date of Peer Review: **Jun 12, 2021**
Date of Acceptance: **Jul 22, 2021**
Date of Publishing: **Sep 01, 2021**