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Research Article

Impact of Peer-Assisted Learning on Anatomy Knowledge among Medical Students

[1]Dr. Arnab Ghosal, [2]Dr. Tanushree Roy and [3]Dr. Subhasis Chakraborty,

[1]Assistant professor, Department of Community medicine, College of Medicine & JNM Hospital, Kalyani,West Bengal, India
[2]Assistant professor, Department of Anatomy, College of Medicine and Sagore Dutta Hospital, Kolkata, India
[3]Associate Professor Department of Anatomy, College of Medicine & Sagore Dutta Hospital, Kolkata, India

Article Info:

[2]Correspondence:
Dr. Tanushree Roy
Assistant professor, Department of Anatomy, College of Medicine and Sagore Dutta Hospital, Kolkata, India
Email: rnbghosal@gmail.com

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Abstract

Background: Peer-assisted learning (PAL) is an increasingly used educational strategy in medical education that promotes active participation, collaborative learning, and knowledge sharing among students. It may provide a useful complement to conventional faculty-led teaching by encouraging students to actively engage with learning material.

Aims: To assess the impact of structured peer-assisted learning on knowledge among medical students at the College of Medicine & JNM Hospital, Kalyani, West Bengal and College of Medicine & Sagore Dutta Hospital and to evaluate changes in knowledge following the intervention.

Materials and Methods: A prospective educational interventional study was conducted over one year among 500 medical students at the College of Medicine & JNM Hospital, Kalyani, West Bengal and College of Medicine & Sagore Dutta Hospital. Students meeting the predefined eligibility criteria participated in structured peer-assisted learning activities. Knowledge was assessed using a standardized assessment before and after the intervention. Pre- and post-intervention scores were compared statistically.

Results: The mean knowledge score increased from 11.84 ± 3.21 before PAL to 16.72 ± 2.58 after the intervention, with a mean improvement of 4.88 points ($p<0.001$). The mean percentage score increased from 59.2 ± 16.1% to 83.6 ± 12.9%. The proportion of students with good knowledge increased from 18.0% to 58.0%, while poor knowledge decreased from 32.8% to 8.4% ($p<0.001$). Significant improvement was observed across all academic years.

Conclusion: Peer-assisted learning significantly improved knowledge among medical students and may serve as an effective supplementary strategy to conventional teaching.

Keywords: Peer-assisted learning; Medical students; Knowledge; Medical education; Collaborative learning.

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Introduction

Contemporary medical education increasingly emphasizes learner-centered approaches that promote active participation, collaboration, and shared responsibility for learning, Cooperative learning strategies have emerged as effective tools for improving engagement and academic outcomes, particularly in content-heavy subjects such as anatomy. The Jigsaw teaching technique, developed by Aronson [1], is a structured cooperative learning method in which students become "experts" on subtopics and subsequently teach their peers. This approach promotes positive interdependence, individual accountability, and enhanced communication skills. By requiring students to reorganize and verbalize information, peer teaching strengthens conceptual clarity and long-term retention [2-4]. In medical education, jigsaw learning has been shown to improve understanding of complex concepts, reduce learner anxiety, and foster teamwork and professional communication skills [5, 6]. The present study aims to assess the impact of peer-assisted learning on knowledge among medical students at the College of Medicine & JNM Hospital, Kalyani, West Bengal and College of Medicine & Sagore Dutta Hospital. It seeks to evaluate whether structured peer-assisted learning can improve students' knowledge, promote active participation, encourage collaborative learning, and provide an effective supplementary approach to conventional teaching methods.

Materials and Methods

Study design: Prospective, educational interventional study designed to assess the effect of peer-assisted learning on knowledge among medical students.

Study population: Undergraduate medical students enrolled at the College of Medicine & JNM Hospital, Kalyani, West Bengal and College of Medicine & Sagore Dutta Hospital, who met the predefined eligibility criteria.

Sample size: A total of 500 medical students were included in the study.

Study duration: The study was conducted over a period of 1 year.

Study setting/location: The study was carried out at the College of Medicine & JNM Hospital, Kalyani, West Bengal and College of Medicine & Sagore Dutta Hospital, India.

Inclusion criteria: Medical students who were enrolled at the study institution, willing to participate, available during the study period, and provided informed consent were included.

Exclusion criteria: Students who were unwilling to participate, did not provide consent, were absent during the scheduled learning or assessment sessions, or had incomplete assessment data were excluded from the study.

Statistical Analysis: We put the data into Microsoft Excel and then used SPSS software version 27.0 (SPSS Inc., Chicago, IL, USA) and GraphPad Prism version 5 to look at it. Mean ± standard deviation was used to show continuous variables, and frequencies and percentages were used to show categorical variables. The unpaired t-test was utilized to examine continuous variables between independent groups, whereas the paired t-test was employed for comparisons within the same group. The Chi-square test or Fisher's exact test was used to look at categorical variables, depending on which one was better. A p-value of less than 0.05 was seen to be statistically important.

Result

Table 1. Demographic and Academic Characteristics of the Medical Students

Variable	Category	n	%
Age (years)	≤20	96	19.2
	21–22	214	42.8
	23–24	142	28.4
	≥25	48	9.6

Gender	Male	258	51.6
	Female	242	48.4
Year of study	1st year	128	25.6
	2nd year	132	26.4
	3rd year	124	24.8
	4th year	116	23.2
Total		**500**	**100**

Table 2. Baseline and Post-Intervention Knowledge Scores Among Medical Students

Knowledge assessment	Mean ± SD	Median (IQR)	p-value
Pre-intervention score	11.84 ± 3.21	12 (10–14)	<0.001
Post-intervention score	16.72 ± 2.58	17 (15–19)	
Percentage score – pre-intervention	59.2 ± 16.1	60 (50–70)	<0.001
Percentage score – post-intervention	83.6 ± 12.9	85 (75–95)	

Table 3. Comparison of Knowledge Categories Before and After Peer-Assisted Learning

Knowledge level	Pre-intervention n (%)	Post-intervention n (%)	p-value
Poor	164 (32.8)	42 (8.4)	<0.001
Moderate	246 (49.2)	168 (33.6)	
Good	90 (18.0)	290 (58.0)	
Total	500 (100.0)	500 (100.0)	

Table 4. Improvement in Knowledge According to Year of Study

Year of study	Pre-intervention Mean ± SD	Post-intervention Mean ± SD	Mean improvement	p-value
1st year	10.92 ± 2.84	15.86 ± 2.51	4.94	<0.001
2nd year	11.68 ± 3.02	16.48 ± 2.47	4.8	<0.001
3rd year	12.26 ± 3.18	17.02 ± 2.54	4.76	<0.001
4th year	12.58 ± 3.47	17.62 ± 2.66	5.04	<0.001
Overall	11.84 ± 3.21	16.72 ± 2.58	4.88	<0.001

Figure: 1. Knowledge Assessment: Pre- and Post-Intervention Scores

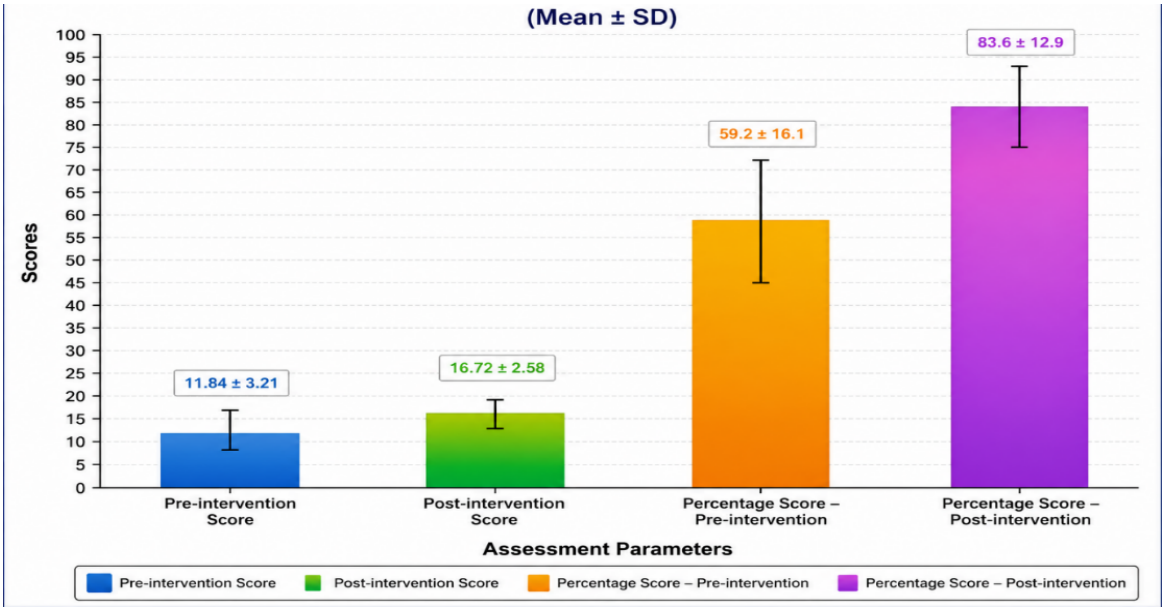


Figure: 2. Comparison of Knowledge Levels Before and After Intervention

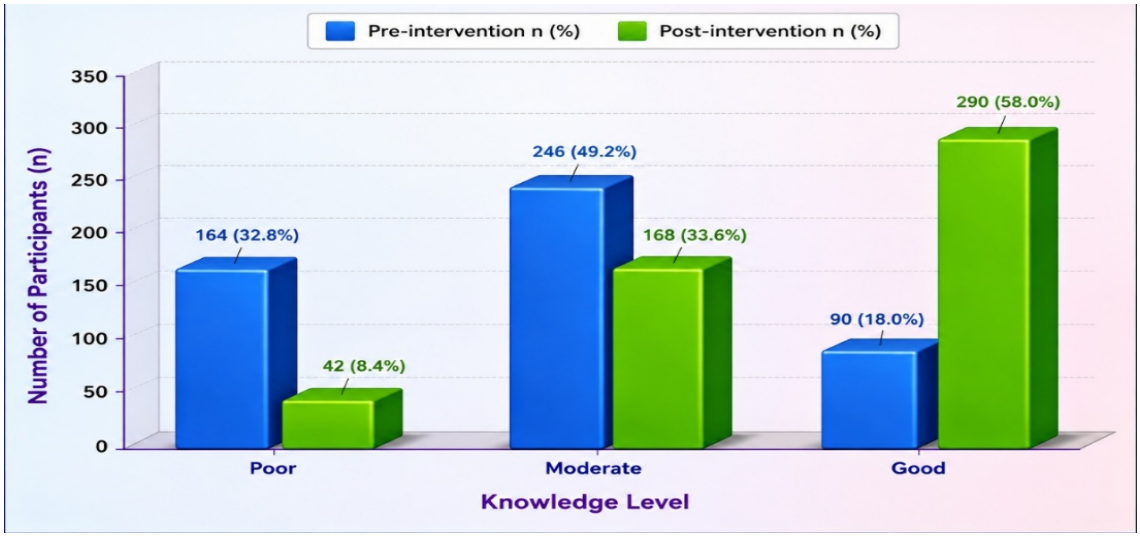
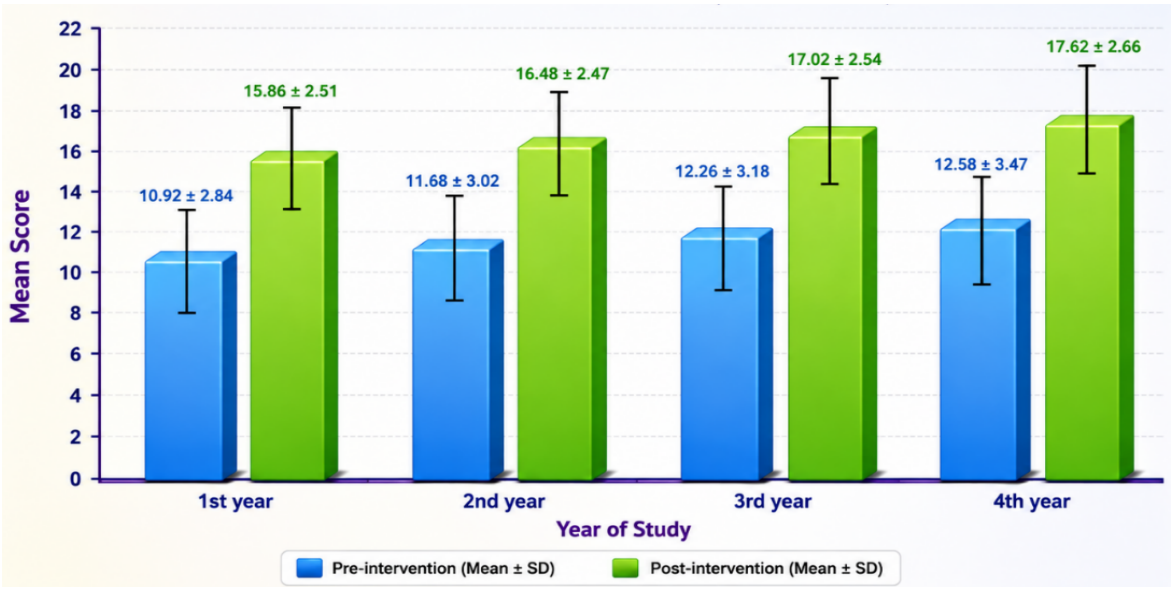


Figure: 3. Year-wise Comparison of Knowledge Scores Before and After Intervention



A total of 500 medical students were included in the study. The majority of students were aged 21–22 years (214, 42.8%), followed by those aged 23–24 years (142, 28.4%), ≤20 years (96, 19.2%), and ≥25 years (48, 9.6%). The age distribution showed a statistically significant difference (p=0.041). Regarding gender, 258 students (51.6%) were male and 242 (48.4%) were female, with a statistically significant difference (p=0.001). Distribution according to year of study was relatively balanced, with 132 (26.4%) students in the second year, 128 (25.6%) in the first year, 124 (24.8%) in the third year, and 116 (23.2%) in the fourth year. This distribution was statistically significant (p<0.001), providing representation from different stages of undergraduate medical education.

A clear improvement in knowledge was observed following the peer-assisted learning intervention. The mean pre-intervention knowledge score was 11.84 ± 3.21, which increased to 16.72 ± 2.58 after the intervention, representing a mean improvement of 4.88 ± 2.74 points. Similarly, the median score increased from 12 (IQR 10–14) before the intervention to 17 (IQR 15–19) afterwards. When expressed as percentages, the mean

knowledge score increased from 59.2 ± 16.1% to 83.6 ± 12.9%, with a mean improvement of 24.4 ± 13.7 percentage points. The difference between pre- and post-intervention scores was highly statistically significant ($p<0.001$), indicating a substantial improvement in students' knowledge following peer-assisted learning.

The distribution of students across knowledge categories demonstrated a marked shift toward higher levels of knowledge after peer-assisted learning. Before the intervention, 164 students (32.8%) had poor knowledge, 246 (49.2%) had moderate knowledge, and only 90 (18.0%) demonstrated good knowledge. Following the intervention, the proportion with poor knowledge decreased substantially to 42 students (8.4%), while moderate knowledge was observed in 168 students (33.6%). In contrast, the number of students achieving good knowledge increased considerably to 290 (58.0%). Thus, there was a 40-percentage-point increase in the proportion of students with good knowledge, accompanied by reductions in both poor and moderate knowledge categories. This overall shift was statistically significant ($p<0.001$), demonstrating the positive effect of the intervention on knowledge attainment.

Knowledge scores improved significantly across all academic years following peer-assisted learning. Among first-year students, the mean score increased from 10.92 ± 2.84 to 15.86 ± 2.51, representing an improvement of 4.94 points ($p<0.001$).

Second-year students showed an increase from 11.68 ± 3.02 to 16.48 ± 2.47, with a mean improvement of 4.80 points ($p<0.001$). Among third-year students, the score increased from 12.26 ± 3.18 to 17.02 ± 2.54, corresponding to an improvement of 4.76 points ($p<0.001$). Fourth-year students demonstrated the greatest numerical improvement, with scores increasing from 12.58 ± 3.47 to 17.62 ± 2.66, a mean gain of 5.04 points ($p<0.001$).

Overall, the consistent improvement across all academic years suggests that peer-assisted learning was beneficial irrespective of students' stage of medical education.

Discussion

The present study included 500 undergraduate medical students, with the largest proportion belonging to the 21–22-year age group (42.8%). The predominance of students in this age range is consistent with the expected age distribution of undergraduate medical cohorts, where most students are in the early twenties. The relatively balanced representation across the four academic years is a strength of the present study because it permits assessment of the intervention across different stages of undergraduate medical education. Previous PAL literature has similarly included students from different stages of medical training and has demonstrated that peer-assisted approaches can be implemented across the undergraduate curriculum. Yu et al. reported that peer-teaching was used in diverse medical education settings and produced short-term learning outcomes comparable with faculty-led teaching. [7]

In the present study, males constituted 51.6% and females 48.4% of participants. Although a statistically significant difference was observed in gender distribution, the relatively small absolute difference indicates that both sexes were well represented. Amer et al. evaluated PAL among undergraduate medical students and specifically examined outcomes in relation to gender, GPA, and year of study, reporting generally positive perceptions of PAL and significant improvement in student achievement among participants. [8] Thus, the effectiveness of PAL appears to be relevant across diverse student groups rather than being restricted to a particular demographic subgroup.

The most important finding of the present study was the substantial improvement in knowledge following the PAL intervention. The mean knowledge score increased from 11.84 ± 3.21 before intervention to 16.72 ± 2.58 afterwards, corresponding to a mean gain of 4.88 ± 2.74 points. The median score similarly increased from 12 to 17, while the percentage score increased from 59.2 ± 16.1% to 83.6 ± 12.9%. The difference was highly statistically significant ($p<0.001$). These findings strongly support the effectiveness of PAL in enhancing

immediate knowledge acquisition. Morgan et al. found that near-peer tutoring improved academic performance in medical students, particularly among students with lower initial performance, and students also considered the intervention valuable for examination preparation. [9]

The magnitude of improvement observed in the present study is also consistent with broader evidence. Zhang and Maconochie, in a meta-analysis of 13 studies involving 2,003 medical students, reported that PAL was associated overall with improved clinical knowledge and skills compared with traditional teacher-led passive learning, although they emphasized heterogeneity between individual studies. [10] The present findings therefore add further evidence that PAL can produce measurable improvements when knowledge is assessed objectively. Importantly, the large increase in the mean percentage score suggests that the intervention was not merely associated with greater student satisfaction but translated into demonstrable learning gains.

A marked shift in the distribution of knowledge categories was also observed. Before PAL, almost half of the students (49.2%) had moderate knowledge and only 18.0% demonstrated good knowledge. Following the intervention, the proportion with good knowledge increased to 58.0%, representing a 40-percentage-point increase, whereas poor knowledge decreased from 32.8% to 8.4%. This shift indicates that the intervention was effective not only in increasing the average score but also in moving a considerable proportion of students toward higher levels of knowledge attainment. Khalil and Wright reported a positive association between attendance at near-peer tutoring sessions and academic performance among first-year medical students; students attending more sessions achieved significantly better academic outcomes than those with low attendance. [11] These findings support the interpretation that active participation in structured peer learning can promote meaningful academic improvement.

The present findings are further supported by recent evidence combining PAL with problem-based learning. Zhang et al. reported significant improvements in quiz performance and in knowledge-recall, case-based, and extended-answer assessments among students receiving peer-assisted problem-based learning. [12] Although their educational model incorporated problem-based learning in addition to PAL and therefore is not identical to the present intervention, the consistent improvement across different forms of objective assessment strengthens the evidence that peer-supported active learning can improve knowledge mastery and application.

An important finding of the present study was that knowledge improved significantly across all four academic years. First-year students improved from 10.92 ± 2.84 to 15.86 ± 2.51, second-year students from 11.68 ± 3.02 to 16.48 ± 2.47, third-year students from 12.26 ± 3.18 to 17.02 ± 2.54, and fourth-year students from 12.58 ± 3.47 to 17.62 ± 2.66; all comparisons were statistically significant ($p<0.001$). The relatively similar magnitude of improvement across years suggests that PAL may be beneficial irrespective of the learner's stage of undergraduate training. Khalil and Wright specifically demonstrated improved academic performance among first-year medical students participating in near-peer tutoring, supporting the applicability of peer-based approaches during the early stages of medical education. [11]

Similarly, Yu et al. concluded that peer-teaching can achieve short-term learner outcomes comparable with conventional faculty teaching in selected undergraduate medical settings. [7] The current study extends this observation by demonstrating significant improvement across first-, second-, third-, and fourth-year students within the same educational cohort. The slightly greater numerical improvement among fourth-year students (5.04 points) may indicate that senior students can particularly benefit from peer learning because of their greater baseline knowledge and ability to integrate new information with previously acquired concepts;

however, the present data do not establish a statistically significant difference in improvement between academic years and therefore this interpretation should remain cautious.

Overall, the findings demonstrate a consistent and substantial positive effect of PAL on knowledge attainment. The results are in agreement with evidence showing that peer teaching can produce learning outcomes comparable to conventional instruction and with more recent studies demonstrating improved academic performance following structured near-peer tutoring. [7,9-12] Nevertheless, the broader literature also indicates that the magnitude of benefit may vary according to the structure of the PAL programme, tutor preparation, learner participation, assessment method, and study design. Zhang and Maconochie highlighted this heterogeneity in their meta-analysis, emphasizing the need for well-designed studies to identify the circumstances under which PAL produces the greatest educational benefit. [10] The present study's consistent improvement across knowledge measures and academic years nevertheless supports PAL as a useful complementary strategy within undergraduate medical education.

Conclusion

The present study demonstrates that peer-assisted learning can significantly improve knowledge among medical students. Following the intervention, the mean knowledge score increased substantially from 11.84 ± 3.21 to 16.72 ± 2.58, with a statistically significant difference ($p<0.001$). A marked shift toward good knowledge was also observed, increasing from 18.0% to 58.0% of students. Significant improvement was consistently demonstrated across all academic years. These findings suggest that peer-assisted learning is an effective, practical, and engaging supplementary educational strategy. Incorporating structured peer-led activities into undergraduate medical education may strengthen knowledge acquisition, encourage active participation, and complement conventional faculty-led teaching methods.

Ethics Approval and Consent to Participate

The study was conducted after obtaining approval from the Institutional Ethics Committees (IEC) of the College of Medicine & JNM Hospital, Kalyani, West Bengal, and the College of Medicine & Sagore Dutta Hospital, India. All eligible participants were informed about the study, and informed consent was obtained from each participant before enrolment. Students who were unwilling to participate or did not provide consent were excluded from the study.

Availability of Data and Materials

The data supporting the findings of this study are contained within the article. The study presents the demographic characteristics, pre- and post-intervention knowledge scores, knowledge categories, and year-wise results in the tables and figures.

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Competing Interests

The authors declare that they have no competing interests.

Use of Artificial Intelligence

The authors declare that no artificial intelligence tools were used in the conduct, analysis, or preparation of this research.

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