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ORIGINAL ARTICLE

Peer-Assisted Learning vs Expert-Assisted Learning in Osteology: A Comparative Crossover Study in Medical Education

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Abstract

Background: Anatomy forms the structural foundation of medical education, and osteology is a core component of first-year MBBS training. Despite its importance, osteology—particularly of the axial skeleton—is frequently perceived as difficult by students due to the volume of factual information, three-dimensional orientation, and limited instructional time. Expert-Assisted Learning (EAL) has traditionally been employed to teach osteology; however, increasing student numbers, reduced curriculum duration, and faculty constraints have encouraged exploration of alternative strategies such as Peer-Assisted Learning (PAL). **Objectives:** The primary objective of this study was to compare academic performance of undergraduate medical students taught axial skeleton osteology using Peer-Assisted Learning versus Expert-Assisted Learning. Secondary objectives were to assess student perceptions of PAL and to evaluate its feasibility as a sustainable supplementary teaching-learning strategy in osteology. **Methods:** A comparative crossover study was conducted among 50 first-year MBBS students. Participants were randomly allocated into two groups. Group A received Expert-Assisted Learning and Group B received Peer-Assisted Learning in small groups guided by academically forward peer tutors. Following assessment, the teaching methods were crossed over for a comparable osteology topic. **Results:** Students taught using Expert-Assisted Learning achieved significantly higher scores than those taught through Peer-Assisted Learning. The mean score for EAL was 18.72 ± 6.18, compared to 16.34 ± 6.21 for PAL ($p = 0.0088$). Despite lower objective scores, students reported positive perceptions of PAL, highlighting better interaction, comfort, and peer support. **Conclusion:** Expert-Assisted Learning remains superior for achieving higher academic performance in osteology. However, Peer-Assisted Learning is well accepted and promotes active engagement. PAL can be effectively integrated as a supplementary strategy to reinforce learning and optimise faculty resources in undergraduate anatomy education.

Keywords: Peer-Assisted Learning, Expert-Assisted Learning, Osteology, Axial Skeleton, Medical Education

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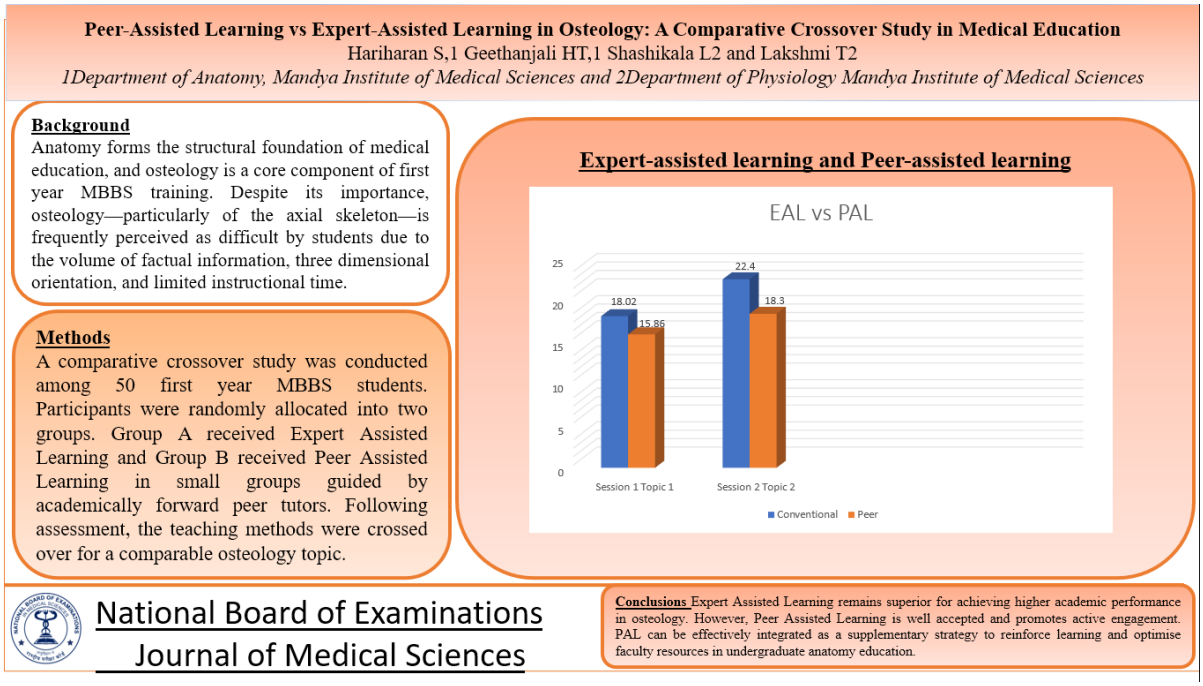
Graphical Abstract



Introduction

Anatomy is universally recognised as a cornerstone of undergraduate medical education, providing the structural and spatial basis required for clinical reasoning, diagnostic accuracy, and procedural competence [1,2]. Among the various subdivisions of anatomy, osteology occupies a central role during the first year of the MBBS curriculum, as it introduces students to skeletal framework, joint mechanics, and muscle attachments that underpin later learning in gross anatomy, radiology, orthopaedics, and surgery [3]. Despite its importance, osteology is often regarded as one of the most challenging components of anatomy due to the extensive factual content, three-dimensional complexity, and requirement for repeated visual-tactile exposure to bone specimens [4,5].

The axial skeleton, comprising the skull, vertebral column, ribs, and sternum, presents additional difficulties for novice learners. These bones possess multiple landmarks, foramina, and articulations that demand precise identification and spatial orientation. For first-year students transitioning from pre-university education, mastering these details within a compressed academic schedule can be overwhelming [5,6]. In India, revisions in the undergraduate medical curriculum and reduction of the First MBBS duration have further intensified academic pressure, often limiting the time available for small-group teaching and individual clarification [7].

Traditionally, anatomy teaching has relied on Expert-Assisted Learning (EAL), wherein experienced faculty members deliver structured instruction through lectures, demonstrations, and tutorials. EAL ensures content accuracy, uniformity of instruction, and integration of clinical relevance, making it particularly effective for complex and detail-oriented subjects such as osteology [6,8]. However, the increasing intake of medical students, limited faculty strength, and growing administrative responsibilities of teachers

have strained the feasibility of exclusively relying on expert-led teaching [7]. Additionally, some students may hesitate to actively participate or ask questions in faculty-led settings due to fear of judgement or lack of confidence.

Peer-Assisted Learning (PAL) has emerged as a learner-centred educational strategy aimed at addressing these challenges. Topping defined PAL as an instructional method in which individuals from similar social and educational backgrounds help each other learn while simultaneously reinforcing their own knowledge through teaching [1]. Educational theory suggests that PAL is supported by the concepts of cognitive congruence and social congruence, wherein peer tutors, having recently learned the same material, are better able to explain concepts at an appropriate level and create a less intimidating learning environment [9]. This may encourage active questioning, discussion, and collaborative problem-solving among learners.

Several studies in medical education have reported that PAL improves student motivation, engagement, communication skills, and self-confidence [2,10,11]. In anatomy education, PAL has been applied to dissection sessions, surface anatomy teaching, and revision tutorials, with many studies demonstrating comparable or equivalent outcomes to traditional teaching [12-14]. However, evidence regarding its effectiveness in producing superior objective academic performance remains inconsistent. While some authors have reported equivalence between PAL and EAL, others have demonstrated that faculty-led instruction yields better examination scores, particularly for foundational and content-heavy subjects [3,6,15].

Notably, there is limited literature specifically evaluating PAL in osteology of the axial skeleton using a crossover study design, which allows direct comparison of teaching methods within the same cohort and reduces inter-group variability [16]. Given the contextual challenges of medical education in India—such as large class sizes, limited access to specimens, and faculty shortages—there is a need to critically evaluate whether PAL can serve as an effective supplementary strategy without compromising academic standards [7].

The present study was therefore undertaken to compare Peer-Assisted Learning and Expert-Assisted Learning in teaching axial skeleton osteology to first-year MBBS students. By employing a crossover design, the study aimed to assess academic performance, explore student perceptions, and evaluate the feasibility of integrating PAL as a sustainable adjunct to traditional anatomy teaching.

Objectives

Primary Objective

- To compare the academic performance of undergraduate medical students learning axial skeleton osteology through Peer-Assisted Learning versus Expert-Assisted Learning.

Secondary Objective

- To assess students' perceptions of Peer-Assisted Learning as a teaching-learning method in osteology.
- To evaluate the feasibility of implementing Peer-Assisted Learning as a sustainable supplementary teaching strategy in undergraduate osteology.

Methodology

This comparative crossover study was conducted in the Department of

Anatomy at Mandya Institute of Medical Sciences, Karnataka, India, during routine tutorial sessions for first-year MBBS students. Ethical clearance was obtained from the institutional ethics committee, and informed consent was obtained from all participants. Fifty first-year MBBS students were enrolled in the study. Inclusion criteria comprised willingness to participate and regular attendance in tutorial sessions. Five academically forward students were selected as peer tutors based on previous internal assessment performance and voluntary participation.

Participants were randomly divided into two equal groups (Group A and Group B).

Session 1: Group A received Expert-Assisted Learning through faculty-led small-group tutorials, while Group B underwent Peer-Assisted Learning in groups of five students guided by peer tutors.

Session 2 (Crossover): The teaching methods were interchanged. Group A received PAL and Group B received EAL for a comparable topic from axial skeleton osteology.

The duration of teaching sessions, learning objectives, bone specimens, and topics were standardised across both groups to minimise instructional bias.

Peer tutors were oriented regarding the scope of the syllabus, learning objectives, and expectations prior to teaching sessions. They were provided access to bone specimens and recommended textbooks for preparation. After each teaching session, students were given 1–2 days for self-study and clarification of doubts from faculty or peers. Academic performance was assessed using a 30-mark spotter test conducted by an independent faculty member who was not involved in teaching. Answer scripts were evaluated by the paper setter to minimise observer bias.

Student perceptions regarding both teaching methods were collected using a structured Likert-scale questionnaire. The questionnaire assessed aspects such as clarity of concepts, engagement, comfort in asking questions, perceived effectiveness, and overall satisfaction. Data were analysed using paired sample t-tests to compare mean scores between EAL and PAL. Perception data were analysed using descriptive statistics and expressed as percentages. A p-value of less than 0.05 was considered statistically significant.

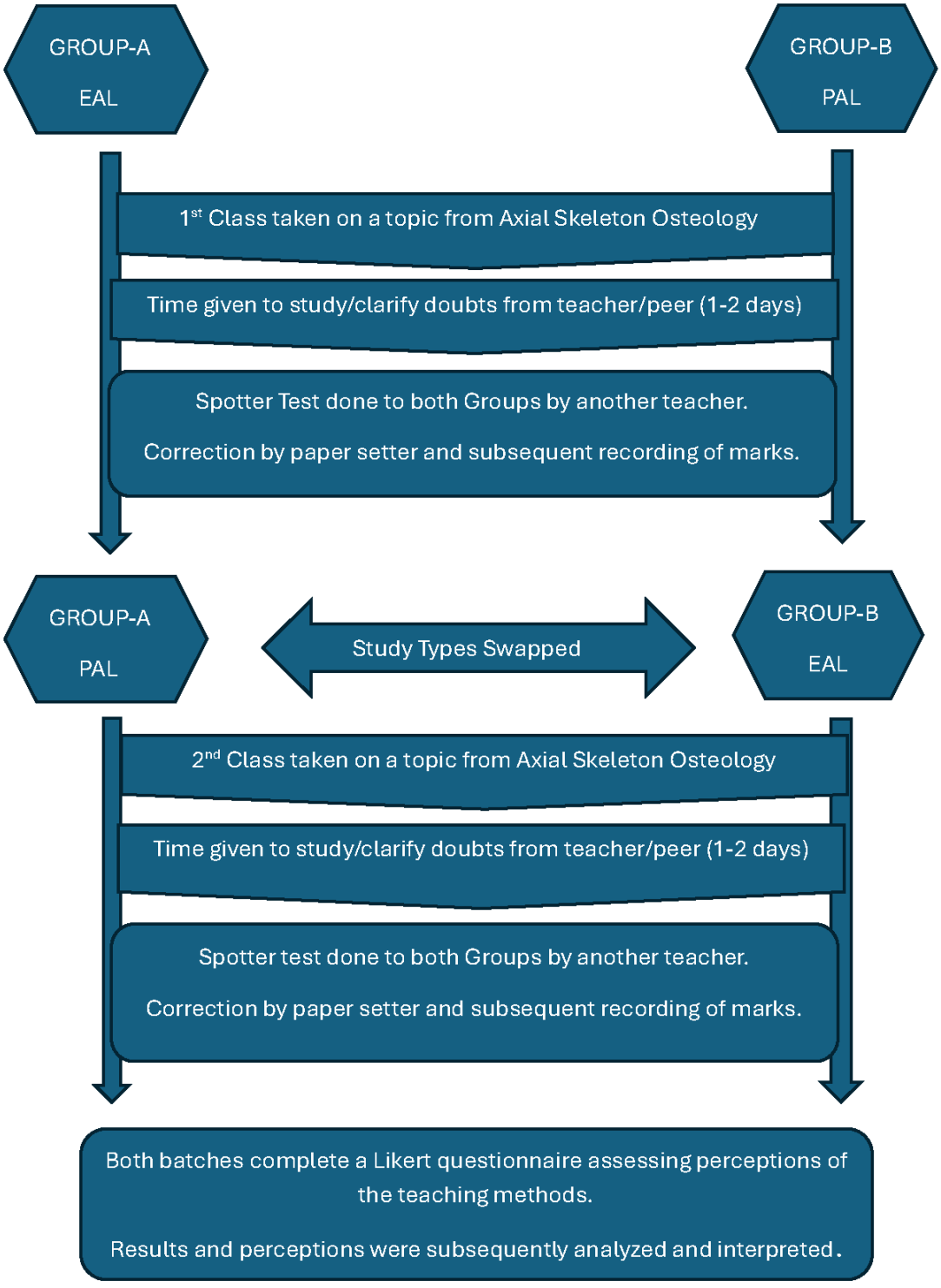


Figure 1. Study flowchart depicting Expert-Assisted Learning (EAL) and Peer-Assisted Learning (PAL) intervention design.

Results

Expert-Assisted Learning consistently resulted in higher academic scores compared to Peer-Assisted Learning across both sessions of the crossover study. The overall mean score achieved through EAL was 18.72 ± 6.18, whereas PAL yielded a mean score of 16.34 ± 6.21. This difference was statistically significant ($p = 0.0088$), indicating superior academic performance with faculty-led instruction.

Session-wise analysis also demonstrated higher mean scores for EAL in both teaching cycles, suggesting that the observed difference was not topic-specific but related to the teaching method itself. Despite this, analysis of student feedback revealed that a substantial proportion of students perceived PAL as an engaging and supportive learning method. Many students reported increased comfort in interacting with peers, better opportunities for discussion, and reduced hesitation in asking questions during PAL sessions.

Academic Performance

Expert-Assisted Learning consistently resulted in higher academic scores compared to Peer-Assisted Learning across both sessions of the crossover study. The overall mean score achieved through EAL was 18.72 ± 6.18, whereas PAL yielded a mean score of 16.34 ± 6.21. This difference was statistically significant ($p = 0.0088$), indicating superior academic performance with faculty-led instruction.

Session-wise analysis also demonstrated higher mean scores for EAL in both teaching cycles, suggesting that the observed difference was not topic-specific but related to the teaching method itself. These findings indicate that for complex and detail-intensive topics such as axial skeleton osteology, expert guidance plays a critical role in enhancing immediate academic outcomes.

Student Perceptions

Student perceptions regarding both teaching-learning methods were assessed using a structured Likert-scale questionnaire (Fig. 3) administered after completion of both sessions. The questionnaire explored multiple domains including clarity of concepts, ease of understanding, level of interaction, comfort in asking questions, motivation to learn, perceived effectiveness, and overall satisfaction.

Analysis of perception data revealed that a majority of students expressed favourable opinions toward Peer-Assisted Learning despite its comparatively lower objective scores. A substantial proportion of students agreed or strongly agreed that PAL sessions were more interactive and promoted active participation. Students reported feeling more comfortable asking questions and expressing doubts during peer-led sessions, attributing this to reduced fear of judgement and a more informal learning environment.

Many students perceived that explanations provided by peer tutors were easier to understand, as peers used simpler language and relatable examples. PAL was also viewed as encouraging collaborative learning, discussion among group members, and mutual support. These aspects contributed to increased learner engagement and motivation, particularly among students who were hesitant to participate actively during faculty-led tutorials.

In contrast, Expert-Assisted Learning was rated higher for clarity, organisation of content, and confidence in the accuracy of information delivered.

Students acknowledged that faculty-led sessions were more structured, examination-oriented, and effective in highlighting important osteological landmarks and clinically relevant details. Consequently, EAL was perceived as more beneficial for examination preparation and acquisition of precise anatomical knowledge.

Overall satisfaction ratings indicated that while students recognised EAL as superior for academic performance, they valued PAL as a supportive and engaging learning experience. A majority of respondents expressed that an integrated approach combining expert-led teaching with peer-assisted sessions would be the most effective strategy for learning osteology.

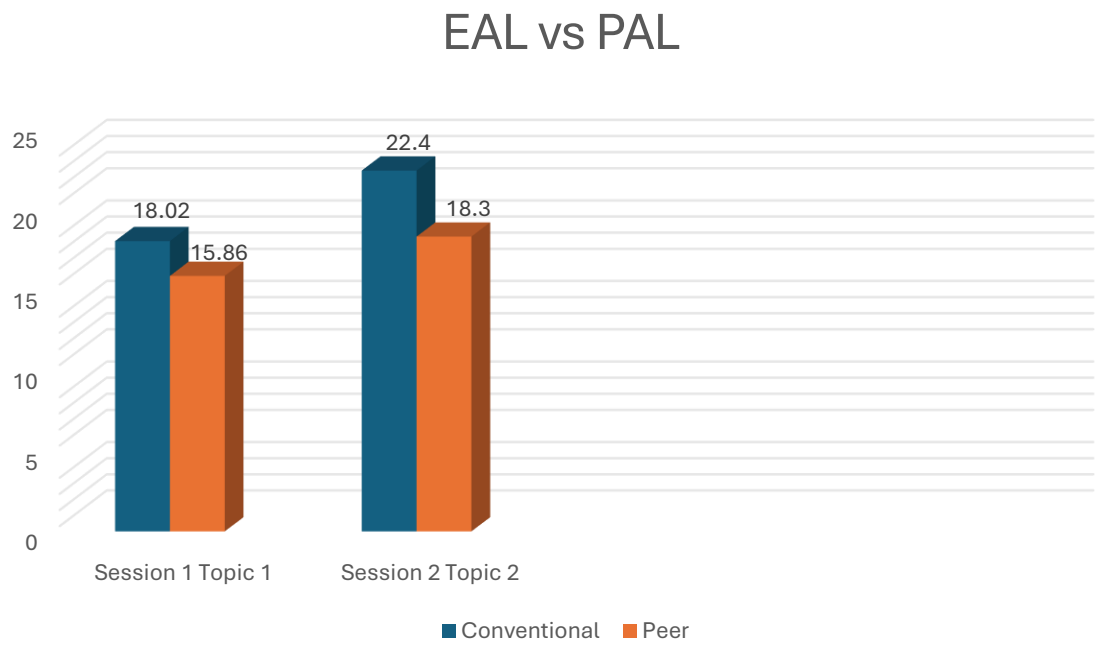


Figure 2. Comparison graph of Expert-assisted learning and Peer-assisted learning.

Table 1. Mean scores of Expert-assisted learning and Peer-assisted learning across two sessions.

	Session 1 Topic 1	Session 2 Topic 2
Conventional	18.02	22.4
Peer	15.86	18.3

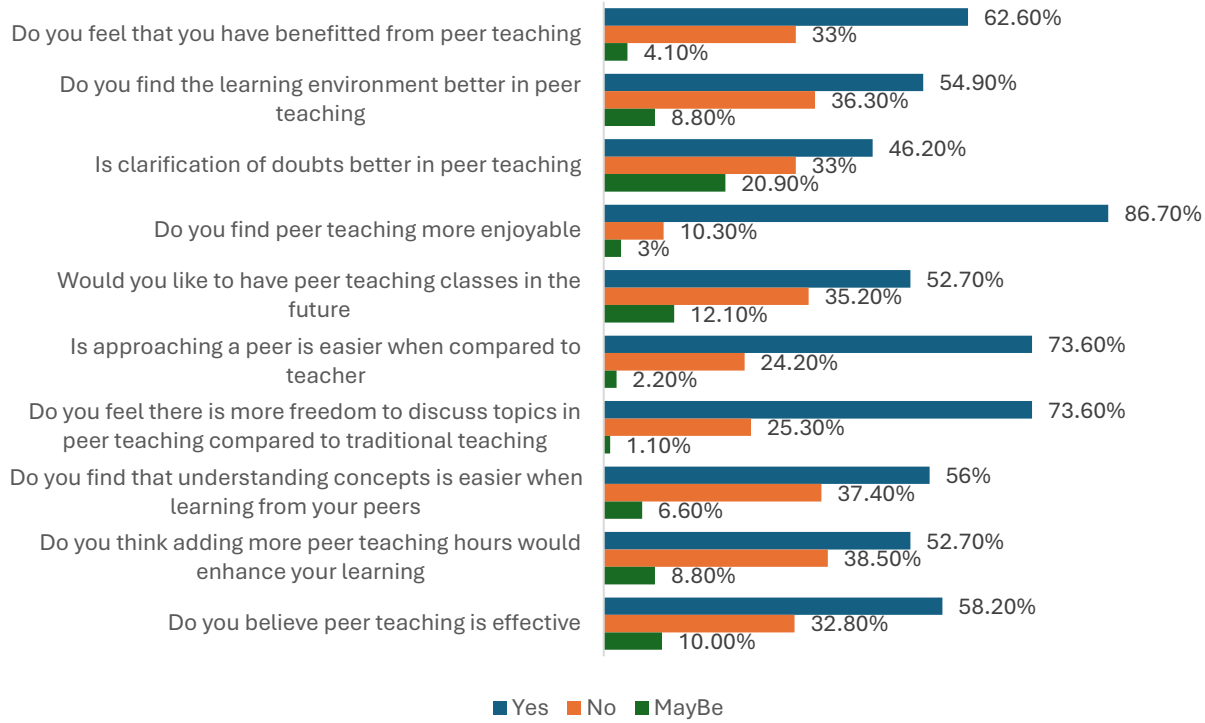


Figure 3. Likert-Scale based Questionnaire.

Discussion:

The present study evaluated the effectiveness of Peer-Assisted Learning compared to Expert-Assisted Learning in teaching axial skeleton osteology using a crossover design. The findings demonstrate that students taught through Expert-Assisted Learning achieved significantly higher scores in objective assessments. This underscores the continued importance of faculty-led instruction for complex and detail-oriented subjects such as osteology.

The superior performance associated with EAL is consistent with earlier studies that emphasised the role of faculty expertise, structured delivery, and emphasis on examination-relevant details [3,6,15]. Experienced teachers are able to contextualise osteological features clinically, clarify subtle anatomical variations, and correct misconceptions promptly—advantages that are particularly relevant for first-year students who are still developing foundational understanding.

Although Peer-Assisted Learning resulted in lower mean scores, student perceptions toward PAL were largely positive. These findings align with previous literature reporting improved engagement, motivation, and learner satisfaction with peer-led teaching [2,10,11]. Hermann-Werner et al. highlighted that PAL fosters a supportive and less hierarchical learning environment, which may enhance participation even if objective performance does not surpass traditional methods [4]. Cognitive congruence between peer tutors and learners may facilitate understanding by enabling explanations at an appropriate level and encouraging open discussion [9].

Several authors have suggested that PAL is particularly effective as a

reinforcement or revision strategy rather than as a primary mode of instruction [12–14]. In the present study, the absence of formal pedagogical training for peer tutors and the inherent complexity of axial skeleton osteology may have contributed to the comparatively lower scores observed with PAL. Similar observations were reported by Geethanjali et al. and Mussarat et al., who found that while PAL was well accepted, faculty-assisted teaching resulted in better academic outcomes [3,6].

The crossover design employed in this study enhances internal validity by allowing each student to experience both teaching methods, thereby reducing confounding due to inter-individual differences [16]. However, the assessment was limited to short-term objective performance using spotter tests and did not evaluate long-term retention or higher-order cognitive outcomes such as clinical application.

From an educational standpoint, the findings suggest that Peer-Assisted Learning should be integrated as a supplementary strategy rather than a replacement for Expert-Assisted Learning. PAL can be effectively utilised for small-group discussions, revision sessions, and alleviating faculty workload, particularly in resource-constrained settings [7,10]. Such a blended approach may optimise learning outcomes while fostering collaborative skills and professional development among medical students.

Limitations

The study has certain limitations, including a relatively small sample size, single-institution setting, short duration of intervention, and lack of assessment of long-term knowledge retention. Peer tutors did not receive formal training in teaching methodology. Future research involving multicentric studies with larger cohorts, structured peer-tutor training, and longitudinal follow-up are recommended to further explore the role of PAL in anatomy education.

Conclusion

Expert-Assisted Learning remains superior in achieving higher academic performance in axial skeleton osteology among first-year MBBS students. Nevertheless, Peer-Assisted Learning is positively perceived and promotes engagement, comfort, and collaborative learning. PAL should be adopted as a supplementary teaching-learning strategy to reinforce osteology instruction and optimise faculty resources, rather than as a substitute for traditional expert-led teaching.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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