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Original Article

Anatomy Section

Enhancing Neuroanatomy Learning using Specimen Videos: An Educational Interventional Study among First-year MBBS Students from Gujarat, India

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ABSTRACT

Introduction: The practical teaching of neuroanatomy is challenging because of the fragility of brain tissues, scarcity of specimens, and the need for visualisation of minute structural details. This requires an upgrade in teaching methodology to enhance learning and overcome problems in neuroanatomy practical teaching. Incorporating prerecorded videos of neuroanatomy specimens into practical teaching could help bridge this gap.

Aim: To evaluate the prerecorded neuroanatomy specimen videos as a supplementary tool in teaching the practical aspect of neuroanatomy.

Materials and Methods: This crossover educational interventional study was conducted at SMIMER Medical College, Surat, Gujarat, India from October 2024 to September 2025. All 250 first year MBBS students who volunteered were assigned to two groups using computer-generated sampling. The study was conducted in two phases with two different neuroanatomy topics. In phase I, after the theory lecture on Topic 1, Group A was exposed to prerecorded videos of neuroanatomy specimens, and Group B was taught directly using conventional cadaveric specimens in the dissection hall by the same faculty. In phase 2, after the theory lecture on Topic 2, both groups were flipped, and the same procedure was repeated. At the end of each phase, students were provided with Multiple Choice Questions (MCQs) (to assess topic-related knowledge) and a Likert scale-based questionnaire (to assess their perception of the teaching method they were exposed to). After completing both phases, a dichotomous response questionnaire was administered to gather final feedback on the preferences and effectiveness of the two teaching modalities. The collected data were analysed using both between-group and crossover comparisons, including unpaired and paired statistical tests for MCQ score, the Chi-square test for the Likert Questionnaire, and the Z-test for dichotomous responses.

Results: In this study, of the 250 students, 108 were male, and 142 were female, with a mean participant age of 17.18±0.63 years. The mean MCQ Score for Topics 1 and 2 was 5.11±1.44 and 4.90±1.62 in the prerecorded video teaching method, and 4.11±1.46 and 3.65±1.80 in the dissection hall teaching method, respectively, and were found statistically significant. Analysis of Likert-scale questionnaire data showed statistically significant results for the prerecorded video teaching method in terms of overall satisfaction, better visualisation of specimen details, audibility of information, achievement of learning objectives, and enhancement of neuroanatomy knowledge (p-value <0.001).

Conclusion: The present study analysed students' perceptions of practical teaching methodologies in neuroanatomy and found that prerecorded videos of neuroanatomy specimens can serve as a supplementary tool alongside conventional dissection hall teaching.

Keywords: Cadaveric dissection, Medical education, Neuroanatomy videos, Teaching modality

INTRODUCTION

Human anatomy is a vast and comprehensive subject for first-year medical students and those in allied health sciences. A sound knowledge of gross anatomy is essential for medical graduates, as it forms the basis for clinical practice [1]. Neuroanatomy, an important subdivision of anatomy, deals with the structure and organisation of the nervous system. However, it is often considered one of the most difficult topics for students due to its structural complexity, limited exposure to clinical cases, and challenges in teaching [2]. The scarcity of cadavers and reduced teaching faculty further aggravate these difficulties [3].

Continuous improvement of teaching methodologies is necessary in education to enhance students' learning experience. With the modification in the duration allocated for teaching anatomy under the new Competency-Based Medical Education (CBME) guidelines, educators are required to complete the subject within a limited timeframe while ensuring effective student understanding [4,5]. Therefore, the use of supplementary teaching methods has become increasingly important [6]. Traditionally, practical teaching of neuroanatomy relies on schematic diagrams and cadaveric dissection. Although these methods remain fundamental, they may not always provide a clear understanding of the three-dimensional relationships and intricate structural details of brain tissue [7].

Several alternative teaching methods have been explored for neuroanatomy education, including clinical case-based learning, three-dimensional computer-assisted neuroanatomy, case studies, flipped classrooms, computer-assisted teaching, and plastinated models [8-11]. The need for innovative supplementary methods can be addressed by incorporating prerecorded videos of neuroanatomy specimens into practical teaching [6]. Videos prepared from real cadaveric neuroanatomy specimens can effectively demonstrate the depth and details of anatomical structures. Such visual resources can enhance clarity and improve students' understanding of the three-dimensional organisation of neural structure, and also allow them to review it at any time, as per their convenience [12]. Therefore, the present study aimed to evaluate the prerecorded neuroanatomy

specimen videos as a supplementary tool in teaching the practical aspects of neuroanatomy.

Null hypothesis: There is no significant difference in knowledge gain between students taught by prerecorded neuroanatomy specimen videos and the conventional dissection hall teaching method.

MATERIALS AND METHODS

An educational interventional study was conducted in SMIMER College, Surat, Gujarat, India from October 2024 to September 2025. Prior ethical clearance was obtained from the Institutional Ethics Committee of SMIMER. (IEC/out / No.- 86).

Universal sampling was conducted to include all 250 enrolled first year MBBS students for the academic year 2024-25. Participation was truly voluntary, with no academic benefit or consequences. Participants were allocated to two groups by a simple randomisation procedure (Computer-generated sampling) by an independent researcher. All 250 students had participated and were divided in two equal groups: Group A and Group B. Two neuroanatomy topics were selected by consensus among three subject experts. Topic 1: External features of the medulla and Topic 2: Floor of the 4th ventricle.

Inclusion criteria: First-year MBBS students enrolled at SMIMER Medical College, Gujarat, who provided informed consent and participated in both phases of the study were included in the study.

Exclusion criteria: Students who did not provide consent, were absent during any phase of the study, or failed to complete the feedback questionnaire or assessment tools were excluded from the study.

Assessment questionnaire: The questionnaires were developed by the authors with the help of 3 subject experts from the anatomy department. General demographic information (Name, Roll No., e-mail ID) was collected from all participants. The questionnaire comprised three sections. Section-I comprises seven Multiple-Choice Questions (MCQs) to test knowledge of the topic covered. Each MCQ was worth one mark per question (total 7 marks per topic). MCQ scripts were scored by a faculty member blinded to group allocation. Section-II comprises five questions, standardised according to Likert's criteria, to assess students' perceptions of the teaching method [13]. Participants responded to five items using a 5-point Likert-type scale, ranging from response-1 to response-5. Section-III comprised five dichotomous questions (yes/no responses) to assess students' preferences and gauge the perceived usefulness of each teaching modality.

In this study, two different practical teaching methods of neuroanatomy were used and assessed: 1) Conventional teaching in Dissection Hall using neuroanatomy specimens; and 2) Prerecorded video of neuroanatomy specimens in the classroom. To avoid any bias, neuroanatomy specimen videos, dissection hall teaching and theory lecture were delivered by a single faculty member. Videos were recorded in high-definition resolution (1080p, Full HD) with a microphone to ensure audio quality.

Procedure

Each prerecorded video session lasted for total 20 minutes (Video duration of Topic-1: seven minutes and remaining time for query solving and interaction with students; Video duration of Topic-2: nine minutes and remaining time for query solving and interaction with students). Similarly, conventional dissection sessions lasted for 20 minutes with query solving and interaction. Dissection sessions accommodated groups of 25 students, while video sessions were conducted simultaneously for the entire group. Both sessions covered identical learning objectives. The study was conducted in two phases. Both groups were flipped at the end of phase-I. A washout period of almost two weeks was maintained between the two phases to minimise carryover effects [14]. Different neuroanatomy topics were used in each phase to reduce topic familiarity bias. The procedure is briefed in [Table/Fig-1].

	Neuroanatomy practical teaching method		
	Prerecorded video of Neuroanatomy specimen	Conventional Teaching method of Specimen (Dissection)	Assessment (Immediately after each phase)
Phase I Topic 1	Group A	Group B	Feedback questionnaire comprising Section I and II
Phase II Topic 2	Group B	Group A	Feedback questionnaire comprising Section I, II and III

[Table/Fig-1]: Showing procedure followed to conduct the study.

The questionnaires (Section I and II at the end of phase 1 and Section I, II and III at the end of Phase-2) were provided electronically to the students as Google Forms. Assessment was conducted immediately (within 30 minutes) after completion of each teaching session.

STATISTICAL ANALYSIS

Data were entered and analysed using Epi Info 7.1. As this was a crossover study design, both between-group (video vs dissection within each phase) and within-subject comparisons across phases were considered. Continuous variables (MCQ scores) were expressed as mean±Standard Deviation (SD) and compared between groups using an unpaired Student's t-test and for crossover comparison by a paired t-test. Categorical variables (Likert-scale responses, dichotomous preferences) were expressed as frequencies and percentages and compared using the Chi-square test. For the dichotomous Section III responses, a z-test for two proportions was applied. For analysis, a p-value of < 0.05 was considered statistically significant.

RESULTS

A total of 250 first-year MBBS students participated having a mean age of 17.18±0.63 years. Group A comprised 53 males (42.4%) and 72 females (57.6 %); Group B comprised 55 males (44%) and 70 females (56%). The gender distribution between Group A and Group B showed no statistically significant difference (χ^2=0.065, p-value=0.80), indicating comparability of groups at baseline. Group A mean age was 17.20±0.79 years and for Group B it was 17.19±0.39 years. An independent t-test showed no statistically significant difference between the groups (t=0.25, p-value=0.80), indicating that the groups were comparable at baseline.

Statistical analysis of Section I of the questionnaire, containing seven MCQs on topic-related knowledge gained, showed a higher score for the group exposed to the prerecorded video specimen than for the group exposed to the conventional dissection hall teaching method. The difference between the two groups was statistically significant, as shown in [Table/Fig-2].

Topics	Groups	MCQ score (out of 7) Mean±SD	t-value	p-value
Topic 1	Group A: Prerecorded video	5.11±1.44	5.45	<0.01
	Group B: Dissection teaching	4.11±1.46		
Topic 2	Group A: Dissection teaching	3.65±1.80	5.77	<0.01
	Group B: Prerecorded video	4.90±1.62		

[Table/Fig-2]: Statistical analysis between two groups (n= 125 in each group, Section-I of Questionnaire containing 7 MCQs for topic-related knowledge gained by each method).
Unpaired student's t-test

The video method MCQ score for all 250 students was 5.00±1.54, and the dissection method score for all 250 students was 3.87±1.66 (out of 7). A paired t-test was conducted to compare the effectiveness of two teaching methodologies in a crossover study design, and found that the video method group demonstrated a statistically significantly higher score than dissection method group (p-value <0.001).

As shown in [Table/Fig-3,4] (Section II of the feedback Questionnaire, based on Likert-scale responses), more students favoured the video teaching method than the conventional dissection method (p-values <0.001 and 0.004, respectively). Across all measured domains, video-based teaching was rated more favourably, particularly in terms of satisfaction, visualisation, audibility, relevance, and effectiveness, compared with the dissection method, which elicited mixed or neutral responses.

Students felt that the neuroanatomy video would be more helpful for understanding minute structural details, long-term retention of knowledge, and better performance in the examination [Table/Fig-5]. For improving quality of video specimen question, 65 students (26%) out of 250 suggested feedback in the form of: 23 students (9.1%) suggested: making more videos for other topics of neuroanatomy, 15 students (6.07%) suggested: to provide videos for revision, 14 (5.63%) students suggested: to include videos at end of each lecture session (5.63%), 5 (1.95 %) students suggested: to add some animation in video, four students (1.52%) suggested: to add important questions at the end of videos, four students (1.73%) created integrated approach of video and dissection methods. Videos made by faculty are more preferable. Students' preferred for long-term retention was based on self-reported perception and not an objective retention test.

DISCUSSION

Neuroanatomy is widely regarded as one of the most challenging subjects in the undergraduate medical curriculum due to its complex three-dimensional organisation [15]. The analysis of Section I of the questionnaire, which contained MCQs assessing topic-related knowledge gained by each method, showed that post-teaching MCQ scores for both topics differed significantly between the two groups, indicating the benefit of using prerecorded neuroanatomy specimen video teaching. This finding was similar to the study by Tiwari S, who also found a statistically significant difference in the scores of the two groups compared for incorporating videos alongside lectures and concluded that videos are more effective than lectures alone for teaching Anatomy [16]. In a study done by Mahmud W et al., there was a slightly higher score in the experimental group (+1.26 marks), but it was statistically not significant, although 93% of students favoured regular inclusion of dissection videos in the curriculum, and 50% termed it the best source for learning gross anatomy [17].

Topic	Parameter	Teaching method	Response-1	Response-2	Response-3	Response-4	Response-5	p-value*
Topic-1	1. Overall satisfaction	Video (Group A)	64 (51.4%)	39 (31.2%)	16 (12.8%)	2 (1.6%)	4 (3.2%)	<0.001
		Dissection (Group B)	25 (20%)	59 (47.2%)	29 (23.2%)	10 (8%)	2 (1.6%)	
	2. Visualisation of minute details	Video (Group A)	61 (48.8%)	42 (33.6%)	13 (10.4%)	3 (2.4%)	6 (4.8%)	<0.001
		Dissection (Group B)	22 (17.6%)	43 (34.4%)	46 (36.8%)	11 (8.8%)	3 (2.4%)	
	3. Audibility of information	Video (Group A)	68 (54.4%)	24 (19.2%)	22 (17.6%)	8 (6.4%)	3 (2.4%)	<0.001
		Dissection (Group B)	20 (16%)	36 (28.8%)	56 (44.8%)	12 (9.6%)	1 (0.8%)	
	4. Relevance to achieve learning objectives	Video (Group A)	72 (57.6%)	35 (28%)	16 (12.8%)	1 (0.8%)	1 (0.8%)	<0.001
		Dissection (Group B)	37 (29.6%)	57 (45.6%)	24 (19.2%)	7 (5.6%)	0	
	5. Effectiveness in knowledge enhancement	Video (Group A)	70 (56%)	37 (29.6%)	15 (12%)	0	3 (2.4%)	<0.001
		Dissection (Group B)	29 (23.2%)	52 (41.6%)	38 (30.4%)	6 (4.8%)	0	

[Table/Fig-3]: Students' perception about two teaching methodologies for Topic-1 (Section-II of the feedback Questionnaire based on a Likert scale).
*Chi-square test derived p-value; Response-1: Very satisfied/Very relevant/ Very effective; Response-2: Somewhat satisfied/Moderately relevant/Somewhat effective; Response-3: Neutral; Response-4: Somewhat dissatisfied/Somewhat relevant/Somewhat ineffective; Response-5: Very dissatisfied/Not relevant at all/Very ineffective

Topic	Parameter	Teaching method	Response-1	Response-2	Response-3	Response-4	Response-5	p-value*
Topic-2	1. Overall satisfaction	Video (Group B)	50 (40%)	44 (35.2%)	25 (20%)	4 (3.2%)	2 (1.6%)	0.004
		Dissection (Group A)	27 (21.6%)	67 (53.6%)	22 (17.6%)	0	9 (7.2%)	
	2. Visualisation of minute details	Video (Group B)	18 (14.4%)	71 (56.8%)	32 (25.6%)	0	4 (3.2%)	0.001
		Dissection (Group A)	22 (17.6%)	43 (34.4%)	46 (36.8%)	0	14 (11.2%)	
	3. Audibility of information	Video (Group B)	23 (18.4%)	60 (48%)	34 (27.2%)	5 (4%)	3 (2.4%)	0.001
		Dissection (Group A)	31 (24.8%)	28 (22.4%)	29 (23.2%)	32 (25.6%)	5 (4%)	
	4. Relevance to achieve learning objectives	Video (Group B)	55 (44%)	36 (28.8%)	33 (26.4%)	1 (0.8%)	0	<0.001
		Dissection (Group A)	24 (19.2%)	39 (31.2%)	61 (48.8%)	1 (0.8%)	0	
	5. Effectiveness in knowledge enhancement	Video (Group B)	45 (36%)	58 (46.4%)	19 (15.2%)	3 (2.4%)	0	0.001
		Dissection (Group A)	29 (23.2%)	50 (40%)	41 (32.8%)	1 (0.8%)	4 (3.2%)	

[Table/Fig-4]: Students' perception about two teaching methodologies for Topic-2 (Section-II of the feedback Questionnaire based on a Likert scale).
*Chi-square test derived p-value; Response-1: Very satisfied/Very relevant/ Very effective; Response-2: Somewhat satisfied/Moderately relevant/Somewhat effective; Response-3: Neutral; Response-4: Somewhat dissatisfied/ Somewhat relevant/Somewhat ineffective; Response-5: Very dissatisfied/Not relevant at all/Very ineffective

Section-III of feedback questionnaire	Prerecorded specimen video	Conventional dissection method	p-value*
1.Which teaching methodology do you consider would be better in terms of understanding of minute structural details of neuroanatomy specimen?	150 (60%)	100 (40%)	0.001
2. Which teaching methodology do you consider would be better in long term retention of the knowledge?	137 (54.8%)	113 (45.2%)	<0.05
3. Which teaching methodology do you consider would help you achieve better performance in the examination?	143 (57.2%)	107 (42.8%)	<0.05
4. Do you think a neuroanatomy video can be a supplementary tool to the conventional teaching method?	223 (Yes) (89.2%)	27 (No) (10.8%)	0.001
5. Do you have any other suggestions for improving the quality of specimen videos in neuroanatomy education?	65 (Yes) (26%)	185 (No) (74%)	0.001

[Table/Fig-5]: Student's perception about two teaching methodologies (Section-III of feedback Questionnaire) (n=250).
*p-value derived from z-test for two proportions

A study by Welch MC et al., showed that anatomical dissection videos are an important resource for learning neuroanatomy among students [18]. In a study by Strkalj G et al., on the use of short anatomy videos in Anatomy education, students perceived them as a very useful resource for study and requested more videos for the anatomy curriculum [19]. In another study by Viswasom AA and Jobby A, students favoured osteology videos over conventional bone teaching methods and opined that incorporating newer multimedia techniques should be used as a source for anatomy learning [20]. Similarly, in a study of Pradhan S et al., for YouTube video utilisation and effectiveness amongst first year MBBS students, it was found that more than 90% students perceived YouTube video as an effective educational tool and opined that a multifaceted approach involving comprehension, visualisation, and memorisation is crucial for mastering anatomy [21].

A study by Alsaid B et al., reported that 84.5% of students in the intervention group perceived short social media videos as a useful supplementary resource in neuroanatomy [22]. In a systematic review, Newman HJ et al., reported that technology-enhanced teaching methods are not inferior to conventional didactic approaches, particularly in understanding of complex spatial anatomy and in reducing cognitive load [23]. A study of Patera E et al., also documented that most multimedia resources are effective in students' understanding of structural neuroanatomy but less useful in understanding functional and clinical neuroanatomy [24].

Despite the advantages, specimen videos should be viewed as a supplementary teaching tool rather than a substitute for traditional methods such as cadaveric dissection. Hands-on exposure to real specimens remains essential for developing tactile understanding and professional attitudes toward anatomical study.

Limitation(s)

Single-institution study, only two neuroanatomy topics, no delayed retention test, self-reported perception bias, and a possible novelty effect of video technology remain. Generalisation of these results to the wider spectrum of anatomy teaching and formal assessment of reliability and validity indices for the questionnaire was not performed in the current study. No cost-benefit ratio was assessed; however, once produced, videos offer long-term reusability. A washout period of approximately two weeks considered adequate due to different topics in both phase; however, complete elimination of cognitive carryover in learning-based interventions cannot be ensured.

CONCLUSION(S)

The present study showed that students' preferred neuroanatomy specimen video teaching method over conventional teaching in the dissection hall for understanding complex neuroanatomical structures. These prerecorded neuroanatomy specimen videos can be used as a supplementary tool in teaching the practical aspect of neuroanatomy.

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