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A comparative study of effectiveness of cadaver dissection versus computer assisted dissection

Rashmi Malhotra[a,*], Manu Malhotra[b], Ranjeeta Kumari[c]

[a] Assistant Professor, Department of Anatomy, Institute of Medical Sciences, Rishikesh, Uttarakhand 249201, India
[b] Associate Professor, Department of Otolaryngology, Institute of Medical Sciences, Rishikesh, Uttarakhand 249201, India
[c] Associate professor, Department of Community Medicine, Institute of Medical Sciences, Rishikesh, Uttarakhand 249201, India

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ABSTRACT

Introduction: The aim of this study was to compare the effectiveness of computer assisted virtual dissection with that of actual dissection as analyzed through students' achievements and attitudes.
Methods: We conducted a prospective inferential study with fifty 1st year medical students who undertook dissection classes through computer – assisted dissection, actual dissection on cadavers and combination of both in three different sessions. The students' scores in the assessment tests after undergoing these dissection schedules were analyzed using paired *t*-tests. Students' attitudes regarding these two methodologies were assessed by a set of questionnaire.
Results: Students who participated in the actual cadaver dissection, supplemented by computer assisted virtual dissection scored significantly higher ($p = 0.004$) as compared to any of dissection methods used alone on post-dissection assessment tests. The proportion of students achieving more than 50% marks was also significantly higher with the combination method. Analysis of the survey questionnaire indicated differences in attitudes of students for actual dissection and computer-simulated virtual dissection. Vast majority of students (97.6%, n = 48) stated that computer assisted dissection cannot replace the actual dissection of cadavers, but were in the favor of incorporating the computer assisted virtual dissection as an integral part of teaching of human anatomy as a complementary tool to the actual dissection.

1. Introduction

The study of anatomical details of the human body has been a cornerstone in medical education all across the globe since ages.[1] Anatomy and dissection have long been considered the foundation of medical education. The use of human cadavers as a learning tool has been in practice ever since Andreas Vesalius started dissecting the cadavers in 1514.[1,2] Several Authors have advocated that the dissection of cadaver gives students a better appreciation of the three-dimensionality of the human body and better understanding of variations in human anatomy.[3–7] Medical students not only connect to the human body in a better way but also develop a feeling of empathy which is essential for a future doctor to develop.[8] In different studies authors have advocated better performances and peer interaction by students exposed to actual dissection of cadavers as compared to the students that had no contact with the cadaver.[9–11] However, many of the recent authors emphasize upon the virtual methods of dissection and favor modern computer based teaching arguing that the actual dissection of cadaver is a story of the old days. Their studies reported many advantages to students that had a non- cadaver based study than the students that carried out dissection.[12–18]

Different authors have used either post-training evaluation tests or questionnaire method to assess the effectiveness of the actual and virtual dissection in separate group of students and have contributed to the debate.[19–23] However the evidence generated by the combination of post-training evaluation tests and questionnaire method is lacking in the available literature. In this study, we have tried to sort out the issue through a combination of assessment tests conducted after training and a questionnaire filled by the students. The questionnaire would gather information regarding students' opinion and perception on the use of computer assisted virtual dissection, as compared to the traditional dissection of cadavers in learning gross anatomy. The purpose of

* Corresponding author at: Rashmi Malhotra ¾, Type IV Flats, Veerbhadra Marg, AIIMS Rishikesh, Uttarakhand 249201, India.
E-mail addresses: rashmi_krrish@yahoo.co.in (R. Malhotra), manumalhotrallrm@gmail.com (M. Malhotra).

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the study was to find out which type of dissection training was better for the students in enhancing the learning and reproduction of knowledge as assessed through scores in exams and correlate the objective and subjective data.

2. Material and methods

This was a prospective, inferential study conducted in the Department of Anatomy of All India Institute of Medical Sciences (AIIMS), Rishikesh. The institutional ethics committee approved the study protocol. Fifty, first year medical students participated in the study after giving informed consent. The study was performed in three sessions of six weeks each (Fig. 1). In the first session, the anatomy of superior and inferior extremities were taught without actual dissection of cadavers with the help of dissection videos of respective regions and online medical animations during the practical hours, supervised by the teachers who tried to emphasize on the most important aspects. The actual dissection for these extremities was performed after the assessment test to maintain their level of understanding. In the second session, the students studied anatomy of abdomen and thorax through actual dissection on cadavers, assisted by the teachers. In the final session, the students carried out actual dissection on the regions of head, neck and brain as well as visualized the dissection videos of these regions. The videos of dissection were, provided to them in pen drives also. The learning and understanding of the subject by the students after each session were evaluated by assessment tests that included objective multiple-choice questions, which were recall based, comprehension based and application based.

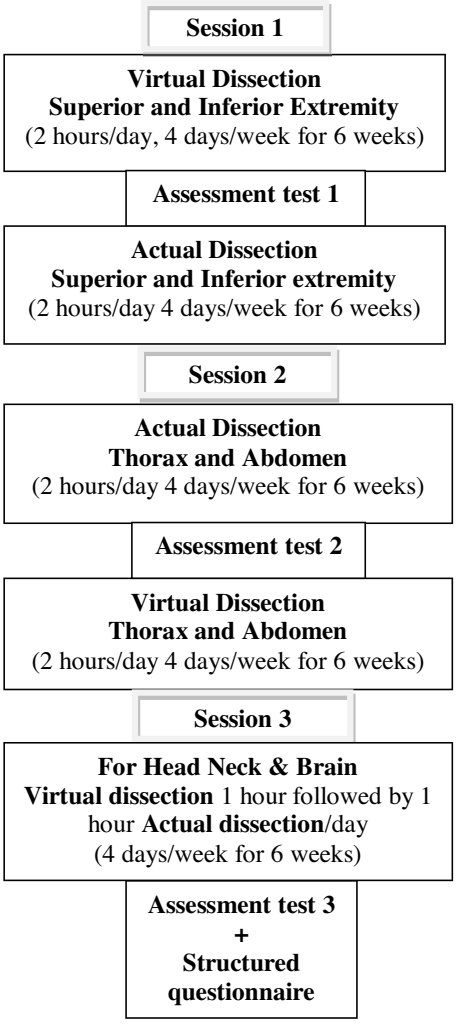

Fig. 1. Flowchart showing research methodology.

Mean scores were calculated after each test session. Significance of difference between scores of different sessions was evaluated by paired *t*-test, using computer program Microsoft Excel Data Analysis Tool Pack. To find out the significance of difference in the ratios of the students who passed in tests to the failed students (i.e. obtaining less than 50% of marks), Chi square test using Epi Info software was applied. *p* values of less than 0.05 were considered statistically significant. The students also filled up a structured questionnaire where in they reported about their perception about virtual, actual and virtual + actual dissection sessions. Frequency of responses of questionnaire was assessed to know the attitudes of students towards both the methods of dissections.

3. Results

The mean score of the evaluation test performed after first session was 53.00 ± 11.91, after second session was 54.06 ± 9.83 and after final session was 58.82 ± 7.68 (Table 1). Comparison of the mean scores of virtual and actual dissection training evaluation tests with paired *t*-test showed no significant difference ($p = 0.58$). However, there was a significant difference between mean scores of virtual and virtual + actual dissection training assessment tests ($p = 0.004$), and between actual and virtual + actual dissection training evaluation tests ($p = 0.008$). This clearly shows that the combination of traditional and virtual dissection techniques show better results than any of the techniques practiced alone.

It is notable that 64% (n = 32) students passed in assessment test after actual virtual training, 68% (n = 34) students passed in assessment test after virtual training and 88% (n = 44) passed assessment test in the combined training program.

3.1. Statistical analysis

On statistical analysis of the results,in terms of percentage of students scoring 50% or more marks, in the assessment tests by applying Chi Square test, it was found that the pass-fail ratio was significantly better when actual and virtual dissection training was used hand in hand (p = 0.01) rather than, when these techniques were used alone (Table 2).

The subjective assessment of the teaching modalities was done through the questionnaire filled in by the students revealed that majority (66%, n = 33) of the students had agreed to the fact that combination of the two methodologies of dissection has a greater impact on their learning. Most of the students (56%, n = 28) felt that combination method made the subject interesting as compared to either of the dissection methodologies practiced alone. It was however, seen that equal number of students (40%, n = 20) found

Table 1
Comparison of scores in assessment tests after virtual, actual and actual+ virtual dissection.

Type of dissection	Mean ± Standard Deviation	*p* value
Virtual versus Actual dissection		
Virtual	53.002 ± 11.91	0.58
Actual	54.06 ± 9.83	
Virtual versus Actual + Virtual dissection		
Virtual	53.00 ± 11.9	0.004
Actual+ Virtual	58.82 ± 7.68	
Actual versus Actual + Virtual dissection		
Actual	54.06 ± 9.83	0.008
Actual + Virtual	58.82 ± 7.68	

Table 2
Passed/Failed ratio of students in assessment tests after virtual, actual and actual+ virtual dissection).

Type Of Dissection	Pass % (n = 50)	Chi^2 Value (X^2)	*p*value
Virtual versus actual dissection			
Virtual	34/50 = 68	0.04	0.83
Actual	32/50 = 64		
Virtual versus actual + virtual dissection			
Virtual	34/50 = 68%	4.72	0.03
Actual+ Virtual	44//50 = 88%		
Actual versus actual + virtual dissection			
Actual	32/50 = 64%	6.63	0.01
Actual + Virtual	44/44//50 = 88%		

actual dissection and combination techniques were equally helpful in revision, though 20% (n = 10) students felt that virtual dissection material are sufficient for revision/recall. The combination methodology was rated 9/10 by 56% students (n = 28), as compared to actual dissection which was rated 7/10 by 40% students (n = 20), and virtual dissection 5/10 by only 4% students (n = 2). Majority of the students (97.6%,n = 48) felt that computer assisted virtual training program could never replace teaching through cadaveric dissection but were in the favor of incorporating the computer assisted virtual dissection as an integral part of teaching human anatomy as a complementary tool to the actual dissection (Table 3).

4. Discussion

During the last decade, we have witnessed a massive advancement in the field of technology, which has crept into all the aspects of our lives, and medical education is not an exception. Generalization in use of computers, access to the web and an increasing number of software and websites related to the subject of anatomy, have revolutionized the ways of teaching the subject of human anatomy to the students. The modern medical students who get admitted to various medical colleges of India are the ones who have been acquainted with computers right from their primary education in schools. With the advent of web-based technology coupled with the rapid increase in the availability of educational software and information databases through the internet, computer-aided instruction (CAI) is becoming an important component of the modern education systems. The medical curriculum has been redesigned and the time allotted for teaching of the basic sciences has been reduced.[24,25]

It is also important to note that with new medical colleges coming up every year, this scarcity of cadavers is becoming a major setback to the process of actual dissection in many colleges who find the availability of computer dissection software easier. Emotional impacts on some students on exposure to the cadavers, health and safety issues associated with the use of cadaver are also some of the concerns that warrant against the actual dissection.[26–28]

However, several authors are of the opinion that lessons learnt from direct learning through human body are incomparable.[29–32] Computer simulation and technology can never equate with the complex and miraculous reality of a human body.[3] Cadaver dissection allows the first visual and tactile experience of "human body and life" for aspiring future physicians.[33] Dissection prepares the medical students to confidently face the picture of death that is so important in treating life. There is no "short cut" way around it. As stated by Granger "the cadaver provides an appreciation of human life through an understanding of death and dying".[34] Three-dimensional visualization has the most significant impact on the teaching and learning of gross anatomy and since times immemorial, it has been through cadaver dissection. It allows students a first-hand access to the actual structures and three – dimensional spatial relationships of the body.[35] The experience of cutting through various layers of the body to discover clinically vital structures is unparallel. Students' contact with cadavers is important in order to enhance communication and teamwork.[36]

Despite, the antiquity of the debate on the subject of cadaver versus virtual dissection, there is no literature that combines objective assessment and the subjective perception of the students undergoing different forms of training. In the current work, we have tried to amalgamate both methodologies. It is also notable that in this study, the students have reported their opinions after been exposed to cadaver, virtual and combination methods separately for different anatomical extremities. Since results show significant improvement in assessment tests with the use of combination technique of training, it indicates at ending of debate that continues in the quest for the better teaching methodology of human body. Moreover, the perceptions reported by the students clearly indicate that though cadaver dissection is more interesting and effective in learning as compared to the virtual, the combination method still stands out in comparison to both the methods practiced separately.

5. Conclusion

We are of the opinion that cadaver dissection is the foundation upon which the entire medical curriculum is constructed. However, just as a mega-structure requires lots of additional pillars and supports for strength and longevity, computer assisted virtual dissection acts as a reinforcement tool, which enhances the reproducibility of the anatomical knowledge gained by actual dissection. Virtual dissection going hand in hand with the actual helps the students to recollect the minute details of human body, if by any chance they have missed them in the actual dissection. Prior visualization of dissection videos makes the students mentally and academically prepared for carrying out actual dissection. They get an idea about the landmarks, incisions, and structures on which they have to emphasize. Similarly, these videos are very helpful in revision of the regions prior to exams. They cannot carry actual cadavers to their study rooms whereas the "Virtual Cadavers" could move around with them in their pockets. They can learn from

Table 3
Analysis of Questionnaire filled by the students.

No.	Questions	Actual Dissection	Virtual Dissection	Combination
1	Which dissection methodology has more instructional/learning value?	16 (32%)	1 (2%)	33 (66%)
2	Which dissection technique makes learning anatomy interesting?	20 (40%)	2 (4%)	28 (56%)
3	Which dissection methodology assists in recall/revision?	20 (40%)	10 (20%)	20 (40%)
4	Overall rating in scale of 1–10?	>7 (20, 40%)	≥5 (2, 4%)	≥9 (28, 56%)
5	Can cadaveric dissection be replaced by computer assisted dissection in the near future?	YES 2 (4%)		NO 48 (97.6%)
6.	Can computer assisted dissection be used as a complementary tool to actual dissection.	YES 48(97.6%)		NO 2 (4%)

them anywhere, in hostels, libraries, even in dining hall! Our study therefore suggests proper amalgamation of both types of dissection methodologies for the best learning of human anatomical details and better performance by the students in their exams.

Conflict of interest

The authors have none to declare.

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