DOI: 10.7860/IJARS/2022/56680.2826

Original Article

Anatomy Section

Impact of Plastinated Tracheobronchial Tree Cast on Students' Learning in a South Indian Medical School- A Quasi-experimental Study

SV UMA[1], LEELAVATHY[2]

ABSTRACT

Introduction: Plastination is a technique used in anatomy to preserve body parts or whole body by indefinitely replacing water and lipids contained in it with a curable plastic. This process renders human tissue dry, non toxic and odourless. The students consider these specimens as user friendly in enhancing their learning.

Aim: To evaluate and compare the knowledge gained and its long term retention, between two groups of students, by the use of plastinated specimens and that of routine lecture class of same topic, respectively.

Materials and Methods: This quasi-experimentall study was conducted in the Anatomy Department of Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India, between November 2018 to January 2019. Total 150 Bachelor of Medicine and Bachelor of Surgery (MBBS) students from first year were divided into two groups- G1 and G2 of 75 students each. G1 was taught bronchopulmonary segments with tracheobronchial tree cast and a regular theory class was conducted on the same topic for G2. Both the groups were evaluated with a written questionnaire on the same day (T1) after the session and after 10 weeks (T2). The test scores of both the groups were compared using independent sample t-test and paired sample t-test was used to compare T1 and T2 scores of same groups.

Results: The number of students taken for analysis among G1 was 48 (28 girls and 20 boys) out of 75 and G2 was 47 (30 girls and 17 boys) out of 75 and their mean age was 19±1 years. The mean score of G1 for T1 was 6.30 and for T2 it was 8.60, whereas the mean score of G2 for T1 was 11.05 and T2 was 8.58. Statistically significant difference was observed within both the groups G1 (p-value=0.023) and G2 (p-value=0.002) for T1 and T2. There was a statistically significant difference on inter group comparison for T1 (p-value <0.01), whereas, on comparing the test scores for T2 of G1 and G2 there was no significant difference.

Conclusion: The results bring about the importance of visual and tactile learning of bronchopulmonary segments which has an impact on the memory for a longer period rather than didactic lecture classes. The use of plastinated specimens as an adjuvant to dissection in anatomy teaching will help in better understanding of the subject and retention for a longer period of time.

Keywords: Anatomy models, Knowledge gain, Plastic embedding, Tactile learning

INTRODUCTION

The gross specimens, an integral part of anatomy in learning, provide illustrations and explanations in understanding the disease. In the medical curriculum, anatomy, one of the essential basic subjects, has to be retained and form a foundation for the clinical practice. In this context knowledge of applied anatomy is very important [1,2].

Formalin is the age old fixative used to preserve the specimens. Generally the specimen would always be immersed in the formalin tank or glass jar. Whenever the students wanted to use, the specimens would be removed from tank and washed in water beforehand. There was always a preference by students to handle real specimens, which was easy to handle, durable, non toxic in nature and odorless [3,4]. They preferred specimens which could be handled without any protective equipment like gloves and help them in understanding the structure unlike the jar specimens where it would not be possible to do so [3,4]. All the above qualities were observed in plastinated specimens. These specimens were non toxic, non infectious and did not exude fumes that irritate the mucous membranes and which could be stored easily in simple plastic bags [3,4].

Plastination was invented in 1978 by Dr Gunther Von Hagens of University of Heidelberg. Three types of plastination can be observed- whole body/organ plastination; luminal cast plastination and sheet plastination. In whole body/organ plastination, the whole of the structure or organs and its relationships can be preserved. In luminal cast plastination, the hollow organs like lungs, stomach, intestine, ventricles of brain, vascular pattern of heart and kidneys can be plastinated. Beautiful and precise bronchial pattern could be observed by this technique. In sheet plastination, thin transparent or thick opaque sections of the body or an organ may be preserved in the form of cross sectional anatomy of organs [3].

Literature shows that plastinated specimens facilitated the process of teaching anatomy and enhanced the learning [5-8]. The two major areas of application for plastinated specimens are teaching and research. For teaching purposes, durable and quality specimens are produced and in research, the technique of sheet plastination maintains the arrangement of all tissue components and the luminal cast showing the branching pattern of vessels, tracheobronchial tree to study in their undisturbed context [8].

In a study by Bhandari K et al., the students understood the complex structure of primary bronchus and its further division through plastinated specimen and according to the students, the bronchial tree was not visible and it was always assumed in cadaveric specimen [9]. Very limited Western and Indian literature is available regarding the comparison between the two methodologies for learning bronchopulmonary segments, hence this study was planned [3,6-10].

In present study the luminal cast plastinated specimen of tracheobronchial tree was used to enhance the learning experience of the students. The objectives were to evaluate and compare quantitatively the knowledge acquired by the students with the use of plastinated specimen with that of routine lecture class on same topic and also the long term retention of the knowledge gained by both methods.

MATERIALS AND METHODS

This quasi-experimental study was conducted during November 2018 to January 2019 in the Anatomy Department of Sapthagiri Institute of Medical Sciences and Research Centre Bangalore, Karnataka, India, after obtaining ethical clearance from Institutional Ethical Review Board (IECC no: SIMS&RC/IECC/08/2017).

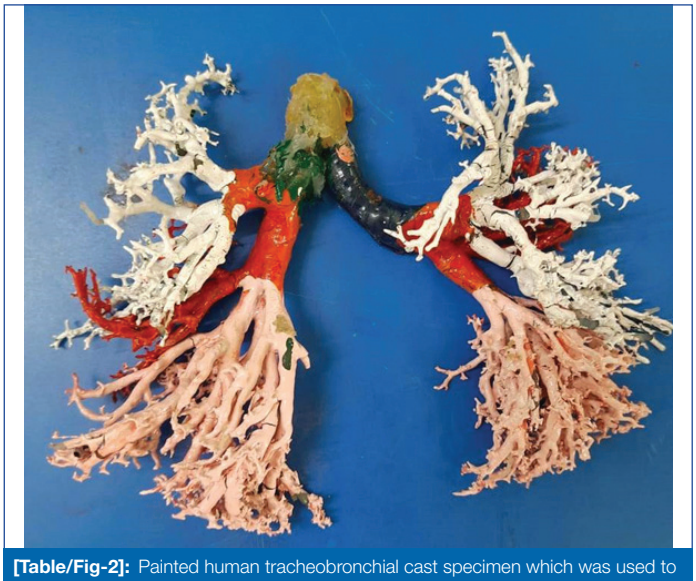
Inclusion criteria: All the first year medical students who were willing to participate in the study were included.

Exclusion criteria: Those students who were absent either for T1 or for T2 and were not willing to participate were excluded.

Total 150 first year MBBS students were enrolled in the study by convenient sampling and were divided into two groups of 75 each.

Group 1: The first group of students having roll numbers 1 to 75 were taught with plastinated whole lung [Table/Fig-1] to get an orientation regarding the tracheobronchial tree and also the painted silicon luminal cast of human lung [Table/Fig-2] was used for teaching the bronchopulmonary segments. Both the specimen was prepared in the Anatomy Department of the institute. Various segments were shown and surgical importance of the same was discussed in the group of 10-11 students by the facilitator for half an hour each. At the end of the session all 75 were given a chance to hold the plastinated lung and tracheobronchial luminal cast to revise for one hour.

[Table/Fig-1]: The plastinated sheep lung- left lower lobe dissolved to demonstrate the bronchial tree cast and alveoli. On the right side is the zoomed in view of luminal cast of end part of tracheobronchial tree with alveoli.



[Table/Fig-2]: Painted human tracheobronchial cast specimen which was used to teach the bronchopulmonary segments.

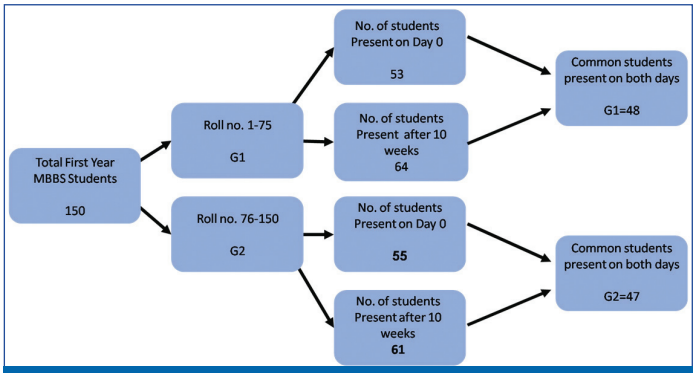
Group 2: The second group of students having roll numbers 76 to 150 (G2) were taught in the lecture hall. A routine theory class was delivered on bronchopulmonary segments for an hour with the help of a power point presentation highlighting the segments and their surgical importance without the specimen.

Study Procedure

Immediately after the lecture or practical session, both groups were given test (T1) on the same day. Questionnaire was designed by the author and validated by the faculty members of the Anatomy Department by pilot testing of the questionnaire on a small group of 10 students. The reliability of the questionnaire was found to be satisfactory (Cronbach's alpha of 0.70). The questionnaire consisted of twelve questions regarding the anatomy of bronchopulmonary segments of lung and its applied clinical importance (Annexure-1). The questions were open ended with a maximum score of 1 for each correct answer and 0 score for incorrect answer, hence maximum total score was 12 and minimum 0.

A follow-up test after 10 weeks (T2) was conducted without any prior information to check the long term retention of the knowledge gained. The set of questions given for both T1 and T2 were same. The other group of students (G2) who were not taught using silicon luminal cast of lung were also taught using the same plastinated models in the practical class after data collection.

The total number of students present for the test on same day were 108 and for test after 10 weeks were 125 out of the total of 150 respectively. Excluding the absentees on either of the days the number of students taken for analysis among G1 was 48 out of 75 and G2 was 47 out of 75 [Table/Fig-3].



[Table/Fig-3]: Flowchart of students distribution.

STATISTICAL ANALYSIS

The test scores of both the groups were calculated using software Statistical Package for the Social Sciences (SPSS) version 16.0. The mean score was calculated for test 1 and 2. Paired sample t-test was used to compare the marks obtained by the respective group for test 1 and 2 and independent sample t-test for comparing the results of test 1 among G1 and G2 and also the results of test 2 between G1 and G2.

RESULTS

The number of students present for the test on same day were 108 and for test after 10 weeks were 125 out of the total of 150 respectively. Excluding the absentees on either of these days the total number of students taken for analysis among G1 was 48 (28 girls and 20 boys) out of 75 and G2 was 47 (30 girls and 17 boys) out of 75 and their mean age was 19±1 years.

The [Table/Fig-4] shows the mean test scores T1 and T2 for groups G1 and G2. Comparing the test scores, T1 for both G1 (6.30) and G2 (11.05), there was a significant difference ($p \leq 0.01$) whereas on comparing the test scores, T2 of G1 (8.60) and G2 (8.58) no significant difference was observed between them ($p=0.674$).

The mean score of G1 for T1 was 6.30 and for T2 it was 8.60, whereas the mean score of G2 for T1 was 11.05 and T2 was 8.58.

Day	G1-average score	G2-average score	p-value
T1 (max marks 12)	6.30	11.05	**<0.01**
T2 (max marks 12)	8.60	8.58	0.674

[Table/Fig-4]: Comparison of the test scores on day 0 (T1) between G1 and G2 as well test score after 10 weeks (T2) between G1 and G2.
Independent sample t-test. Level of significance: p≤0.05

On comparing the mean test scores between T1 and T2 separately for both groups statistically significant difference was observed; G1 (p-value=0.023) and G2 (value=0.002) [Table/Fig-5].

Groups	T1-average score out of 12	T2-average score out of 12	p-value
G1 (48)	6.30	8.60	**0.023**
G2 (47)	11.05	8.58	**0.002**

[Table/Fig-5]: Comparison of the test scores on day 0(T1) and after 10 weeks (T2) for group 1(G1) and group 2(G2).
Paired t-test; level of significance: p ≤0.05

DISCUSSION

The results show that in G1, the mean score value increased from 6.30 to 8.60, whereas the mean score of G2 decreased from 11.05 to 8.58. The reason for increase in score in G1, could be that the students practically studied the bronchopulmonary segments with plastinated specimen, which helped in retaining the knowledge for a longer period of time after the class. It might be due to the visual and tactile memory. Moreover the practical classes which were informal and interactive compared to theory class also might have added to the advantage of retention. On comparison the students in G2 who attended passive didactic lectures about the same topic, in T1 immediately after the class got a good score even more than G1 but over the period of time the scores reduced. The reason for high scores immediately after class in G2 could be attributed to immediate recall memory of the lecture class which fades away over a period of time. These results bring about the importance of visual and tactile learning of bronchopulmonary segments which has an impact on the memory for longer period rather than didactic lecture classes.

In a study done by Eberlova L et al., of Czech republic in the year 2017, on teaching human anatomy through porcine corrosion casting of liver, lung and kidney, the second year medical students reported that viewing the corrosion casts helped them to interconnect the histology of lungs with gross anatomy and also was very useful to understand the clinical condition affecting lung [10].

In a study by Lujan HL et al., of Michigan, four students (two medical, one health science and one science major student) were allowed to create the model of complex structure which is hard to be seen in dissection and the bronchial casts provided a three-dimensional, clear view of the series of rapidly branching airways. The students found this procedure to be an inspiring and motivated to learn and understand the complex morphology [11].

Schmid S and Bogner FX, of Germany from their study on 126 ninth grade students reported that if more efforts are taken by students, during the lesson then there was higher chances of the knowledge gained to be retained for a longer period of time. In present study also it reveals that the active learning using psychomotor effort helps the students to retain it for a longer period of time [12].

In another study done by Bhandari K et al., in India, the plastinated specimen of renal artery, bronchopulmonary segments of lungs and arch of aorta were used for teaching MBBS, Bachelor of Dental Sciences (BDS), Physiotherapy and MSc students. In which the author reported 95% of students understood the complicated structures with plastinated specimens, 92% understood the spatial orientation of the specimen better than wet specimen whereas almost 95% commented that the relation of the organs could not be understood with plastinated organ [9].

Murillo OR et al., in his study on 179 second year medical students of Spain, also revealed that students expressed their satisfaction in learning neuroanatomical structures with plastinated specimens [13]. Fruhstorfer BH et al., on conducting a study on 125 first year medical students of UK, revealed that students appreciated the three dimensional structure and relations but the majority of them felt the specimen lacked emotional and tactile perceptions [14]. Desouza FM et al., India, reported that these plastinated luminal casts of tracheobronchial tree had an advantage of providing dynamic information of the structure which otherwise would not be observed by the students [15].

Limitation(s)

In the present study, the cross-over teaching of the groups was not done for data collection, due to lack of time, but the clarifications were done for both groups during the practical classes. The proportion of high achievers and low achievers were not equally distributed in the two groups.

CONCLUSION(S)

The conclusion could be that in G1, where students practically studied the bronchopulmonary segments with plastinated specimen, could retain the knowledge for a longer period of time after the class, whereas the students in G2 who were given passive didactic lectures about the same topic, scored well immediately after the class even more than G1 but over the period of time their scores reduced. It is recommended to do cross over teaching studies between plastination and lectures in future. The use of plastinated specimens as an adjuvant to dissection in anatomy teaching will help in better understanding of the subject and retention for a longer period of time. Moreover the convenient handling of the specimen enhances studying of anatomy in all times and places.

Acknowledgement

The authors would like to acknowledge their Head of the Department, colleagues, other staff and students for the support rendered.

REFERENCES

[1] Turney BW. Anatomy in a modern medical curriculum. The Annals of the Royal College of Surgeons of England. 2007;89(2):104-07.
[2] Smith CF, Mathias HS. What impact does anatomy education have on clinical practice? Clinical Anatomy. 2011;24(1):113-19.
[3] Ravi S, Bhat V, 2022. Plastination: A novel, innovative teaching adjunct in oral pathology. J Oral MaxillofacPathol. 2011;15(2):133-37.
[4] Lischka M, Prihoda M. Establishing and operating a plastination laboratory at the institute of anatomy, university of Vienna. J Int Soc Plastination. 1987;1:12-16.
[5] Perumal V. A sectional anatomy learning tool for medical students: Development and user-usage analytics. Surgical and Radiologic Anatomy. 2018;40(11):1293-1300.
[6] Riederer B. Plastination and its importance in teaching anatomy. Critical points for long-term preservation of human tissue. J Anat. 2013;224(3):309-15.
[7] Latorre R, Bainbridge D, Tavernor A, LópezAlbors O. Plastination in Anatomy learning: An experience at Cambridge University. J Vet Med Educ. 2016;43(3):226-34.
[8] Sora M, Latorre R, Baptista C, López-Albors O. Plastination-A scientific method for teaching and research. Anatomia, Histologia, Embryologia. 2019;48(6):526-31.
[9] Bhandari K, Acharya S, Srivastava A, Kumari R, Nimmagada H. Plastination: A new model of teaching Anatomy. International Journal of Anatomy and Research. 2016;4(3.2):2626-29.
[10] Eberlova L, Liska V, Mirka H, Tonar Z, Haviar S, Svoboda M, et al. The use of porcine corrosion casts for teaching human anatomy. Annals of Anatomy Anatomischer Anzeiger. 2017;213:69-77.
[11] Lujan HL, Krishnan S, O'Sullivan DJ, Hermiz DJ, Janbaih H, DiCarlo SE. Student construction of anatomic models for learning complex, seldom seen structures. Am J Physiol-AdvPhysiol Educ. 2013;37(4):440-41.
[12] Schmid S, Bogner FX. Effects of students' effort scores in a structured inquiry unit on long-term recall abilities of content knowledge. Educ Res Int. 2015;2015:01-11.
[13] Murillo OR, López-Soler M, Roda-Murillo A, Ramírez-Ortiz I. Plastination in the teaching of neuroanatomical. Eur J Anat. 2006;10(2):85-89.

[14] Fruhstorfer BH, Palmer J, Brydges S, Abrahams PH. The use of plastinated prosections for teaching anatomy-the view of medical students on the value of this learning resource. Clin Anat. 2011;24(2):246-52.

[15] DeSouza FM, Natekar EP, Karapurkar MN. A novel and innovative teaching tool using low-cost luminal cast plastination of the trachea-bronchial tree. Indian Journal of Anatomy. 2016;5(2):143-47.

PARTICULARS OF CONTRIBUTORS:
1. Associate Professor, Department of Anatomy, Sapthagiri Institute of Medical Sciences and Research Centre, Bangalore, Karnataka, India.
2. Associate Professor, Department of Allied Health Sciences, Ramaiah University of Applied Sciences, Bangalore, Karnataka, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:
SV Uma,
407, 13th Block, Heritage Estate Apartment, Doddaballapur Main Road, Yelahanka, Bangalore, Karnataka, India.
E-mail: drsvuma@gmail.com

PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 04, 2022
- Manual Googling: May 18, 2022
- iThenticate Software: Jul 06, 2022 (17%)

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. NA

Date of Submission: **Mar 26, 2022**
Date of Peer Review: **Apr 15, 2022**
Date of Acceptance: **May 25, 2022**
Date of Publishing: **Oct 01, 2022**

Annexure-1: Questionnaire

S. No.	Questions	Answer
1	Define bronchopulmonary segment	
2	How many segments are there in each lung	
3	Clinical importance of bronchopulmonary segment	
4	Does each segment has its own connective tissue covering	
5	What structure accompanies the segmental bronchus	
6	Name the segments in the middle lobe of right lung	
7	The pulmonary arteries carry	
8	The order of division of tracheobronchial tree is	
9	Name the extrapulmonary parts of the tracheobronchial tree	
10	What structure runs in the intersegmental plane	
11.	Name the common segments for lung abscess	
12.	Is bronchopulmonary segment a bronchovascular segment? Why?	