

Views of medical students on anatomy education supported by plastinated cadavers

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Abstract

Objectives: The purpose of this study was to assess the awareness of medical students who receive education with anatomical plastinated cadavers and determine their views on the education model that is provided to them.

Methods: This study was performed on İstanbul Medeniyet University first (n=150) and second (n=190) semester volunteer medical students (n= 340). Data were collected using questionnaire that consisted of 27 closed-ended questions.

Results: 68.8% of the students did not have any knowledge about fixation methods, while 47.4% did know about plastination. 60.2% of the students believed that the anatomy education provided with plastinated cadavers had a positive effect on their anatomical knowledge. 39.4% of the students believed the anatomy education provided with plastinated cadavers affected their theoretical anatomy exam success positively. 60.8% of the students believed that anatomical structures were sufficiently represented in three dimension in the plastinated cadaver. 76.2% of the students described the system where the anatomical structures could be seen most easily as the musculoskeletal system, and 50% described most difficulty as neuroanatomy.

Conclusion: We believe that the data of this study will benefit the studies that will assess the effectiveness of plastinated cadavers in anatomy education.

Keywords: cadaver; education; medical students; plastination

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Introduction

Cadavers are indispensable tools that have been used by students and educators for teaching anatomy since the Renaissance.^[1] Students are able to see the relationships among anatomic structures macroscopically and in three dimensions in anatomy education with cadavers. Cadavers are usually preserved by the method formaldehyde fixation. However, there are some disadvantages of the method of fixation by formaldehyde. The negative effects of formaldehyde on different systems on body have been reported previously.^[2,3]

With the fixation method that was first developed by Gunther von Hagens in 1977^[4] and named plastination, the exposure of students and lecturers to formaldehyde was prevented. The histological characteristics of the tissues that are fixated with this method are also preserved.^[5] Tissues may be stored for a long time in a non-toxic, dry, durable and odorless way.^[6] Therefore, plastinated cadavers have been a significant tool of education

in anatomy training in time and their usage has become prevalent.^[7,8]

Due to the lack of cadaver donation in Turkey and the increasing number of medical schools, problems are experienced in obtaining cadavers for undergraduate and postgraduate anatomy education.^[9] Being able to observe the anatomic structures clearly three dimensionally and being helpful to conceptualizing and understanding diagnostic tests increased the interest of medical schools on plastinated cadavers.^[6,10] Therefore, the aim of this study was to assess the awareness of medical students educated using plastinated cadavers, and determine their views on this education model.

Materials and Methods

Educational Methodology

The anatomy classes that are provided in the School of Medicine of İstanbul Medeniyet University (IMU)

where this study was carried out are given in semesters I and II in all committees. In semester I, locomotor system subjects including bones, joints and muscles are studied. In semester II, the cardiovascular system, respiration system, gastrointestinal system, neuroanatomy and urogenital system are studied in this order. In anatomy education where subjects are systematically given, practical classes are held in anatomy laboratories following theoretical classes. Practical classes are held with study groups of 10–15 people. The students selected in the workgroups prepare for the content of the subject to be taught by consulting with the educators before the practical class and take an active role in the classes. Firstly, they examine the structures related to the subject on anatomy models under the coordination of the educators. The students' working time with the anatomy models changes between 45 and 60 mins based on the subject. Then, the structures in question are presented to the workgroups on plastinated cadavers and plastinated pieces by expert educators for about 15–20 min. In this study, imported plastinated cadavers and pieces prepared for anatomy education were used. The students were able to ask questions comfortably to the educators at all stages of the education. In the practical applications, one whole-body plastinated cadaver, plastinated pieces for one upper extremity and one lower extremity were used. The whole-body plastinated cadaver was in two halves as left and right in the mid-sagittal plane. While surface structures were visible on one half of the body, surface structures were partly removed from the other half so that the deeper structures could be observed. Anatomy practical examination was held at the end of each committee. In these examinations, questions were asked on anatomy models and plastinated specimens. The numerical weight of the questions that were asked over plastinated cadavers constituted about 10% of all questions based on the anatomy subjects that were learned.

Procedure

This study was carried out in the period of March–May 2018 with a total of 340 students that were enrolled in IMU faculty of medicine in semester I (n=150) and in semester II (n=190). Ethics approval was received before this cross-sectional descriptive study (Approval no: 2018/00071; date: 06.03.2018). The data were collected by a questionnaire that consisted of 27 closed-ended questions based on the principle of volunteerism. Thirteen questions employed a 5-point Likert-type scale where the options were “Always”, “Mostly”, “Frequently”, “Sometimes” and “Never”. For the reliability of the responses, the students were given the freedom to include or not include their

names. The questionnaire contained questions on the demographic characteristics and success levels of the students, questions on their levels of knowledge on fixation and plastination, questions on the contribution of the education that is provided with plastinated cadavers on their levels of knowledge in anatomy, and questions on the subjects that they utilized the least and the most in the education provided with plastinated cadavers.

Statistical Analysis

After obtaining percentages and frequencies, data were analyzed using the Statistical Package for Social Sciences (SPSS for Windows, version 22.0, Armonk, NY, USA). Means and standard deviations were provided for the nominal data, while frequencies and percentages were provided for the categorical data. Pearson's chi-squared test and Fisher's exact test were used to determine the relationships among the categorical variables. $p < 0.05$ was accepted as the level of statistical significance.

Results

The mean age of the 340 students who participated in the study was 20.04 ± 1.37 (min:18–max:26); 178 (52.4%) were females and 162 (47.6%) were males. The descriptive characteristics, success statuses and weekly durations of personal study for anatomy of students are shown in **Table 1**.

68.8% of the students did not have any knowledge on fixation methods, while 47.4% did know about plastination. The distribution of the knowledge levels of the students on the concepts of fixation, plastination and cost of plastinated cadavers are presented in **Table 2**.

The views of the students on the methodology of the education provided to them with plastinated cadavers, its contribution to their levels of theoretical and practical knowledge, effect on their theoretical and practical examination success and contribution of the clinical practices they will conduct in the future were assessed on a 5-point Likert-type scale. The responses that were provided to these questions by the students are given in **Table 3**.

The anatomical systems where the structures can be seen the least and the most on plastinated cadavers were asked. 76.2% of the students described the system where the anatomical structures could be seen the most as the musculoskeletal system, and 50% described the system where structures could be seen the least as neuroanatomy.

While 53.8% of the students responded to the question “Did you have a perception of meeting a real human body when you met a plastinated cadaver for the first time?” as “No”, the rates of those who provided answers

Table 1

The descriptive characteristics, success statuses and weekly durations of personal study for anatomy of students in semester I and II.

General information of students		Academic semester		Total number of students n (%)
		Semester I (n)	Semester II (n)	
Gender	Female	77	101	178 (52.4)
	Male	73	89	162 (47.6)
Repeated courses	No	129	166	295 (86.8)
	Yes / 1 time	19	18	37 (10.9)
	Yes / 2 times	1	6	7 (2.1)
	Yes / 3 times	-	-	-
	Yes / 4 times	1	-	1 (0.3)
Grade point average	0-49	9	4	13 (3.8)
	50-59	50	27	77 (22.6)
	60-69	48	78	126 (37.1)
	70-79	33	55	88 (25.9)
	80-89	10	23	33 (9.7)
	90-100	-	3	3 (0.9)
The weekly anatomy study time	0-1 hours	60	96	156 (45.9)
	1-3 hours	53	62	115 (33.8)
	3-5 hours	25	24	49 (14.4)
	More than 5 hours	12	8	20 (5.9)

of “Yes” and “Undecided” were 26.6% and 20%, respectively.

The students responded to the question “Would you consider joining a course about methods for preparing plastinated cadavers in the following years?” as “Yes” by 30%, “No” by 37.6% and “Undecided” by 32.4%.

82.6% of the students responded to the question “Would you like to receive anatomy education by mak-

ing a dissection on cadavers by yourselves?” as “Yes”, while the rates of those who responded as “No” and “Undecided” were 6.8% and 10.6%, respectively.

The relationship between the responses of the students to questions that asked the adequacy of the duration of the education provided with plastinated cadavers, its contribution on the levels of knowledge on anatomy and its contribution on theoretical and practical examination success and their class levels they were enrolled in is shown in **Table 4**.

Table 2

The distribution of the knowledge levels of the students on the concepts of fixation, plastination and costs of plastinated cadavers and the statistical significance levels.

		Academic semester		Total number of students n (%)	p
		Semester I n (%)	Semester II n (%)		
Do you have any knowledge of fixation methods?	Yes	4 ^a (2.7)	9 ^a (4.7)	13 (3.8)	0.572
	No	106 ^a (70.7)	128 ^a (67.4)	234 (68.8)	
	I have less information	40 ^a (26.7)	53 ^a (27.9)	93 (27.4)	
Do you have any knowledge of plastination?	Yes	38 ^a (25.3)	23 ^b (12.1)	61 (17.9)	0.0001*
	No	52 ^a (34.7)	109 ^a (57.4)	161 (47.4)	
	I have less information	60 ^a (40)	58 ^a (30.5)	118 (34.7)	
Do you have any knowledge of the costs for plastinated cadavers?	Yes	63 ^a (42)	28 ^b (14.7)	91 (26.8)	0.0001*
	No	48 ^a (32)	114 ^b (60)	162 (47.6)	
	I have less information	39 ^a (26)	48 ^a (25.3)	87 (25.6)	

Each subscript letter (a, b) denotes a subset of class categories whose column proportions do not differ significantly from each other at the 0.05 level. For each pair of columns, the column proportions (for each row) are compared using a z test. If a pair of values is significantly different, the values have different subscript letters assigned to them. *p<0.05.

Table 3

Views of students on the education provided with plastinated cadavers.

	Always n (%)	Mostly n (%)	Frequently n (%)	Sometimes n (%)	Never n (%)
Do you think the duration of education that is provided with plastinated cadavers is sufficient within the total education time for anatomy?	6 (1.8)	25 (7.4)	31 (9.1)	141 (41.5)	137 (40.3)
Do you think the anatomy education provided with plastinated cadavers provided significant contributions on your theoretical anatomy knowledge levels?	46 (13.5)	96 (28.2)	63 (18.5)	94 (27.6)	41 (12.1)
Do you think the anatomy education provided with plastinated cadavers provided significant contributions on your practical anatomy knowledge levels?	56 (16.5)	104 (30.6)	63 (18.5)	90 (26.5)	27 (7.9)
Do you think the anatomy education provided with plastinated cadavers affected your theoretical anatomy examination success positively?	27 (7.9)	55 (16.2)	52 (15.3)	122 (35.9)	84 (24.7)
Do you think the anatomy education provided with plastinated cadavers affected your practical anatomy examination success positively?	35 (10.3)	80 (23.5)	40 (11.8)	111 (32.6)	74 (21.8)
Do you think the anatomy education provided with plastinated cadavers will provide benefits in the clinical applications that you will perform in the future?	58 (17.1)	75 (22.1)	68 (20.0)	98 (28.8)	41 (12.1)
Do you think anatomical structures were sufficiently represented in three dimensions in the plastinated cadaver?	29 (8.5)	98 (28.8)	80 (23.5)	109 (32.1)	24 (7.1)
Do you think the relationships of the anatomical structures that you worked on in the plastinated cadaver with surrounding structures were represented clearly?	16 (4.7)	84 (24.7)	86 (25.3)	129 (37.9)	25 (7.4)
Are you satisfied that anatomic structures are presented on a plastinated cadavers in groups of 10-15 people?	22 (6.5)	52 (15.3)	54 (15.9)	106 (31.2)	106 (31.2)
Do you think you have sufficiently contacted the plastinated cadaver?	16 (4.7)	28 (8.2)	29 (8.5)	62 (18.2)	205 (60.3)
Do you think the numbers of plastinated cadavers and pieces at the laboratory where you receive education are sufficient?	10 (2.9)	37 (10.9)	43 (12.6)	108 (31.8)	142 (41.8)
Are you pleased that a part of the examination questions in the anatomy practical examination are asked through a plastinated cadaver?	20 (5.9)	39 (11.5)	48 (14.1)	92 (27.1)	141 (41.5)
Would you like for the numerical values of the questions that are asked through a plastinated cadaver in the anatomy practical examination to be increased?	23 (6.8)	20 (5.9)	25 (7.4)	60 (17.6)	212 (62.4)

Discussion

Although cadaver dissection has been seen as the main component of anatomy education for centuries,^[11] educational instruments such as computer-assisted educational tools (simulation and animation), radiographical images, three-dimensional plastic anatomical models and virtual reality applications are used prevalently due to advances in technology today.^[3,12-14] In recent years, plastinated cadavers also became alternative educational tools to wet cadavers, and they have been started to be included in the educational process especially in countries where there are problems in cadaver donation.^[15] This is why feedback that is received from students

regarding the methodology of education provided with plastinated cadavers will provide opportunities for developing more effective education strategies.

Plastination is known as a fixation method where tissue fluids and partly tissue lipids are slowly replaced by polymers. In this method, students can comfortably touch the cadaver and the exposure to toxic substances that are used in classical fixation is prevented.^[15] Despite the advantages of plastinated cadavers, the knowledge of students in different regions of the world regarding plastination is insufficient. 70% of the students in Nigeria and 98.23% of the students in India had no knowledge on plastination.^[6,7] In this study, the rate of students who had no knowledge on

Table 4

Distribution of the views of students on the education provided with plastinated cadavers based on class levels and their statistical significance levels.

		Academic semester		p
		Semester I n (%)	Semester II n (%)	
Do you think the duration of education that is provided with plastinated cadavers is sufficient within the total education time for anatomy?	Always	4 ^a (2.7)	2 ^a (1.1)	0.001*
	Mostly	19 ^a (12.7)	6 ^b (3.2)	
	Frequently	22 ^a (14.7)	9 ^b (4.7)	
	Sometimes	74 ^a (49.3)	67 ^b (35.3)	
	Never	31 ^a (20.7)	106 ^b (55.8)	
Do you think the anatomy education provided with plastinated cadavers provided significant contributions on your theoretical anatomy knowledge levels?	Always	24 ^a (16)	22 ^a (11.6)	0.005*
	Mostly	53 ^a (35.3)	43 ^b (22.6)	
	Frequently	28 ^a (18.7)	35 ^a (18.4)	
	Sometimes	35 ^a (23.3)	59 ^a (31.1)	
	Never	10 ^a (6.7)	31 ^b (16.3)	
Do you think the anatomy education provided with plastinated cadavers affected your theoretical anatomy examination success positively?	Always	15 ^a (10)	12 ^a (6.3)	0.007*
	Mostly	26 ^a (17.3)	29 ^a (15.3)	
	Frequently	30 ^a (20)	22 ^b (11.6)	
	Sometimes	55 ^a (36.7)	67 ^a (35.3)	
	Never	24 ^a (16)	60 ^b (31.6)	
Do you think the anatomy education provided with plastinated cadavers affected your practical anatomy examination success positively?	Always	22 ^a (14.7)	13 ^b (6.8)	0.006*
	Mostly	40 ^a (26.7)	40 ^a (21.1)	
	Frequently	22 ^a (14.7)	18 ^a (9.5)	
	Sometimes	42 ^a (28)	69 ^a (36.3)	
	Never	24 ^a (16)	50 ^b (26.3)	
Do you think anatomical structures were sufficiently represented in three dimensions in the plastinated cadaver?	Always	21 ^a (14.0)	8 ^b (4.2)	0.001*
	Mostly	55 ^a (36.7)	43 ^b (22.6)	
	Frequently	36 ^a (24)	44 ^a (23.2)	
	Sometimes	31 ^a (20.7)	78 ^b (41.1)	
	Never	7 ^a (4.7)	17 ^a (8.9)	

Each subscript letter (a, b) denotes a subset of class categories whose column proportions do not differ significantly from each other at the 0.05 level. For each pair of columns, the column proportions (for each row) are compared using a z test. If a pair of values is significantly different, the values have different subscript letters assigned to them. *p<0.05.

fixation was 68.8%, while the rate of those who had no knowledge on plastination was 47.4%. Moreover, the plastination knowledge levels of semester I students were higher in comparison to those of semester II students. Although the plastination knowledge levels of the students in this study were higher than those in previous studies, it was observed that almost half of them did not have any knowledge on the concept of plastination. In this study, semester I and II students were not informed about the plastination techniques before the lectures. In this context, providing basic information about plastination techniques in anatomy classes may increase students' awareness on plastination. Higher utilization of plastinated cadavers by semester I students based on the subjects they learned may have caused their higher levels of knowledge in comparison to semester II students.

Debates about the effectiveness of educational tools that are used in anatomy education have been going on for

years. As in the past, it is stated today that cadaver dissection is the main and most valuable element of anatomy education.^[16,17] Additionally, the value and interest paid by students to dissection in anatomy education are still ongoing.^[18,19] While the students in this study have used models and plastinated cadavers, 82.6% stated that they would like to receive anatomy education by making dissections by themselves.

On the other hand, the prevalence of using plastinated cadavers has made it necessary to assess the effectiveness of these educational materials on students. In study of Fruhstorfer et al.,^[20] 93.6% of the students (the sum of "good" and "very good" answers) stated that plastinated cadavers were valuable in learning anatomy. Similarly, in the study of Azu et al.,^[7] 75% of the students believed that plastinated cadavers were useful in learning anatomy. While Lattore et al.^[15] found that plastinated cadavers were useful for both anatomy students (mean 2.34/3) and anatomo-

my educators (mean 2.43/3). In this study, the rate of the students who stated that plastinated cadavers had positive contribution on their theoretical anatomy knowledge was found as 60.2% (the sum of frequently, mostly and always). We also found that the views of semester I students on the positive contribution of plastinated cadavers to their theoretical knowledge levels were more positive than those of semester II students. The reason why semester I students found plastinated cadavers to be more useful may be that the structures of the locomotor system, especially muscles, that are studied in semester I are more clearly seen in plastinated specimens. These results show the positive contribution of plastinated cadavers on anatomy education.

In a well-dissected plastinated cadaver, anatomical structures can be more easily distinguished from each other in comparison to a wet cadaver. In a previous study, students reported that structures are more clearly seen in plastinated cadavers and their relationship with surrounding structures are represented better.^[6] The non-toxic nature of plastinated cadavers and the fact that students can comfortably touch them are anticipated positively by students. However, the fact that the structures are hard and breakable when forced is a disadvantage for students in reaching deeper structures.^[20] Making the dissection before plastination, in compliance with the education program, and conducting especially the dissection of muscles from the surface towards the deep in a topographical discipline may increase the effectiveness of plastinated cadavers in anatomy education. In this study, the students thought that anatomical structures were sufficiently represented in three-dimension in plastinated cadavers. Removal of surface structures (especially muscles) on the plastinated cadaver that was used in this study in a topographical discipline led to the better observation of deeper structures such as nerves and vessels. This situation may have been reflected in the satisfaction levels of the students in their feedback.

The students educated using plastinated cadavers in this study were in groups of 10–15 people. As the number of plastinated materials was not sufficient, the time spent with plastinated cadavers in each group was limited to 15–20 minutes. This situation reflected negatively on the feedback of the students. 60.3% of the students stated that they could not touch the plastinated cadaver and 40.3% said the duration of the education provided with the plastinated cadaver was not sufficient. Making the number of plastinated cadavers sufficient for the number of students will increase the effectiveness of plastinated cadavers in anatomy education and reflect in student feedback more positively.

Conclusion

Anatomy education provided to the students using plastinated cadavers contributed positively to the anatomy knowledge levels of the students. However, the knowledge levels of students on plastination were not sufficient. We believe that the data of this study will be useful to studies that will assess the effectiveness of plastinated cadaver usage in anatomy education.

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