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Opinion

Short Practise in Human Body Dissection Benefits Acquisition of the Musculoskeletal System in First Year Medical Students at University of Castilla-La Mancha (Spain)

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Abstract: Dissection in anatomy teaching is key in medicine; however, a debate is underway about whether it complements well a modern curriculum in the digital era. We aimed to determine whether a short add-on dissection practise facilitates learning of the gross anatomy relative to studying it with just prosection, plastic models, and digital 3D atlases. We tested the hypothesis that dissection, even if brief, benefits both aptitudes and attitudes with respect to anatomy learning. A total of 106 1st year medical students studied the musculoskeletal system with prosection and models and a 3D digital atlas (5 h). Of these, 52 had a further 2 hours self-directed dissection session (a handout was provided with instructions) while the reminder 54 students, who lacked the experience of dissection, formed the control group. Academic grades and student satisfaction were evaluated. The dissection group obtained 10% higher grades in anatomy ($F_{1,51} = 12.71$, $p < 0.001$) and were highly satisfied with the dissection session (Likert scale 0–5, median = 4, IQR = 3.5), also rating the sessions as particularly motivating (median = 4, IQR = 4.4). We conclude that human body dissection, even for a limited time, has a positive impact on human anatomy grades in 1st year medical students, and is valued and motivating.

Keywords: medical education; anatomy; human body dissection; encoding; memory; motivation; improvement; grades

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1. Introduction

1.1. Dissection Plays a Part in Medical Training

The acquisition of knowledge in human anatomy is a foundational part of the medical curriculum worldwide. In most medical and health sciences schools, anatomy is one of the academic pillars, alongside genetic, molecular and systems level analysis of function, and therapeutics. Collectively, these form the basis for the understanding of the healthy and diseased human body [1]. From its origins in classical times, including the creation of famous "dissection theatres" (e.g., in Italy), anatomical dissection has contributed to learning the organisation of the human body over the centuries and remains an important part of medical and surgical training [2].

However, although it is widely known that learning starts with practise, the quantitative extent and qualitative nature of its contribution to gaining knowledge of anatomy remain unclear. This question is relevant, especially with curricular demands that shorten the time available for dissection. This study has its roots in two key issues: academic and humanistic. As elsewhere, human anatomy is taught in the first and second years of the medical curriculum at the Anatomy and Medical Embryology section of the School of Medicine of the University of Castilla-La Mancha. A currently jeopardised element of many anatomy courses is the use of human bodies for teaching purposes. It is unquestionable that anatomical dissection, by allowing direct observation of the body of study,

offers a remarkable benefit quite unique to the discipline [1,3–6]. The difficulty in grasping academic knowledge is not as abstract as in psychology, physics or economics; after all, anatomy deals with something as concrete as the components of the human body. Despite this, anatomy is traditionally a hard subject for medical and other health sciences students, likely because of the sheer volume of information to be learned. However, in our medical curriculum, we count the benefit of personal contact with the professor/lecturer/mentor and associated clinical assistants that make up the teaching team. A challenge for teaching staff is to empathise with the struggle of the students and shape an efficient and motivating teaching strategy for human anatomy. The goal is for the students to create an anatomical model of the human body functions. However, medical training should go beyond purely academic, especially in health sciences.

1.2. Dissection Teaching Goes beyond Purely Academic Training

As proposed by [3] and more recently by Hildebrandt [7], dissection fosters not only learning facts about the human body, but also the empathic and humane treatment of the bodies used for dissection. In addition, it enables the acquisition of habits of mind such as self-reflection, team reasoning, associative and deductive thinking, and integrative cognitive and affective skills, all of which are key aspects of learning clinical professionalism. A further human face of dissection, set implicitly from the very beginning of medical training, is the contact with the reality of death by facing real dead bodies and therefore, the opportunity to think about ethical and deontological aspects of the limits posed by medical training, also a key aspect of clinical professionalism.

In addressing these issues, and with the view of searching for an effective strategy in anatomy teaching, we face a growing emergence of educational technology, student-centred and problem-solving teaching orientation [3,4,8–10]. Modern teaching methods, such as e-books, realistic 3D models and e-3D visual atlases see [2] for review, websites with sophisticated atlases and *youtube* dissection videos may be more in line with the technological present demands of the medical education [11], especially when dealing with medical imaging [12]. An important limitation inherent to this type of teaching technique, however, is that no matter how realistic the body representation is achieved, models and virtual images are far away from real visual and haptic contact with a human body, not to mention the lack of the team-work component when learning is performed individually. Dissection of human bodies opens up this possibility by allowing the view and manipulation of body structures in a team. This has an impact in health disciplines, particularly in their first year, when they start to have some understanding of how the human body functions. In this context, there are the two extremes in regard to human dissection. On the one hand, many universities have medical as well as human anatomy degrees draining long hours of learning about every organ in the body in the dissecting room from very early in the medical degree, for example, Glasgow University, see more examples of universities in [3]. On the other hand, some schools reserve dissection for postgraduate MSc degrees and advanced surgical courses, avoiding it almost completely during the medical degree.

1.3. Dissection Is Costly, but Try without It

A debate is thereby set on how essential dissection as a learning tool for medical students is. The costly and laborious process of managing body donations, the resources required in terms of access to donations, facilities for preservation and storage, and the need for specially trained personnel to prepare the bodies for the classes required have limited or dissuaded many schools from offering dissection classrooms. However, a large body of evidence indicates that dissection is beneficial for learning anatomy in medicine [13,14] and very positive if it is allied with peer training by companion students [3].

Our long-term aim is to optimise the possible use of human body dissection over the early years. This aim prompted us to examine, first, whether first-year medical students (first trimester), with no other dissection experience than the organised practical classes

(gross anatomy labs), were able to conduct a dissection with just a handout. They demonstrated to be perfectly able to do so. Accordingly, second, we took the next step in this study to test experimentally whether adding a short dissection session would impact positively on grades, motivation and retention by the students.

2. Materials and Methods

2.1. Subjects

A total of 106 first-year students from the Medical School of the University of Castilla-La Mancha (UCLM, Albacete, Spain) took part in the study between October 2019 and January 2020. Of those, 52 (31 female), formed the dissection group and volunteered to take part in the dissection experience. The remainder 54 students (45 female) formed the control group.

2.2. Ethics

This study was carried out within the academic year as part of the anatomy training, and therefore, ethical approval was granted by the academic unit. Students were informed and only those who chose to take part filled in the questionnaires. Data were collected and handled anonymised.

2.3. Practical Classes of Anatomy at the University of Castilla-La Mancha

The medical curriculum at the University of Castilla-la Mancha is organised into courses for six years before completing the formation period. Each course is divided into modules of objectives and every module has five phases. The human anatomy teaching in this centre is distributed over the first three years of the medical degree. In the first year, the first semester starts with general embryology followed by the specific embryology of the musculoskeletal system and in the adult (Anatomy I). The second semester focuses on the head and introduction to nervous system (Anatomy II). During the second year, anatomy covers the whole-body organs in 9 modules. This is taught in conjunction with physiology and histology with the aim of providing an integrated structural and functional view of the human body in health and disease. All along these two years, gross anatomy is taught with lectures and practical sessions in which the students can use online material via an Intranet (lectures, scientific articles, videos), 3D models, medical imaging materials, and e-atlases as well as prosection.

In anatomy courses, the first-year medical students spend a total of 5 h divided in two 2.5 h sessions in anatomy facilities. There are two types of facilities, one is a "Wet Lab" and the second one is a "Dry Lab", whereby they can use their handbooks, atlases, class notes, study plastic 3D models and real bones, and have access to a 3D atlas in a big computer screen located in the lab's wall (Complete Anatomy, Elsevier, https://3d4medical.com/, accessed on 26 August 2022). In a typical 2.5 h session, the first 30 min is devoted to a brief explanation of the body structures by the lecturer. The following 60 min is devoted to showing the dissected structures in groups of 7–8 students per body by the lecturer, together with the students' own examination of the already dissected body. Each prosection is prepared the day before and retains a regional and topographical order. In the last hour, students spend the time allocated to study the prosection region just shown at the "Dry Lab", at their own rhythm, and may ask questions to the lecturer or teaching assistant. It must be emphasised that, with the purpose of isolating the effect of the dissection session on grades, the session was organised away in regards to temporal timing with theory teaching.

2.4. Dissection Procedure

From the total of 106, the dissection group (N = 51) was organised into teams of 4–6 students and were allowed to dissect a topographic region of the musculoskeletal system previously assigned in a 2 h session. Each team was later organised into smaller groups of 2 students who would perform the dissection. The regions were chosen con-

sidering criteria such as accessibility of the region and relative difficulty. Students would dissect one of the following: the occipital triangle (superficial), suboccipital triangle (deep), the infrahyoid muscles and the carotid sheet, scalene muscles and the proximal section of the brachial plexus, vasculature and innervation of the posterior triangle of the neck, abdominal muscles, superficial muscles of the back, and the deep muscles of the back. MM and RI (authors) supervised each session, checking all procedures in terms of security, etc., but they were not present unless they were specially requested.

2.5. Questionnaire

Students rated the dissection session via an anonymous questionnaire. Responses to the 19 items were coded in a Likert scale with 5 options: strongly agree scored 5; agree, 4; neutral, 3; disagree, 2; strongly disagree, 1. Data were summarised as median with variability expressed as the range between lower quartile (Q1) and higher quartile (Q3).

Of the questions, 12 were cognitive and 7 motivational. Cognitive questions were designed to assess whether the session was productive in terms of encoding, acquisition and consolidation of the contents. Examples of cognitive questions were: "I choose the dissection to consolidate my knowledge of Anatomy"; "The dissection has helped me to build-in-mind real images of the anatomical structures"; "The dissection has helped me to better understand Human Anatomy". In contrast, the motivational questions were designed to assess the degree to which the session encouraged them to work and study anatomy. Examples of motivational questions were: "If there are more sessions like this, I would volunteer again"; "I believe practical sessions with human bodies are fundamental to learn Human Anatomy"; "Dissection has put me in touch with the medical reality of death"; "To study anatomy as part of a team has been favourable for learning".

2.6. Anatomy Assessment

Students' knowledge of the musculoskeletal system is assessed with a final exam consisting of a multiple-choice test of 60 questions with 5 response options each. Students are allowed 90 min to answer this test. On the same day of the final exam, they also had a practical test consisting of 10 questions, 5 on the material studied in the "Wet Lab", related to the prosection preparations, and 5 questions on the "Dry Lab" materials. Each of the 10 practical questions must be identified and the answer written in a period of 30 s. (Short Open, Response Quick, SHORQ question) in which a single structure is indicated.

3. Results

As shown in Figure 1A, the students who practised the dissection session scored 10% over the control group (group with dissection mean ± SEM 6.2 ± 1.6; group with no dissection 5.20 ± 2.20). The advantage for the dissection group was confirmed as a significant effect of the group (one factor ANOVA) in terms of grades obtained in the final anatomy exam ($F_{1,51} = 12.71$, $p < 0.001$).

Students' grades in the practical and theory exams correlated positively ($r = 0.53$, $p < 0.0001$). However, although the trend of the practical exam grades was in the same direction as that of the theory exam in favour of the dissection group, this difference remained below significance (group with dissection 7.4 ± 0.2; control group 6.9 ± 0.23).

Students' ratings of the sessions by the questionnaire (Table 1) indicated high satisfaction of the dissection session (median; IQR, 4; 3.5). Within the questionnaire, 42% of the questions that assessed different motivational aspects got a strongly agree, whereas the cognitive ones got the same rating in 17% of the questions (see Figure 1B). This is indicative that a short dissection session, is at least motivating to further study, even if the subjective impression of improving the cognitive aspects was not, in practice, as great as the students' subjective perception. Table 1 shows item by item the results in each item of the Likert scale. Students rated the motivation items higher than the cognitive ones.

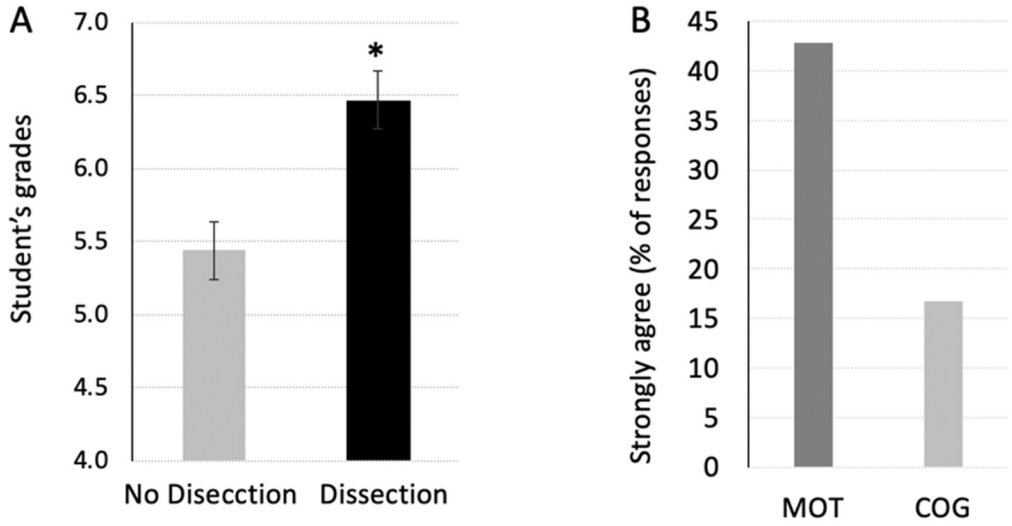

Figure 1. (**A**). Students' grades obtained in the final exam of Human Anatomy I—Musculoskeletal system. Data are expressed as mean ± standard error of the mean (grades scale from 0 to 10). The dissection session was associated with a 10% increase in the final exam grades ($F_{1,51} = 12.71$, $p < 0.001$). (**B**). Percent of strongly agree responses in the questionnaire to motivational questions (MOT) or cognitive ones (COG). Note that the motivational component of the questionnaire scored 25% higher than the cognitive one. * indicates significance at $p < 0.01$.

Table 1. Students' ratings from the dissection session questionnaire.

Cognitive Questions	Median	IQ1–Q3
I choose this dissection session to consolidate my knowledge on gross anatomy.	5	4–5
The dissection session has helped me to build real images of the anatomical structures.	5	4–5
The dissection session has helped me to better understand anatomy.	4	4–5
The session has helped me to create a better visual image of the anatomical structures.	4	4–5
The session has helped me to better conceptualize the contents of anatomy.	4	3–4
The study of anatomy through dissection of human bodies is very different from what I have seen so far.	4	3–5
The dissection has helped me to memorize better the contents of anatomy.	4	3.25-5
The anatomical models are useful to conduct dissection of specific regions.	4	4–5
The dissection session has helped me to better understand anatomy.	3	2–4
I choose this session because studding Anatomy is difficult for me.	3	2–4
I found easier to develop a study strategy after the session.	3	2.25–4
The practical session did not help me to learn anatomy.	2	1–3
Motivational Questions		
I will enrol if more dissection sessions are available	5	4–5
I believe that dissection of embalm human bodies is essential for learning anatomy.	5	4–5
The dissection has put me in touch with the medical reality of death.	5	4–5
Team work has been favourable for learning anatomy	4	4–5
Dissection has motivated me to study anatomy in more detail.	4	3–5
The dissection session helped me to better assume the presence of a lifeless body with the view to appreciate a live one (future patient).	4	4–5
Without dissection, the knowledge of signs from diseases would be more limited.	4	4

4. Discussion

There are two main findings in this study. First, the results showed that just 2 h of self-directed dissection session significantly increased the performance of students' grades by 10% in the theory part of the final exam. The practical test grades showed a parallel trend, but this trend did not reach significance These results confirmed the hypothesis that even a short dissection session has a positive impact on students' knowledge of human anatomy.

Second, although well aware of the limitations of a subjective scale and the questionable insight that students have about their own performance [15], for neuroanatomy, we nonetheless asked them to report the impact of the dissection session on their perceived knowledge and motivation using a Likert 5-point scale. Although students who took part in this study choose to do so voluntarily and this may bias the sample, the clear finding was that the students rated the dissection experience very highly, close to the maximum score, with the most frequent *strongly agree* responses for the motivational questions. This result suggests that although the session was perceived to be modestly helpful for improving the encoding and consolidation of new knowledge, motivation was the key factor highlighted by the students. They found the session very motivating, helping their self-confidence and giving them a sense of importance for what they are studying (e.g., tangible experience of death via direct contact with a dead body and thus the concept of death in medicine). This facet of dissection has been commented on by others [16,17].

Our results are in line with other studies [3,13,14], indicating that dissection remains one of the most effective and beneficial methods of teaching anatomy in medical universities. Other studies also report that it can be a preferred method by students compared to more digital tools [18]. Altogether, this and previous studies support the notion that dissection should not only be maintained but be further integrated into the medical curriculum as well.

The impact of this finding may extend beyond education. Recent data shows that one-third of the medical errors in the United States are attributable to human error [19]. Not infrequently, these errors occur in surgical specialities [20]. Even though the educational emphasis on minimising errors has been put in place in some instances [21], it would be valuable to know more about the type of errors that occur. This raises the question of whether these could be further minimised with higher quality training that incorporates dissection in the medical curriculum or is merely endemic to stressful clinical contexts in which speed may be essential—without regard to training.

As one may expect, students need to get more dissection sessions than offered in this study to obtain benefits in terms of the acquisition of detailed knowledge of anatomy. Although one session is enough to encourage them to study anatomy, sufficient dissection time is required to warrant the acquisition of a scholarly amount of information. What is unclear is whether more sessions would yield a further increase in the understanding of the anatomy, or some asymptote achieved after an "optimum" number of dissection sessions and their scheduling in the curriculum. One issue concerns the benefits of distributed practise over time, as opposed to intensive practise, known from the beginning of the 20th century with the pioneering experimental work of the German psychologist Hermann Ebbinghaus [22], translated in [23]. Distributed practise of about 20 h of dissection sessions across the year may be an optimum for a significant impact on the cognitive component of learning anatomy [24]. A separate issue is that it is now known that knowledge is gained most effectively by memory retrieval rather than just additional training as shown in the *Science magazine* publication by Karpicke and Roediger, cited 1585 times [25]. Although repetition can also improve retention of anatomical contents [26], this astonishing finding is now being actively incorporated into the curriculum of a great number of university teaching programs and bears directly on the value of the dissection experience. Specifically, dissection provides more than just factual knowledge, it fosters integration, self-reflection, capacity to interpret the data, and cognitive and affective skills required for the medical practise [3].

Dissection sessions have been progressively shortened since teaching hours/credits have been reduced from the initial academic program of 1998 [1], especially after the Bologna treaty for the unification of medical degrees all over Europe. For this reason, we compensate the only prosection sessions of the first two years with the optional third-year course, where dissection is central.

For now, our anatomy department compensates the lack of dissection in the first two years with an optional course in dissection in the third year, whereby the students dissect during the entire course. The present results suggest that perhaps for first-year medical students, a short session provides the students with a sense of the importance of becoming a doctor and the responsibilities entailed, and this motivates them to study the discipline of anatomy in more depth. Later on (e.g., in the third year), their anatomy knowledge can be expanded through retrieval practise with more dissection sessions once they have progressed in their initial understanding of the human body.

Dissection of human bodies remains an effective method of teaching anatomy, and enough time should be allotted to integrate it into the medical curriculum. In addition, we hold the view that the combination of dissection of real bodies with separate virtual dissections based on medical imaging, newly developed e-techniques, as well as traditional prosection and realistic 3D models, may collectively be the most efficient way of teaching [27].

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