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Research Report

Differences between Attached and Detached Cadaveric Prosections on Students' Identification Ability during Practical Examinations

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Running title: *in situ* and *ex situ* cadaveric prosections

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ABSTRACT

Cadaveric prosections are effective learning tools in anatomy education. They range from a fully dissected, sometimes plastinated, complete cadaver (*in situ* prosections), to a single, carefully dissected structure detached from a cadaver (*ex situ* prosections). While most research has focused on the advantages and disadvantages of dissection versus prosection, limited information is available on the instructional efficacy of different prosection types. This contribution explored potential differences between *in situ* and *ex situ* prosections regarding the ability of undergraduate students to identify anatomical structures. To determine if students were able to recognize the same anatomical structure on both *in situ* and *ex situ* prosections, or on either one individually, six structures were tagged on both prosection types as part of three course summative examinations. The majority of students (61–68%) fell into one of two categories: those that recognized or failed to recognize the same structure on both *in situ* and *ex situ* prosections. The percentage of students who recognized a selected structure on only one type of prosection was small (1.6–31.6%), but skewed in favor of *ex situ* prosections ($P \leq 0.01$). These results suggest that overall students' identification ability was due to knowledge differences, not the spatial or contextual challenges posed by each type of prosection. They also suggest that the relative difficulty of either prosection type depends on the nature of the anatomical structure. Thus, one type of prosection might be more appropriate for teaching some structures, and therefore the use of both types is recommended.

Key words: gross anatomy education, undergraduate education, cadaver dissection, cadaver prosections, learning

INTRODUCTION

For many centuries, cadaveric dissection has been regarded as the preeminent teaching and learning method for human anatomy (Ellis, 2001; Patel and Moxham, 2006; Estai and Bunt, 2016). This concept is still held by both students and anatomy professionals throughout much of the Western world (Azer and Eizenberg, 2007; Patel and Moxham, 2008; Kerby et al., 2011). However, Western medical schools have recently changed their curricula by reducing the time allotted for gross anatomy and dissection (Leung et al., 2006; Moxham and Plaisant, 2007; Drake et al., 2009). Although the multifaceted benefits of dissection are well-demonstrated (Topp, 2004; Rizzolo and Stewart, 2006), such curricular changes come on the heels of a surge in studies that question its efficacy relative to other teaching methods (Nnodim, 1990; Nnodim et al., 1996; Jones et al., 2001; McLahlan et al., 2004; Wilson et al., 2018). Chief among these alternative teaching methods is the use of prosections, cadaveric specimens that have been dissected by an experienced anatomist for the purpose of instruction.

Anatomy laboratories often incorporate prosections in tandem with dissections. However, some institutions have moved away from dissection entirely, relying heavily on the use of prosections instead (Sugand et al., 2010). Though this shift in instructional method has raised concerns among some anatomical professionals (Cahill et al., 2002; Korf et al., 2008), several studies have found prosections to be as effective as dissection, while requiring less time investment by students (Nnodim, 1990; Nnodim et al., 1996; Yeager, 1996; Dinsmore et al., 1999; Winkelmann, 2007; Ashdown et al., 2013). Accordingly, the popularity of prosections as an effective teaching method should not be discounted (Patel and Moxham, 2008; Kerby et al., 2011).

Some studies also suggest that students may prefer learning anatomy from prosections rather than from dissections. For example, Snelling et al. (2003) found that a group of medical and dental students actually preferred prosection-based learning in lieu of dissection. This preference was especially pronounced among the dental students. Davis et al. (2014) surveyed first and second year medical students, as well as anatomy faculty at the University of Bristol, regarding their perceptions of various styles of anatomical instruction. Among all three subject groups, 90% agreed that access to cadaveric prosections was the most critical component of learning anatomy. In addition, Wisco et al. (2015) found that first-year medical students overwhelmingly preferred prosections instead of dissection, primarily because of the reduced time constraints. Similarly, Whelan et al. (2018) found that three cohorts of medical students at the University of Ottawa favored dissection as an elective, rather than a curricular requirement. These preferences seem to reflect the changing landscape of anatomy curricula across the medical spectrum. However, students' perceptions of learning do not always correspond to their actual learning. For example, Deslauriers et al. (2019) found that, in an undergraduate physics course, students learned more through active-learning activities than passive lectures, and yet their perception of learning skewed in the opposite direction. Such a disparity might also explain why some students prefer learning from prosections (passive learning) rather than dissection (active learning).

Nonetheless, given the recent proliferation of prosections, both in type and in frequency of usage, it is surprising that the term itself remains broad in scope. The term "prosection" can range from a fully dissected, sometimes plastinated, complete cadaver (hereafter *in situ* prosection), to a single, carefully dissected structure detached from the cadaver (hereafter *ex situ* prosection: the brain, an eye, a tumor, etc.). Previous literature has not clearly differentiated between these types of prosection. Although information is limited, the learning utility and value of various prosection types appear to be different. For example, both wet (embalmed) and plastinated *in situ* prosections are sometimes regularly used within a course (Cornwall, 2011). However, wet prosections offer students the opportunity to engage kinesthetically with the body and provide a more realistic learning experience than plastinated prosections (McBride and Drake, 2011). *Ex situ* prosections, by contrast, may give students unique opportunities to develop spatial skills (Samarakoon et al. 2016).

Despite the advantages of using prosections, it remains unclear if the instructional efficacy of two prosection types, *in situ* and *ex situ*, are equivalent, or if they pose similar levels of learning difficulty to students. One hypothesis is that *in situ* prosections provide students with more contextual information than that observed in *ex situ* prosections, which might influence students' learning and visual identification abilities. Specifically, *in situ* prosections likely provide spatial information at different scales, such as global and local positions of the target structure in the body (orientation and location within a body region). In addition, they provide a plethora of other structures that might serve as identifiers or frames of reference for size, shape, or texture comparisons. *Ex situ* prosections, by contrast, are removed from the body, and therefore out of context. Students must mentally orient them, or place them in anatomical position before searching for local cues or useful identifiers. Further, *ex situ* prosections are more contextually simplified than *in situ* prosections. This is because they are often developed for the purpose of providing additional views of a few target structures. The isolation of just a few structures involves the alteration or removal of surrounding structures that could otherwise serve as potential identifiers. Such a hypothesis is consistent with experimental studies that demonstrate the importance of contextual information in facilitating visual search and object recognition (Ehinger et al., 2009; Malcolm and Henderson, 2010; Barenholtz, 2014).

Alternatively, students might be able to identify structures equally on both *ex situ* and *in situ* prosections. This expectation is also plausible because students learn from both types of prosections and studies show that learned spatial configurations facilitate visual search and people rely mostly on memory to detect and recognize objects in familiar-context conditions (Chun and Jiang, 1998; Barenholtz, 2014; Zhao and Ren, 2020).

Based on conversations between the authors and undergraduate students who had completed the human anatomy observation laboratory at The University of Kansas, the difficulty posed by both prosection types appeared to be different. *Ex situ* prosections were frequently cited as being more challenging for students than *in situ* prosections. Thus, this study sought to assess the effect of prosection type on the ability of undergraduate students to identify anatomical structures. Given the differences in contextual information provided by both prosection types, the authors hypothesized that, during an examination, students are more likely to identify structures on *in situ* prosections than on *ex situ* prosections.

MATERIAL AND METHODS

Description of Laboratory Setting

This study was conducted during the spring semester of 2019 in the undergraduate human anatomy observation laboratory at The University of Kansas, Lawrence, Kansas, United States. This 200-level, two-credit-hour laboratory course was separate from the lectures, utilized seven prosected human cadavers, and followed a regional approach. The course was divided into five content units: (1) introduction, back, and central nervous system; (2) upper limb and pectoral girdle; (3) lower limb and pelvic girdle; (4) thorax and abdomen; and (5) head and neck. In addition to cadavers, which were dissected by third- and fourth-year (junior and senior) undergraduate students as part of a 400-level biology course, the laboratory incorporated a number of *ex situ* prosections in all content units (Table 1). Learning was complemented with the use of plastic models and multimedia sources (for example, labeled pictures and video walkthroughs of content) presented through Blackboard Learn™ virtual learning environment and learning management system (Blackboard Inc., Washington, DC).

Nine laboratory sections were offered each semester, each consisting of a maximum of 25 students and meeting for two two-hour sessions per week. A graduate teaching assistant (GTA; either a master's or doctoral level student) and three undergraduate teaching assistants (UTA) taught each laboratory section. At the beginning of each class, the GTA provided brief instructions, and then students rotated among four or five teaching stations, which were each facilitated by one instructor (UTA or GTA). A team of four students worked with each cadaver at a given time, and students spent approximately 20 minutes per teaching station. Throughout the semester, 23 regular laboratory sessions are scheduled, with five of them devoted to reviewing material prior to an examination using a mock test. In addition, 17 weekend review sessions were available to students, each two hours long, led by one GTA and three or four UTAs. Thus, students had access to the laboratory for approximately 5.3 hour per week.

Student learning was assessed during each content unit through summative assessments, two quizzes and one examination, all in short-answer format. Quizzes consisted of ten questions each, and were worth 15% of the course grade, while examinations consisted of 60 questions, were timed (approximately 2 minutes per question), and they were worth 75% of the final grade. At the end of each examination, students had the opportunity to revisit the tagged structures before turning in their examinations. Quizzes and examinations included questions on both *in situ* and *ex situ* prosections, which students were allowed to handle, as well as on plastic models. In addition, students had to completed 19 formative assessments (three or four per content unit) delivered through Blackboard. These assessments were due on the day of each unit examination and together were worth 5% of the course grade. Each formative assessment consisted of ten multiple-choice questions, which students were able to take multiple times, with only the highest grade used in the final grade calculation. Participation in the laboratory accounted for the remaining 5% of the final grade. Students used a laboratory manual developed by the director of the course (V.H.G.). Other information regarding this course is available in Sparacino et al. (2018).

Data Acquisition

The ability of students to identify anatomical structures on both *in situ* and *ex situ* prosections was assessed using six structures tagged as part of three-unit examinations. These examinations were delivered to students of all nine laboratory sections during the spring semester of 2019. The six target structured were: the muscles extensor hallucis brevis and fibularis tertius in the lower limb; the superior mesenteric artery and the fallopian tube in the abdominopelvic region; and the mylohyoid and levator palpebrae superioris muscles in the head and neck regions. These anatomical structures represent different organs from different body regions and were selected primarily on the availability and quality of *ex situ* prosections at the time this study was conducted (Table 1). Once student examinations were graded, the answers were categorized into four groups: those that correctly identified the selected structure on both types of prosections (Group A), only on the *in situ* prosection (Group B), only on the *ex situ* prosection (Group C), and those which misidentified the structure in both cases (Group D). Groups A and D were uninformative in terms of the differences between prosection types, but they informed on the overall level of difficulty of the tagged structure. Thus, a structure was considered "easy" for students to identify if the frequency of Group A was high compared to the other groups. Likewise, if the frequency of Group D was high compared to the other groups, the structure was considered "difficult". The responses from 203 students enrolled in nine laboratory sections (19–25 students per section, $\bar{x} = 23 \pm 2.69$) were recorded. Nearly half of students enrolled in the course were second-year students in the pre-nursing program and most were females (Table 2). During the window of data acquisition, nine students dropped the class. The Institutional Review Board of The University of Kansas (#00145483) reviewed and approved this study.

Statistical Analyses

Statistical analyses were conducted using R software, version 4.0.2 (R Core Team, Vienna, Austria) and bar graphs were created using GraphPad Prism, version 7.04 (GraphPad Software, San Diego, CA). A generalized linear model (GLM) with negative binomial distribution was done to examine the effect of the type of prosection (*in situ* vs. *ex situ*) on the identification ability of students. The GLM was implemented using the MASS package, version 7.3-53 (Venables and Ripley, 2002) and was chosen because count data were over-dispersed and did not follow a normal nor a Poisson distribution. In the analyses, the different types of answers (Groups A–D) served as the fixed factor (independent variable), while the number of students per answer type was the response (dependent) variable. The significance of the model was assessed using a Type II Wald χ^2 test with the car package (Fox and Weisberg, 2019). The estimated marginal means (emmeans) package was used (Russell, 2019) to conduct multiple pairwise comparisons with Bonferroni adjustment to assess for differences among groups, as well as to estimate standardized effect sizes (Cohen's *d*) with a 95% confidence intervals. Average values are given with standard error and sample size.

RESULTS

For all anatomical structures analyzed, the frequency of the different answer types (Groups A–D) varied significantly (extensor hallucis brevis muscle: Wald, $\chi^2 = 77.02$; fibularis tertius muscle: $\chi^2 = 44.22$; superior mesenteric artery: $\chi^2 = 156.19$; fallopian tube: $\chi^2 = 134.60$; mylohyoid muscle: $\chi^2 = 104.57$; levator palpebrae superioris muscle: $\chi^2 = 53.45$; $DF = 3$ and $P < 0.001$ in all cases). Students easily recognized some structures on both types of prosections (Group A), as was the case for the extensor hallucis brevis muscle, fallopian tube, and mylohyoid muscle (Fig. 1). For these structures, the percentage of students who correctly identified them on both prosection types was higher (61.1–68.2%; see Supplemental Material Appendix 1) than those who identified them on only one type, or failed to identify them on both types (P <0.001 in all cases; see Supplemental Material Appendix 2). The estimated effect size differences were also high (Cohen's d = 1.08–2.81), except between Groups A and B, which had a medium effect size (0.63, see Supplemental Material Appendix 3). Other structures, namely the superior mesenteric artery, were clearly more challenging for students to recognize, as 74.9% of them ($P < 0.001$ in all cases; Cohen's d = 1.28 - 2.78) failed to identify this blood vessel on both prosection types (Group D). The levator palpebrae superioris was similarly challenging, as 36.5% of the students failed to recognize it on both prosection types (Group D). For the fibularis tertius muscle, no significant differences were found between the numbers of students who correctly recognized or failed to recognize this structure on both prosection types (Groups A and D; $P = 1.00$, Cohen's $d = 0.07$), as well as between students who recognized it on one type of prosection and not the other (Groups B and C; $P = 0.231$, Cohen's $d = 0.56$).

Four of the six structures showed significant differences between the number of students who recognized them on either *in situ* (Group B) or *ex situ* prosections (Group C). These anatomical structures are the superior mesenteric artery, the fallopian tube, the mylohyoid muscle, and the levator palpebrae superioris muscle. Except for the mylohyoid muscle, more students recognized the selected structures on *ex situ* prosections (Group C) than on *in situ* prosections (Group B) ($P = 0.01$ for superior mesenteric, $P < 0.001$ for remaining structures, Cohen's d = 0.85–3.31). The opposite case occurred for the mylohyoid muscle, in which about 10 times more students recognized this structure on the *in situ* prosection than on the *ex situ* prosection ($P < 0.001$). Among these four structures, the estimated effect size differences between Groups B and C were especially high for both the mylohyoid and levator palpebrae superioris muscles (Cohen's $d = 2.18$ and 3.31).

DISCUSSION

The results showed that the identification ability of students varied depending on the selected structure. In general, the majority of students belonged to either group A or D: those that recognized the same structure on both *in situ* and *ex situ* prosections, or those that failed to recognize it on both prosection types, respectively. Hence, the percentage of students who recognized a selected structure on only one prosection type was small (1.6 - 31.6%). Among them, more students identified structures correctly on *ex situ* prosections (Fig. 1), which is contrary to the authors' initial expectations. These results therefore do not support the premise that the increased contextual information provided by *in situ* prosections leads to greater identification ability among students. Instead, they suggest that both prosection types may present a similar level of difficulty to students. In those cases where difficulty level differs, however, students' identification ability might depends on other factors, including the intrinsic nature of the anatomical structure such as its cognitive load (Sweller, 2010).

For instance, it is possible that an abundance of contextual information can serve the opposite function as intended for students. Because some structures on *ex situ* prosections are frequently removed or altered to expose a particular region, these prosection often are more contextually simplified (structurally simpler) than their *in situ* counterparts. Thus, the intrinsic cognitive load posed by *ex situ* prosections might be lower when compared to *in situ* prosections, thereby reducing working memory load, and facilitating learning and retention (Khalil et al., 2005). This effectively counters the narrative that more contextual information is better when it comes to anatomical prosection, and also explains why structures like the superior mesenteric artery, levator palpebrae superioris, and the fallopian tube were all recognized by students more often on *ex situ* prosections than *in situ* ones (Fig. 1).

Unlike those structures, the mylohyoid muscle was more frequently recognized on *in situ* (31.6% of students) than on *ex situ* prosections (3.3%) (Fig. 1). Even so, this may still be due to differences in cognitive load requirements presented by both prosections. *In situ*, this muscle is simply dissected, being displayed as a thin layer of tissue just below the mandible. In contrast, the *ex situ* prosection depicts this muscle as part of a laryngo-hyoid complex (de Bakker et al., 2019), which retains much of the nearby musculature and soft tissue, but preserves few of the helpful bony identifiers or landmarks. Thus, *ex situ* prosections of the mylohyoid muscle might have a higher intrinsic cognitive load to students.

In other cases, which constitute the majority, both prosection types appeared to provide similar levels of difficulty for students. For example, students identified the extensor hallucis brevis and fibularis tertius muscles on both types of prosection with similar proficiency (Fig. 1). Both of these muscles are relatively small, and are located primarily in and around the foot and ankle. Thus, there is likely not a significant difference between the contextual information/cognitive load provided by the *in situ* prosection (a prosected foot attached to the cadaver) and the *ex situ* prosection (an isolated foot detached from the cadaver). Together, these results suggest that, for both *in situ* and *ex situ* prosections, the relative importance of contextual information, as well as the intrinsic cognitive load, likely depend upon the nature of the anatomical structure itself.

Additionally, because most students either identified or failed to identify the selected structures on both prosection types (Groups A and D), it is also possible that overall identification ability was mainly influenced by knowledge or familiarity differences among students, rather than the spatial or contextual challenges posed by each prosection type. Various studies have indicated that people rely mostly on memory to detect and recognize objects in familiar-context conditions (Chun and Jiang, 1998; Barenholtz, 2014; Zhao and Ren, 2020). Importantly, students learn from both prosection types during the examined course. Thus, the identification abilities of students during an examination might rely mostly on a memorized context while learning, instead of the amount of anatomical context offered by the prosection. This is particularly relevant for *ex situ* prosections in the University of Kansas anatomy laboratory, which are often present in lower numbers than the *in situ* prosections for a given region (Table1). Students may therefore learn to recognize structures on a given *ex si*tu prosection (effectively serving as a “model”), but not the structure in its variable forms and presentations.

Further, negative emotions and stress may impair memory retrieval and learning (Vogel and Schwabe, 2016). Several studies have documented negative, even visceral student reactions toward viewing and smelling cadavers (Snelling et al., 2003; Lee et al., 2011; Getachew, 2014; Rajeh et al., 2017). In addition, examinations in the course analyzed are timed (2 minutes per question) and these are known to negatively affect students' performance (Schwartz et al., 2015). Therefore, future studies should address the effects of these factors on students' ability to identify anatomical structures on both prosection types.

Implications of the study

This study shows that overall students' identification ability was likely due to knowledge or familiarity differences, not the spatial or contextual challenges posed by each type of prosection. Given that instruction in the examined undergraduate course routinely uses both types of prosections, the use of *ex situ* prosections was formerly questionable, because instructors often needed to invest additional time and effort to develop them. Because most students were either able or unable to recognize the selected structures on both prosection types, it seemed at first like the efforts invested in developing *ex situ* prosections were of little or no value for instruction. However, this study also shows that the relative value of the contextual information to students, as well as the intrinsic cognitive load, likely varies among the breadth of anatomical structures. Thus, one type of prosection might be more appropriate for teaching a specific structure than another. For example, *in situ* prosections of the mylohyoid muscle might facilitate students' learning by providing some contextual indicators, combined with a broader and more simplified view, whereas *ex situ* prosections of the levator palpebrae superioris muscle may reduce the intrinsic cognitive load when compared to *in situ* prosections. Consequently, the use of both prosection types is encouraged, given the variety and quantity of structures taught during human anatomy courses and laboratories.

This study examines the learning outcomes of students at the undergraduate level and uniquely compares two different types of prosections. In contrast, the vast majority of gross anatomy studies have focused on students in health professional schools (medical, dental school, or physical therapy programs) and most comparative studies have focused on the efficacy of dissection relative to other instructional methods such as prosections, 3D software, and plastic models (Elizondo-Omaña et al., 2005; Winkelmann, 2007; Wilson et al., 2018). Thus, this study contributes to this gap of knowledge in anatomical science education.

Limitations of the study and future directions

This study has several limitations. First, the number of selected structures (six) was small, and data were gathered and analyzed for only one semester at a single university. Thus, the results might not be applicable to other anatomical structures, other undergraduate anatomy courses, and other institutions. Second, the selected structures, which were chosen based on the quality and availability of detached (*ex situ*) prosections in the laboratory at the time of study, might not have been the best examples to determine the use of contextual information by anatomy students. Subsequent studies should assess other structures with different levels of contextual information in other body regions (upper limb, head, and neck). Third, this study analyzed the accuracy of students' identification, but other response variables might be more informative on the utility of contextual information. For example, experimental studies on visual search and object recognition assess multiple variables that include pupillary movements (areas where the eyes are focused, or their movement patterns during a search) as well as the time spent by the participant in recognizing an object (Malcolm and Henderson, 2010; Katti et al., 2017). In addition, it is unknown the percentage of students who changed their answers before turning in their examinations. Thus, further studies should assess differences in these variables between prosection types. Fourth, the authors were unable to control the time spent teaching using either prosection type, or the order in which these were presented to the students. Thus, it is conceivable, and perhaps even expected, that some structures would be taught more frequently using the *in situ* prosection rather than its *ex situ* counterpart, or vice versa. This disparity may have biased students' learning and identification abilities, because greater allocated time to a particular knowledge domain or task will result in higher learning outcomes (Johnson, 2002). Finally, this study did not consider students' perceptions of the use of these prosection types and thus did not include measurements of the internal validity and reliability of the results. Analyses did not examine performance across the class strata, which is particularly relevant in the context of this study because students in the upper and lower quartile of a class tend to benefit differently from instruction (Pizzimenti et al., 2016). Thus, it is unknown how students' performance relates to their identification abilities on each prosection type. Equally relevant is assessing the type of learning approach students use when learning from both prosection types, and how it may influence their identification abilities. Medical students in their earlier years prefer a deep learning approach (intention to understand the subject and underlying meaning), which they switch later in their careers to a more strategic one (mixture of deep learning and memorization of ideas and information to meet assessments) (Smith and Mathias, 2007). Because students in the examined course are from a wide range of majors (Table 2), different learning approaches are expected. Thus, it is possible that those students able to identify the selected structures on both types of prosections use a deep learning approach, whereas those who failed to recognize them on one or both prosections types use a surface learning approach (memorization).

CONCLUSIONS

In conclusion, both types of prosections appear to present similar levels of learning difficulty to undergraduate students, depending upon the nature of the structure selected. This is despite the fact that *ex situ* prosections are perceived to be more difficult by some students in the examined course. Identification differences among prosection types, while proportionately small, may be due to varying levels of intrinsic cognitive load, and/or knowledge and familiarity differences among students. Contextual information, depending on the structure, may be inversely correlated to identification ability among students (more information equals increased difficulty). Thus, depending upon the anatomical structure, one type of prosection might be more appropriate for teaching. Therefore, the continued use of both *ex situ* and *in situ* prosections is broadly recommended.

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FIGURE LEGENDS

Figure. 1. Frequency of undergraduate anatomy students among nine laboratory sections (n = 203 students) at The University of Kansas who correctly identified a given structure in both (*in situ* and *ex situ*) prosection types (Group A), only on the *in situ* prosection (Group B), only on the *ex situ* prosections (Group C), and those which misidentified the structure in both cases (Group D). For each structure, groups with different numbers listed to the right of the bar are significantly different ($P < 0.05$).

Table 1

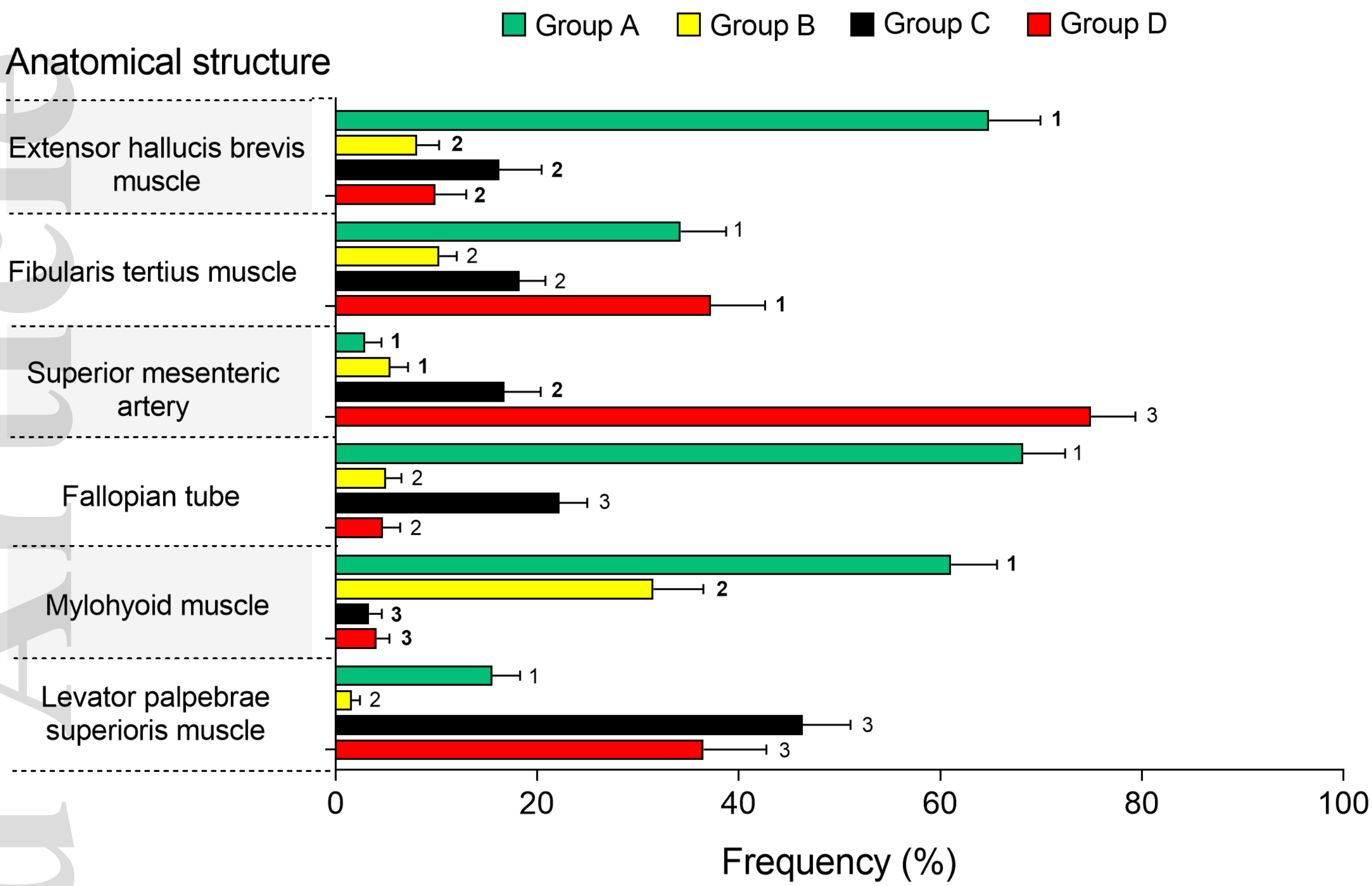
Detached *(Ex situ)* Prosections Available to Students in a Human Anatomy Laboratory Course at The University of Kansas.

Content Unit	Body part	Number of prosections
Introduction, back, and central nervous system	Brain Spinal cord	18 12
Upper limb and pectoral girdle	Arm Shoulder	1 1
Lower limb and pelvic girdle	Leg and foot Knee	1 1
Thorax and abdomen	Gastrointestinal tract Lungs Heart Male reproductive system Male reproductive system Kidney Liver	2 3 pairs 6 2 2 3 5
Head and Neck	Eyes Larynx	13 2

Table 2. Characteristics of Students Enrolled in the Undergraduate Human Anatomy Laboratory Course at The University of Kansas

Characteristics	**Frequency n (%)**
Total number of students	203 (100.0)
Sex	
Female	152 (74.9)
Male	61 (25.1)
College Level	
First-year (freshman)	30 (14.8)
Second-year (sophomore)	99 (48.8)
Third-year (junior)	49 (24.1)
Fourth-year (senior)	25 (12.3)
Major of Study	
Pre-Nursing	94 (46.3)
Community Health	35 (17.2)
Applied Behavioral Science	27 (13.3)
Exercise Science	19 (9.4)
Human Biology	9 (4.4)
Others	19 (9.4)

Data were pooled across nine laboratory sections during the spring semester of 2019.



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