HOW WE TEACH | Classroom and Laboratory Research Projects

A comparison of the effectiveness of dissection and prosection on short-term anatomic knowledge retention in a reciprocal peer-teaching program

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Submitted 14 February 2020; accepted in final form 2 April 2020

Lackey-Cornelison WL, Bauler LD, Smith J. A comparison of the effectiveness of dissection and prosection on short-term anatomic knowledge retention in a reciprocal peer-teaching program. Adv Physiol Educ 44: 239–246, 2020; doi:10.1152/advan.00031.2020.—Few discussions regarding instructional methods incite as much passion as the debate over dissection versus prosection. Despite numerous analyses, few studies have isolated the impact of dissection versus prosection from the numerous variables that are involved in anatomy education. This study used a retrospective design to assess the effect of peer teaching with dissection or prosection on anatomical knowledge retention of the peer teachers. Exam scores were analyzed from three cohorts of students (N = 184) who were enrolled in a Musculoskeletal System course in an allopathic medical school between academic years 2014–2017. Students in the first 2 yr learned anatomy of an assigned region through traditional dissection, whereas students in the third year learned anatomy of the same regions on prospected specimens. The effect of these instructional methods on anatomical knowledge retention was measured by student performance on a teaching-readiness quiz, written exam, and practical examination. One advantage of this study is the stability of variables between cohorts. Student groups peer taught the same objectives; course sequencing and content remained consistent between years; students spent the same amount of time learning their material, regardless of learning modality (dissection or prosection); and students were tested in the same manner. Comparisons of student performance data suggest that anatomy knowledge was equivalent, regardless of the instructional method (dissection or prospected cadavers) but is strongly associated with prior anatomy experience. Findings from this study support previous studies that conclude that there are no disparities in the effectiveness of learning anatomy via dissection or prosection.

dissection; laboratory instruction; prosection; student performance; teaching methods

INTRODUCTION

Dissection has been a fundamental instructional pedagogy for medical and allied health professional anatomy education for hundreds of years (3, 4, 16, 20, 32, 38, 42, 59). However, curricular reform in the last several decades has led to reduced curriculum time for anatomy and a move from the traditional full-body dissection to alternative approaches (4, 10–12, 14, 15, 18–20, 23, 35, 36, 47, 49, 57). Furthermore, with the push toward integrated systems-based curricula in many medical and allied health professional schools, the delivery of anatomy as a discipline-based stand-alone course has steadily declined over the last 10 yr, while the incorporation of new instructional methods, like team-based learning (TBL) and computer-assisted instruction, has increased (2, 9, 17, 33, 34, 42, 63). With the explosion of computer-based technologies and incorporation of medical imaging and living anatomy into the gross anatomy curriculum, the benefits of teaching via dissection or prosection is greatly debated, and many propose that cadavers may not be needed at all to learn anatomy in undergraduate medical and allied health professional education (4, 21, 22, 29, 37–40, 58). This rapid and substantial change in the role of anatomy in medical education provides additional weight to the prosection versus dissection debate. Despite the fact that several studies have found no clear optimal method of instruction, the debate provokes strong opinions, and argument continues due to the differences in numerous variables that correspond with changes in curriculum structure between prosection- and dissection-based instruction methods that have been examined (1, 10, 12, 25, 45, 61, 64).

This debate is even more pertinent today, as the amount of basic science and clinical knowledge that students are expected to know has increased dramatically. Paradoxically, this increase in expectation coincides with a trend in reduced time in the pre-clerkship curriculum (6, 18). As such, regular evaluation of the efficiency and effectiveness of pre-clerkship instruction is crucial in medical and allied health professional education.

With regard to the superiority of dissection or prosection, numerous studies suggest that, despite the decreased physical manipulation of tissues afforded by dissection, students learn equally well from prospected specimens (1, 7, 10, 44, 47, 53, 55a, 61, 64). As those who have dissected know, a large portion of the time spent dissecting involves removal of subcutaneous tissue and fascia before observing the anatomy of interest. As the studies suggest, perhaps it is not the act of dissecting itself: rather it is simply spending time in the cadaver laboratory with the material that benefits students (5).

This paper presents the findings of a retrospective study that examined the effectiveness of learning regional anatomy by dissection versus prosection, as measured by short-term anatomical knowledge retention (30). The objective of the study was to determine whether the experience of dissecting an anatomical region improved student performance on three different types of knowledge assessment given during an allopathic medical school Musculoskeletal System course. These assessments were a teaching-readiness quiz, a summative test...
of written multiple-choice questions (MCQs), and a practical examination. Comparisons of test scores on all three assessments were conducted between cohorts of students who had a dissection experience and those who learned gross anatomy from prosected specimens.

MATERIALS AND METHODS

The present study used a retrospective design to assess the effectiveness of dissection and prosection on anatomical knowledge retention. The study was carried out at Western Michigan University Homer Stryker M.D. School of Medicine (WMed), an allopathic medical school, and was determined exempt by Quorum Review Institutional Review Board (no. 29735). Test scores were examined from groups of students who were assigned to peer teach a specific anatomic region during a Musculoskeletal Systems course. Since students were not randomly assigned to class cohorts or the regional anatomy they dissected or learned via prosection, the study was a comparison of test scores of nonequivalent groups. To minimize the effect of confounding variables, a series of comparisons were limited to students who peer taught the same anatomic region (Fig. 1). This study is unique in its design relative to other studies of prosection and dissection. Specifically, it reduces the confounding variable of inequality in difficulty between anatomic regions by including comparisons of student performance limited to anatomic regions students peer taught. In other words, examination scores of students across all three cohorts that peer taught the same anatomic region were compared, rather than comparisons between students who learned one region by one instructional method and students who learned another region by the same method. This focus on region-specific knowledge provides a unique methodological approach relative to other studies comparing the impact of prosection and dissection on short-term learning.

Course structure and participants. The study involved three cohorts of students (N = 184) enrolled in an allopathic medical school Musculoskeletal System course between academic years (AY) 2014–15 to 2016–17. As part of the course, students were required to provide peer instruction on a specific anatomical region (Table 1). Regional assignments were determined by students' self-reported prior anatomy experience, with more experienced students working on one of the two upper extremity areas (forearm or shoulder), intermediate experienced groups were assigned to the lower extremity, and inexperienced groups were assigned to the back region.

Each anatomy group performed two teaching activities during the course. Students acted as peer instructors during the laboratory session covering their region and presented a didactic case-based presentation relevant to their anatomic region. Proficiency was demonstrated in regional anatomy by passing a teaching-readiness quiz, satisfactorily peer teaching content to classmates assigned to other regions, and presenting a case-based didactic presentation. The presentation was evaluated by basic and clinical science faculty who assessed content using a 0- to 5-point rubric for correctness and clinical relevance. Students enrolled in the AY 2014–15 (n = 54) and AY 2015–16 (n = 60) offerings of the course completed a dissection-based curriculum, whereas students enrolled in the AY 2016–17 (n = 70) completed a prosection-based anatomy curriculum.

Aside from the anatomy laboratory preparatory sessions being dissection or prosection based, the content and course design were consistent. Students in dissection cohorts had dedicated time, 10 h distributed over three sessions, to dissect their region and learn the associated objectives during the two preceding courses. While dissecting, students had the assistance of faculty and a professional prosector for consultation. Each region was professionally prosected in entirety on two cadavers, which were available for students to review during their preparatory period. Student dissections were evaluated based on the number of structures preserved and overall

Table 1. Reciprocal peer-teaching regions

| Assigned Region       | Teaching Objectives                                         | Clinical Case Example              |
|-----------------------|-------------------------------------------------------------|-----------------------------------|
| Forearm (forearm to hand) | Cubital fossa, forearm flexors and extensors, palmar and dorsal hand | Carpal tunnel syndrome            |
| Shoulder (shoulder to elbow) | Scapular and pectoral regions, brachium, brachial plexus, and axilla | Rotator cuff tear                 |
| Leg (knee to foot)     | Knee joint, anterior, posterior, and lateral leg, ankle joint, and foot | Fibular head fracture             |
| Hip (hip to knee)      | Gluteal region, hip joint, posterior, anterior, and medial thigh | Hip fracture                      |
| Back                   | Superficial, intermediate, and deep back                     | Herniated nucleus pulposus       |
quality. Since student dissection regions were assigned according to previous anatomy experience, the more challenging dissections were completed by the more experienced students. Student-produced specimens did not differ significantly in quality of observable structures compared with specimens produced by a professional prosector. Students in the prosection cohort had the same allotment of time, 10 h distributed over three sessions, during the previous courses to learn the same objectives on specimens prepared by a professional prosector. In total, 12 cadavers were available for study for each cohort during the course.

During the Musculoskeletal System course, students spent 4 h/wk in the gross anatomy laboratory rotating between learning and peer teaching on the prospected cadavers. The anatomy component of this course for the first two offerings was similar to other programs that use a dissection/peer-teaching approach, which involves student dissection, reciprocal peer teaching, and subsequent learning from previously dissected specimens. However, a major distinction is the absence of the typical “hand-off” method commonly described in this approach (7, 46, 53, 64). In the approach used at WMed, all students learned from all specimens (student or professionally prossected) and were not reliant on a single cadaver. In addition to the student peer instructors for each region, three faculty were also available to assist students as they studied the session objectives. The format of the anatomy component during the third offering of the course differed only in that there was no student dissection in the preparatory weeks, and all observation of structures was on previously prospected cadaveric material. The amount of laboratory contact hours was equal during all three offerings of the course. Lectures, TBL events, and textbook reading assignments were also consistent.

Assessments. Students were assessed on their anatomical content knowledge retention in the following ways: 1) a teaching-readiness quiz to assess preparedness for laboratory instruction; 2) a summative written exam consisting of MCQs; and 3) a 30-station timed practical examination (Table 2). The teaching-readiness quiz was a customized examination that consisted of five multiple-choice identification questions using photographic images that were specific to the students’ assigned region. The quiz was given to all students after they finished their dissection- or prosection-based preparatory period and before the beginning of the Musculoskeletal System course.

The summative written course examination consisted of 120 multiple-choice National Board of Medical Examiners-style questions that cover a variety of disciplines, including physiology, pathology, microbiology, immunology, pharmacology, and biochemistry (48). For this study, only examination questions that were tagged to anatomy objectives were included in the analysis. Ultimately, 27 MCQs were selected from the AY 2014–2015 and AY 2015–2016 examinations, and 26 MCQs were selected from the AY 2016–2017 examination. The reliability, KR-20, score for each examination was similar across the three cohorts (Table 2). The laboratory practical examination consisted of 30 stations with fill-in-the-blank recall questions. The practical was a timed examination with 1 min per station. Most stations comprised a numbered pin placed in the cadaver or clay on skeletal material with an identification question associated with it. Two questions may be asked on one cadaver. Students progressed through the stations without the opportunity to go back to a station. Generally, 27 of the 30 stations asked a first-order identification question, whereas one to two stations asked a second-order question. The final station was reserved for medical imaging, and students were asked to identify normal anatomic structures on a radiograph, computerized tomography, or magnetic resonance imaging.

Data analysis. The scores for region-specific questions were averaged for each examination to produce a region-specific summative and practical examination score for each student. The remaining questions on the summative examination were averaged to produce a non-region-specific exam score for each student; this value was used to control for overall musculoskeletal-specific student knowledge. A one-way ANOVA was conducted to compare each students’ regional knowledge across cohorts [two dissection cohorts (n = 54 and 60) and one prosection cohort (n = 70)] to determine whether there were differences in short-term student learning between the dissection and prosection cohorts. A post hoc Bonferroni analysis with a P of 0.05 was used to compare statistically different results from the one-way ANOVA. Multiple linear regression modeling was conducted to examine the impact of class cohort on region-specific exam scores. Data analysis was completed using IBM SPSS Statistics version 26.

RESULTS

During the study period, WMed was under preliminary accreditation with the Liaison Committee on Medical Education, which required proportional increase in class size between the years of the study. As such, class size over the 3-yr period of the study increased, with classes of 54, 60, and 70 students. Student sex ranged between 43 and 48% female. Student age was similar over the study, however the Medical College Admissions Test (MCAT) score of students increased for the AY 2016–17 cohort (Table 3).

To ensure that students were prepared to teach their anatomical region to peers, they completed a teaching readiness quiz the week after they completed their dissection or dedicated prosection learning time. The quiz was used to gauge readiness to correctly demonstrate anatomic structures on cadavers and

| Table 2. Course assessments |
|-----------------------------|
| No. of Students (N = 184) | No. of Questions, Readiness Quiz | Reliability (KR-20), Written Examination | No. of Anatomy-Based Written MCQs | No. of Practical Examination Questions |
| AY 2015–16 (n = 54) | 5 | 0.83 | 27 | 30 |
| AY 2016–17 (n = 60) | 5 | 0.82 | 27 | 30 |
| AY 2017–18 (n = 70) | 5 | 0.80 | 26 | 30 |

AY, academic year; MCQs, multiple-choice questions.

| Table 3. Student demographics |
|------------------------------|
| No. of Students | Sex, %female | Age, median (range), yr | MCAT Score, means (SD) | Teaching Modality |
| AY 2014–15 | 54 | 44 | 24.8 (21.1–33.7) | 31.67 (2.39) | Dissection |
| AY 2015–16 | 60 | 48 | 25.3 (21.5–45.2) | 31.25 (4.79) | Dissection |
| AY 2016–17 | 70 | 43 | 25.2 (21.1–36.8) | 32.84 (2.36) | Prosection |

AY, academic year; MCAT, Medical College Admissions Test.
Table 4. Readiness quiz scores by region

| Region               | AY 2014–15 Dissection | AY 2015–16 Dissection | AY 2016–17 Prosection | ANOVA (2,179) |
|----------------------|-----------------------|-----------------------|-----------------------|---------------|
|                      | n         | Mean (SD) | n         | Mean (SD) | n         | Mean (SD) | F      | P value |
| Forearm              | 11        | 81.82 (18.88) | 10        | 98 (6.32)  | 9         | 100 (0)    | 7.098  | 0.003  |
| Shoulder             | 10        | 94 (9.66)    | 10        | 84 (18.38) | 10        | 96 (8.43)  | 2.469  | 0.10   |
| Leg                  | 11        | 85.45 (18.1) | 10        | 78 (27.4)  | 11        | 87.27 (16.18) | 0.572  | 0.57   |
| Hip                  | 10        | 90 (14.14)   | 10        | 98 (6.32)  | 20        | 96 (10.46) | 1.571  | 0.22   |
| Back                 | 12        | 93.75 (15.54) | 20        | 99 (4.47)  | 20        | 99 (4.47)  | 1.825  | 0.17   |
| Overall              | 54        | 88.98 (15.88) | 60        | 92.67 (16.04) | 70        | 96 (9.98)  | 3.844  | 0.02   |

Values are means (SD); n, no. of students. P values were calculated using a one-way ANOVA, comparing the three different cohorts for each specific region. F = ANOVA test statistic. AY, academic year.

Further analysis of these student classes indicates that the MCAT scores showed a similar trend: $F(2,179) = 3.844, P = 0.023$. The mean was statistically different between the three cohorts. However, it should be noted that the quiz consisted of five questions, so observed statistical differences between cohorts may not be substantially different in practice (Table 4). Further confirmation of teaching readiness was assessed by a pass/fail oral presentation, of which all student groups passed. Together this suggests that students across cohorts were prepared to teach their region.

Application of anatomic knowledge to clinical scenarios was evaluated through the written multiple-choice course examination administered at the completion of the course. Student scores on questions specific to each anatomical region were compared between the three cohorts (two dissection and one prosection cohort), and initial analysis using a one-way ANOVA of mean region-specific summative examination scores showed significant differences: $F(2,179) = 12.99, P = 0.0001$ (Table 5). Post hoc Bonferroni analysis indicated that the prosection cohort was statistically significantly different from both dissection cohorts (data not shown). When looking at each specific region, only the shoulder and back groups showed statistically significant differences between cohorts; however, these differences were not due to differences in learning modality (prosection or dissection) (Table 5). This suggests that these learning modalities are equally effective, but that student knowledge varied across regions and teaching modalities.

Further analysis of these student classes indicates that the MCAT scores showed a similar trend: $F(2,179) = 3.88, P = 0.022$, with the prosection cohort (mean = 32.84, SD = 2.36) showing statistically significant differences from the dissection cohorts (ASY 2014–15, mean = 31.67, SD = 2.39, $P = 0.009$ and AY 2015–16, mean = 31.245, SD = 4.791, $P = 0.016$). This trend was also observed across the other courses in the curriculum (data not shown). To overcome a potential discrepancy between student cohorts, a multiple linear regression model was used to examine factors that significantly impact the region-specific summative examination scores while controlling for overall summative exam score, cohort, and assigned region: $R = 0.364, P < 0.0001$ (Table 6). Both the region to which the students were assigned and their overall summative exam score were predictive of their region-specific exam score; however, the cohort to which they belonged did not significantly predict their exam score. This provides further support that the method that students used to learn the anatomy material (dissection or prosection) does not impact short-term knowledge. This also indicates that prior anatomical experience has a greater impact on anatomical knowledge than learning method.

Finally, proficiency to correctly identify anatomic structures on a cadaver and recall the appropriate nomenclature was assessed through practical examination. Students who dissected a region performed equally well on practical examination questions as those who learned the same anatomy content on prospected specimens, regardless of region (Table 7). Based on a one-way ANOVA, overall the dissection and prosection instructional methods resulted in similar knowledge retention on region-specific practical examination scores: $F(2,179) = 2.692, P = 0.070$. Further analysis using a multiple linear regression model predicting the region-specific practical score controlling for cohort, overall practical examination score, and region showed that overall practical examination score predicted region-specific scores, but not cohort or region (Table 6). These analyses together indicate that the method students used to learn their anatomical material, dissection or prosce...
Table 6. *Multiple linear regression models for the summative examination and practical examination scores*

| Region-Specific Summative Examination Scores | Region-Specific Practical Examination Scores |
|--------------------------------------------|---------------------------------------------|
| **B** | **95% CI for B** | **t** | **P value** | **B** | **95% CI for B** | **t** | **P value** |
| Constant | 0.20 | –0.12 to 0.51 | 1.23 | 0.22 | 0.14 | –0.02 to 0.30 | 0.30 | 0.09 |
| Region | 0.003 | 0 to 0.005 | 2.02 | 0.05 | 0.001 | –0.001 to 0.002 | 0.92 | 0.36 |
| Cohort | –0.05 | –0.11 to 0.004 | –1.84 | 0.07 | –0.01 | –0.05 to 0.02 | –0.83 | 0.41 |
| Overall examination score | 0.86 | 0.47 to 1.25 | 4.37 | <0.001 | 0.88 | 0.71 to 1.06 | 10.11 | <0.001 |

CI, confidence interval.

Table 7. *Practical examination scores by region*

| AY 2014–15 Dissection | AY 2015–16 Dissection | AY 2016–17 Prosection | ANOVA (2,179) |
|------------------------|------------------------|------------------------|---------------|
| n | Mean (SD) | n | Mean (SD) | n | Mean (SD) | F | P value |
| Forearm | 11 | 88.64 (17.19) | 10 | 90.83 (11.42) | 9 | 85.19 (15.96) | 0.334 | 0.72 |
| Shoulder | 10 | 93.75 (9.32) | 10 | 85.13 (13.84) | 10 | 85 (17.48) | 1.653 | 0.21 |
| Leg | 11 | 91.11 (10.54) | 10 | 82 (19.32) | 11 | 91.82 (14.71) | 1.313 | 0.29 |
| Hip | 10 | 91.43 (9.99) | 10 | 79.17 (15.34) | 20 | 85.83 (12.71) | 2.294 | 0.12 |
| Back | 12 | 84.09 (28) | 20 | 87 (16.89) | 20 | 87.08 (12.53) | 0.111 | 0.90 |
| Overall examination score | 54 | 87.15 (9.9) | 60 | 82.58 (11.89) | 70 | 84.57 (9.31) | 2.692 | 0.07 |

Values are means (SD); n, no. of students. P values were calculated using a one-way ANOVA, comparing the three different cohorts for each specific region. F = ANOVA test statistic. AY, academic year.

DISCUSSION

The transition in the curriculum from regional dissection in the Musculoskeletal System course to learning via prosection provided a unique opportunity to evaluate the effect dissection or prosection had on short-term anatomy retention between very similar cohorts. Overall the outcomes of this study suggest that students who learned by dissection or prosection were equally prepared to provide laboratory instruction to their peers, and they performed equally well on both anatomy-based written MCQs and practical examinations. This indicates that learning via dissection or prosection of specimens enables students to both apply, recognize, and recall anatomical knowledge similarly. Additionally, our data show that prior anatomical knowledge had a greater impact on the knowledge retention of students than the learning modality. This comparison is an important and timely study, as the curricular time for anatomy is being reduced worldwide, and prosection is regularly deemed to be more efficient than dissection (12, 20, 26, 44, 50).

These findings are not surprising based on the meta-analysis by Wilson et al. (61), which found that both instructional methods are equally effective for short-term anatomy retention. It should be noted, however, that the authors of the meta-analysis found a general lack of rigor across studies due to the variety of approaches, educational experiences, and researcher bias (61). The present study attempts to address some of these shortcomings by maintaining comparison groups as similar as possible.

Specifically, the cohorts of students were taught the same objectives, used the same educational resources, had the exact same requirements for peer teaching, were in the anatomy laboratory the same amount of time, and were assessed similarly. It is particularly unique in that comparisons between dissection and prosection groups were controlled for anatomic region. Only individuals assigned to the same regions were compared, which allowed for comparison of close equivalences. Results from these comparisons are more compelling than studies that compare performance data on different anatomic regions (25, 53, 59). As many anatomists know, anatomic regions differ in their complexity and ease of learning for students.

The impact of peer teaching, notably the preparation for peer teaching specific anatomic regions relative to those receiving didactic instruction of the same region, has been a major confounding variable in many studies as well (7, 24, 31, 46, 55, 59, 64). Since all students were required to peer teach the anatomic regions under comparison, results were not limited by the effectiveness of peer teaching. Unlike studies that compared overall anatomy knowledge of students who rotated between dissection and peer teaching different anatomic regions, this study has the advantage of consistency between comparisons (24, 25, 31, 46, 55, 55a, 59, 64).

Furthermore, students were all enrolled in the same degree-granting program and the same Musculoskeletal Systems course, which, aside from the transition to prosection, maintained a consistent curricular organization. The consistency in curricular design between cohorts offers a distinct advantage relative to other studies that compared performance results between students who had different instructional experiences beyond dissection or prosection (7, 25, 44, 45).

Despite the advantages of this study, there are some limitations. It is restricted to a single institution and single course, and is focused on short-term knowledge retention. Additionally, due to the study design, which focused on region-specific knowledge, the number of exam questions focused on each anatomic region under comparison, results were not limited to the impact of dissection or prosection (7, 25, 44, 45).

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Despite the advantages of this study, there are some limitations. It is restricted to a single institution and single course, and is focused on short-term knowledge retention. Additionally, due to the study design, which focused on region-specific knowledge, the number of exam questions focused on each region is small, leading to large variability between and within the region-specific groups. However, due to the large number of students included in this study and the number of regions examined, our ability to draw conclusions about the impact of dissection or prosection on learning is more broadly applicable than in some other studies. Like many educational studies, our students were not randomly assigned to their regional anatomy groups but were instead assigned based on their prior anatomy experience.
a cohort, students in the AY 2015–16 had considerably less formal anatomy course work and experience relative to students in other academic years. However, by controlling for region (a measure of prior experience in our study) in the regression model, prior experience was shown to have an impact on region-specific knowledge on the summative exam, but not the practical examination. This is interesting, as it suggests that increased prior experience may be associated with application of material rather than recognition and recall.

Overall, our data support the idea that, despite the decreased physical manipulation of tissues afforded by dissection, students learn equally well from prosected specimens. This may be explained by the fact that a large portion of the time spent dissecting involves removal of subcutaneous tissue and fascia and not actually examining the anatomy of interest. While many anatomists view this task as an important learning opportunity, in a compressed curriculum with reduced contact hours, we have found this serves as a significant source of anxiety for students. This was a driving force behind the transition of our curriculum from dissection to prosection. One other caveat of our prosection-based curriculum is that the anatomic regions were completely prosected before the event in which they were used. This enables increased time during the learning event for students to manipulate and learn from the prosected specimens. This is in contrast to hand-off methods, which require dissection, peer teaching, and manipulation of prosected specimens in rapid sequence.

As most anatomists recognize, anatomy education, especially in the laboratory, involves more than the transmission of content knowledge: it also involves collaboration, communication, and professionalism. It is widely accepted that dissection provides educational opportunities for teamwork, professionalism, and lessons about death and dying. Yet as many have pointed out, thoughtful and deliberate prosection laboratory classroom design can also provide equal opportunities to see human variation, work as a team, practice professionalism, and enhance communication skills (38, 50, 60, 62). At WMed, which is currently entirely prosection based, students collaborate with their team members, rotating through 8–10 cadavers during each laboratory session, providing ample variation in prosected specimens. Students desiring a dissection experience can take a variety of electives during the pre-clerkship and clerkship years, individually or in groups. All of these learning opportunities provide students with occasions to practice teamwork, collaboration, self-directed learning, observing human variation, professionalism, and concepts of death and dying.

Despite dissection being cited as more time efficient (12, 44, 50, 60), dissection continues to be the dominant instructional method, either as the only approach used or in combination with prosection (12, 20, 24). This is likely related to centuries-old history of cadaver dissection and its place as a deeply embedded tradition or rite of passage for medical students (31, 32, 43, 56). Yet as Latman and Lanier (31) note, “while knowledge may not change, the selection of specific sets of information or knowledge for a course does change as the needs of the clinical practice change.”

The current study demonstrates that there is no inherent benefit or disadvantage to either dissection or prosection. Neither method of instruction is superior for short-term learning anatomy. Similarly, neither method is better with respect to providing opportunities for teamwork, collaboration, professionalism, and lessons about death. The study adds to the body of research that suggests anatomy instruction in medical and allied health professional education needs to be amenable to change. Learning objectives and instructional methods should match desired outcomes rather than adhering to tradition (6, 13, 31, 50, 60).

Conclusion. As medical and allied health professional education continues to evolve and greater demands are placed on students to learn more content in less time, it is imperative that methods of instruction are appropriate and efficient. This study strongly supports that neither prosection or dissection is superior for short-term anatomical knowledge retention. Perhaps the ultimate conclusion is that the best instructional methods are ones that fit the needs of the students and faculty. The bias that faculty feel for instructional methods likely has more to do with their own training rather than student outcomes. It is time to lose our pedagogical biases and create anatomy courses that are appropriate to the facilities, staffing, and time allotments that the institution has established, while making sure that opportunities to address competencies required of today’s physician and allied health professional are provided.

ACKNOWLEDGMENTS

This work was previously presented as an oral presentation at the Experimental Biology meeting in April 2019.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

W.L.-C. and L.B. conceived and designed research; W.L.-C. and L.B. performed experiments; W.L.-C. and L.B. analyzed data; W.L.-C. and L.B. interpreted results of experiments; W.L.-C. and L.B. prepared figures; W.L.-C., L.B., and J.S. drafted manuscript; W.L.-C., L.B., and J.S. edited and revised manuscript; W.L.-C., L.B., and J.S. approved final version of manuscript.

REFERENCES

1. Alexander J. Dissection versus prosection in teaching of anatomy. J Med Educ 45: 600–606, 1970. doi:10.1097/00001889-19700800-00007.
2. Association of American Medical Colleges. Curriculum Structure During Pre-Clerkship Years: Organization. 2015–2018 (Online). https://www.aacmc.org/data-reports/curriculum-reports/interactive-data/curriculum-structure-during-pre-clerkship-years [26 Oct 2019].
3. Azer SA, Eizenberg N. Do we need dissection in an integrated problem-based learning medical course? Perceptions of first- and second-year students. Surg Radiol Anat 29: 173–180, 2007. doi:10.1007/s00276-007-0180-x.
4. Aziz MA, McKenzie JC, Wilson JS, Cowie RJ, Ayeni SA, Dunn BK. The human cadaver in the age of biomedical informatics. Anat Rec 269: 20–32, 2002. doi:10.1002/ar.100646.
5. Bergman EM. Discussing dissection in anatomy education. Perspect Med Educ 4: 211–215, 2015. doi:10.1002/pme.2027-7.
6. Bergman EM, Prince KJ, Drukker J, van der Vleuten CP, Scherpbier AJ. How much anatomy is enough? Anat Sci Educ 1: 184–188, 2008. doi:10.1002/ase.55.
7. Bernard GR. Prosection demonstrations as substitutes for the conventional human gross anatomy laboratory. J Med Educ 47: 724–728, 1972. doi:10.1097/00001889-197207000-00007.
8. Böckers A, Jerg-Bretzke L, Lamp C, Brinkmann A, Traue HC, Böckers TM. The gross anatomy course: an analysis of its importance. Anat Rec 269: 266–274, 2015. doi:10.1002/ase.1483.
9. Brooks WS, Woodley KT, Jackson JR, Hoesly CJ. Integration of gross anatomy in an organism system-based medical curriculum: strategies and challenges. Anat Sci Educ 8: 266–274, 2015. doi:10.1002/ase.1343.
10. Cuddy MM, Swanson DB, Drake RL, Pawlina W. Changes in anatomy instruction and USMLE performance: empirical evidence on the absence of a relationship. Anat Sci Educ 6: 3–10, 2013. doi:10.1002/ase.1343.
58. Sugand K, Abrahams P, Khurana A. The anatomy of anatomy: a review for its modernization. Anat Sci Educ 3: 83–93, 2010. doi:10.1002/ase.139.
59. Thompson AR, Marshall AM. Participation in dissection affects student performance on gross anatomy practical and written examinations: results of a four-year comparative study. Anat Sci Educ 13: 30–36, 2020. doi:10.1002/ase.1859.
60. Topp KS. Prosection vs. dissection, the debate continues: rebuttal to Granger. Anat Rec B New Anat 281B: 12–14, 2004. doi:10.1002/ar.b.20037.
61. Wilson AB, Miller CH, Klein BA, Taylor MA, Goodwin M, Boyle EK, Brown K, Hoppe C, Lazarus M. A meta-analysis of anatomy laboratory pedagogies. Clin Anat 31: 122–133, 2018. doi:10.1002/ca.22934.
62. Woodcock J, Lackey-Cornelison WL, Isaac C. Engage students through active learning and peer teaching in a prosection-based anatomy lab (Abstract). FASEB J 33, Suppl 1: S605.6, 2019.
63. Yaqinuddin A, Ikram MF, Zafar M, Eldin NS, Mazhar MA, Qazi S, Shaikh AA, Obeidat A, Al-Kattan K, Ganguly P. The Integrated Clinical Anatomy Program at Alfaisal University: an innovative model of teaching clinically applied functional anatomy in a hybrid curriculum. Adv Physiol Educ 40: 56–63, 2016. doi:10.1152/advan.00153.2015.
64. Yeager VL. Learning gross anatomy: dissection and prosection. Clin Anat 9: 57–59, 1996. doi:10.1002/(SICI)1098-2353(1996)9<57::AID-CA12>3.0.CO;2-9.