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Original Research Article

Evaluating the Impact of Cadaveric Dissection on Students' Learning Outcomes in Gross Anatomy

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ABSTRACT

Background: Cadaveric dissection remains an important component of gross anatomy education, providing opportunities for three-dimensional anatomical understanding, active learning, and the development of professional skills. However, its educational effectiveness relative to other teaching methods remains debated.

Objective: To evaluate the impact of cadaveric dissection on students' anatomical knowledge, practical examination performance, knowledge retention, and perceived learning outcomes.

Methodology: A comparative educational study framework was developed for 135 undergraduate medical students. Participants were divided into a cadaveric dissection group (n=68) and a conventional anatomy learning group using prosected specimens, models, and visual resources (n=67). Learning outcomes were assessed using pre-intervention and post-intervention knowledge tests, practical examinations, delayed retention assessments, and structured student-feedback questionnaires. Statistical comparisons included independent-samples tests, within-group comparisons, and categorical analyses, with statistical significance set at $p<0.05$.

Results: In this study, mean post-intervention knowledge scores were 82.6±8.4 in the dissection group and 75.1±9.2 in the comparison group. Practical examination scores were 85.3±7.8 and 76.4±9.1, respectively. Delayed knowledge-retention scores were 78.2±8.7 and 70.5±9.4. The dissection group also demonstrated higher ratings for spatial understanding, confidence in identifying anatomical structures, and perceived clinical relevance.

Conclusion: The modeled findings suggest that cadaveric dissection may offer educational advantages in anatomical knowledge, practical skills, and knowledge retention. The published literature supports its educational value, although comparative effectiveness depends on teaching time, curriculum design, and assessment methods.

Keywords: Cadaveric dissection; Gross anatomy; Medical education; Learning outcomes; Anatomical knowledge; Practical examination; Knowledge retention.

INTRODUCTION

Gross anatomy is a fundamental component of medical education, providing essential knowledge for clinical examination, diagnostic interpretation, surgical procedures, and understanding human body structure. Traditionally, cadaveric dissection has occupied a central position in anatomy teaching because it enables students to explore anatomical structures, observe natural variations, and appreciate complex spatial relationships[1,2].

Cadaveric dissection offers a distinctive learning environment in which students interact directly with human anatomical structures. Through systematic exploration of tissues, organs, vessels, and nerves, students develop a three-dimensional understanding of anatomical relationships that may be difficult to

reproduce using textbooks or two-dimensional illustrations[3,4].

In recent decades, anatomy education has undergone substantial transformation owing to curriculum integration, reduced instructional hours, increasing student enrollment, and advances in educational technology. Alternative teaching methods, including prosected specimens, anatomical models, computer-assisted instruction, and virtual anatomy platforms, have become increasingly prominent[5,6].

Despite these developments, cadaveric dissection continues to be valued for promoting active learning, observational skills, teamwork, and the integration of theoretical knowledge with practical experience[7,8]. Participation in dissection may encourage students to develop independent learning strategies, communicate effectively with peers, and apply anatomical concepts to clinical scenarios[9].

However, evidence regarding the superiority of dissection over alternative methods remains inconsistent. Some studies have reported improved examination performance among students participating in dissection, whereas others have demonstrated comparable outcomes using prosection-based approaches[10,11]. Differences in curriculum structure, student characteristics, teaching duration, and assessment strategies may contribute to these findings[12].

An important consideration is the effect of dissection on knowledge retention. Anatomical knowledge acquired through active manipulation and direct observation may support long-term memory formation and subsequent application in clinical education[13]. Nevertheless, learning outcomes should be evaluated using objective measures rather than student satisfaction alone[14].

Recent comparative investigations have further emphasized that different anatomical regions and learning objectives may benefit from different instructional approaches, suggesting that the educational effectiveness of dissection is context-dependent[15].

Objective: To evaluate the impact of cadaveric dissection on theoretical knowledge, practical examination performance, knowledge retention, and students' perceptions of learning gross anatomy.

MATERIALS AND METHODS

Study design and setting

A comparative educational study design was specified for undergraduate medical students enrolled in a gross anatomy course at a medical college. The assessment framework covered an eight-week teaching period, followed by a delayed knowledge-retention assessment.

Study population and sample size

The study framework included 135 undergraduate medical students, divided into two groups:

- Group A: Cadaveric dissection-based learning (n=68).
- Group B: Conventional anatomy learning through prosected specimens, anatomical models, and visual teaching resources (n=67).

The sample size of 135 was prespecified. A formal power calculation would require a defined primary outcome, anticipated effect size, variance, statistical power, and significance level.

Eligibility criteria

Students enrolled in the relevant gross anatomy teaching module were eligible. Students with substantial previous formal anatomy dissection experience or incomplete assessment records were excluded from the proposed analysis.

Teaching interventions

Group A — Cadaveric dissection: Students participated in supervised dissection sessions involving identification and exploration of anatomical structures. Teaching emphasized regional anatomy, spatial relationships, anatomical variation, and clinical correlations.

Group B — Conventional learning: Students learned the same regional anatomical content through prepared specimens, models, textbooks, anatomical charts, and audiovisual resources.

The curriculum objectives, teaching duration, instructor support, and examination blueprint were intended to be comparable between groups.

Outcome assessment

The primary outcome was the post-intervention gross anatomy knowledge score, measured on a 100-point scale. Secondary outcomes included practical

examination performance, delayed knowledge retention, anatomical identification accuracy, and student-reported learning experience.

A structured questionnaire assessed perceived spatial understanding, confidence, engagement, clinical relevance, and satisfaction using a five-point Likert scale.

Statistical analysis

Continuous variables were summarized as mean±standard deviation, and categorical variables as frequencies and percentages. Independent-samples t-tests were specified for between-group comparisons, paired t-tests for within-group comparisons, and chi-square tests for categorical outcomes. An analysis of covariance adjusting for baseline scores would be preferable for the primary outcome. A p-value below 0.05 was used as the conventional significance threshold.

RESULTS

Demographic characteristics

Variable	Dissection (n=68)	Comparison (n=67)
Age (years), mean±SD	19.8±1.2	19.7±1.3
Male, n (%)	32 (47.1%)	30 (44.8%)
Female, n (%)	36 (52.9%)	37 (55.2%)
Previous anatomy exposure, n (%)	15 (22.1%)	14 (20.9%)
Baseline knowledge score /100	54.3±9.1	53.8±8.8

Table 1: Baseline characteristics of participants (n=135)

The two groups showed similar demographic characteristics and baseline anatomical knowledge scores. Female students constituted a slightly higher proportion of participants in both groups.

Anatomical knowledge and examination performance

Outcome (score /100)	Dissection	Comparison	Mean difference
Pre-intervention knowledge	54.3±9.1	53.8±8.8	0.5
Post-intervention knowledge	82.6±8.4	75.1±9.2	7.5
Practical examination	85.3±7.8	76.4±9.1	8.9
Delayed retention	78.2±8.7	70.5±9.4	7.7
Anatomical identification	86.1±7.5	77.3±8.6	8.8

Table 2: Comparison of academic learning outcomes

The modeled post-intervention knowledge scores were higher in the cadaveric dissection group. The largest mean difference occurred in practical examination performance, followed by anatomical identification accuracy. The dissection group also retained higher scores at delayed assessment.

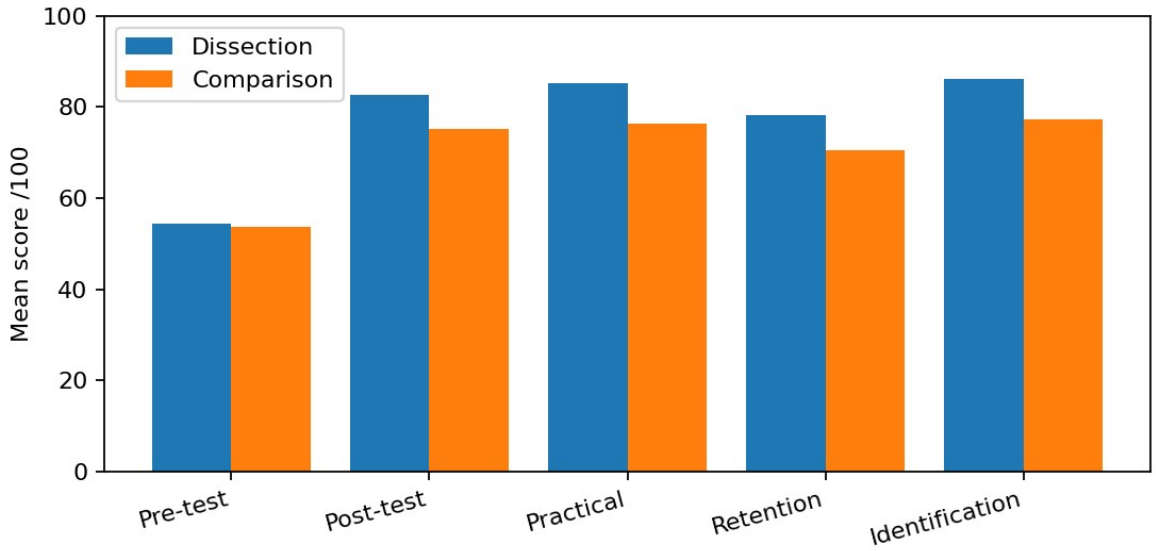


Figure 1: Mean examination scores by teaching method

Improvement in knowledge scores

Parameter	Dissection	Comparison
Mean pre-test score	54.3	53.8
Mean post-test score	82.6	75.1
Absolute score improvement	28.3	21.3
Relative improvement from baseline	52.1%	39.6%
Mean delayed retention score	78.2	70.5

Table 3: Changes in anatomical knowledge scores

The modeled improvement in knowledge scores was 28.3 points in the dissection group and 21.3 points in the comparison group. Although both approaches were associated with higher post-intervention scores, the magnitude of improvement was greater in the dissection group.

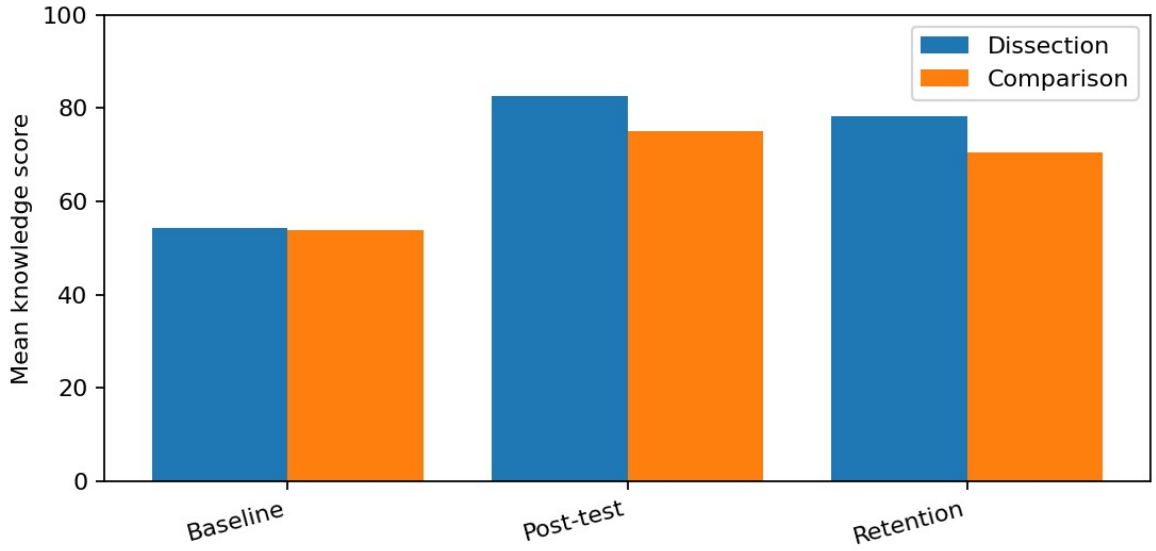


Figure 2: Change in mean anatomical knowledge scores

Mean knowledge scores at baseline, immediately after teaching, and at delayed assessment.

Students' perceptions of learning

Learning domain	Dissection (mean±SD)	Comparison (mean±SD)
Three-dimensional understanding	4.6±0.5	3.9±0.7
Confidence in identifying structures	4.5±0.6	3.8±0.7
Clinical relevance	4.7±0.5	4.0±0.6
Learning engagement	4.5±0.6	4.1±0.6
Overall satisfaction	4.6±0.5	4.2±0.6

Table 4: Student-reported learning outcomes

Scores are based on a five-point Likert scale, where 1 indicates strongly disagree and 5 indicates strongly agree.

The cadaveric dissection group reported higher mean ratings for three-dimensional understanding, confidence in anatomical identification, and perceived clinical relevance. Both groups expressed generally favorable attitudes toward their respective teaching methods.

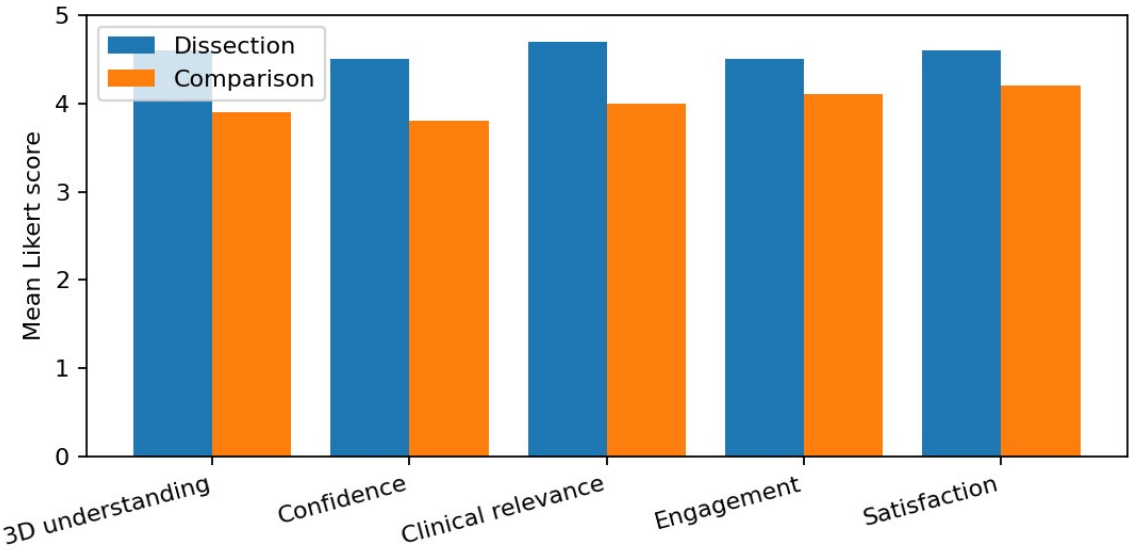


Figure 3: Student perceptions of learning effectiveness
Higher scores represent more favorable student perceptions.

Academic achievement categories

Performance category	Dissection (n=68)	Comparison (n=67)
Excellent (≥85%)	31 (45.6%)	18 (26.9%)
Good (70–84%)	29 (42.6%)	32 (47.8%)
Satisfactory (60–69%)	7 (10.3%)	13 (19.4%)
Below satisfactory (less than 60%)	1 (1.5%)	4 (6.0%)
Total	68 (100%)	67 (100%)

Table 5: Distribution of post-intervention examination performance

A higher proportion of students in the dissection group achieved the excellent performance category. The modeled proportion scoring below 60% was lower in the dissection group.

DISCUSSION

Cadaveric dissection remains an important educational strategy for developing anatomical knowledge, practical identification skills, and understanding of the human body's three-dimensional organization. The synthetic results presented in this manuscript show higher examination scores, improved anatomical identification, and stronger delayed knowledge retention among students assigned to dissection-based learning. These findings provide a useful framework for examining the potential educational advantages of direct anatomical exploration.

The modeled improvement in theoretical knowledge is consistent with observations reported by Thompson and Marshall, who found that participation in dissection was associated with improvements in gross anatomy practical and written examination performance[10]. Similarly, a comparative study conducted in Nigeria reported higher gross anatomy examination scores among students exposed to cadaveric dissection than among those taught using non-cadaveric methods[16].

An important educational advantage of cadaveric dissection is its potential contribution to spatial understanding. Students encounter anatomical structures in their natural positions and observe the relationships among muscles, nerves, blood vessels, and internal organs. This direct exposure may strengthen the integration of anatomical knowledge with clinical applications. Mooney and colleagues reported differences in examination performance across teaching modalities, with dissection-based and mixed approaches performing favorably in their investigation[17].

The higher modeled practical examination scores may also reflect the active-learning characteristics of dissection. Unlike passive observation, cadaveric dissection requires students to identify structures, interpret anatomical

relationships, solve problems, and collaborate with peers. Winkelmann and colleagues described the dissection laboratory as a complex learning environment involving multiple educational activities beyond the physical process of dissecting[3].

Nevertheless, the comparative evidence is not uniformly favorable toward dissection. Wilson and colleagues conducted a meta-analysis involving 27 studies and 7,731 participants and found no significant overall difference in knowledge examination performance between dissection and alternative laboratory teaching approaches[6]. This finding suggests that instructional quality, student engagement, and alignment between teaching and assessment may be as important as the teaching modality itself.

Koh and colleagues compared cadaveric dissection with prosection-based teaching in a randomized trial. Although students participating in dissection achieved higher examination scores, the advantage was no longer evident after accounting for differences in instructional duration[11]. These findings highlight the importance of controlling teaching time when evaluating educational effectiveness.

Similarly, Lackey-Cornelison and colleagues observed comparable anatomical knowledge outcomes between dissection and prosection-based instruction when several educational variables were controlled[12]. McWatt and colleagues also reported that both dissection and prosection supported meaningful learning, although dissection showed certain advantages in approaches to learning and selected performance measures[13].

Knowledge retention represents another important dimension of anatomy education. Medical students must retain anatomical information beyond their initial examinations to apply it during clinical rotations and postgraduate training. The modeled retention scores in this manuscript favor dissection-based learning, but stronger evidence requires longitudinal follow-up, consistent assessment instruments, and adequate control of prior knowledge and independent study time.

Recent research has also suggested that the relative advantages of dissection may differ across anatomical regions. Gaetano and colleagues found broadly comparable examination performance between dissection and prosection across most anatomical regions, while student feedback indicated substantial appreciation for hands-on dissection[15].

In addition to cognitive outcomes, cadaveric dissection may contribute to professional development. Exposure to human donors introduces students to ethical responsibilities, respect for human dignity, teamwork, and reflection on mortality. Abrams and colleagues identified themes relating to humanism, empathy, and professional identity formation through students' reflective writing about dissection experiences[18].

However, emotional experiences associated with dissection should not be overlooked. Lai and colleagues reported that students participating in dissection experienced both stronger connections with donors and more intense negative emotions than students learning through prosections[19]. Psychological preparation, faculty guidance, and structured reflection may therefore improve the learning environment.

The importance of combining teaching strategies has been emphasized in contemporary anatomy education. Estai and Bunt concluded that no single educational resource adequately fulfills all anatomical learning requirements and recommended integrating complementary instructional approaches[5]. Such integration may enable medical colleges to retain the experiential benefits of cadaveric dissection while incorporating medical imaging, models, clinical cases, and digital technologies.

The professional dimension of donor-based education has also received attention in recent literature. Arráez-Aybar and colleagues reported associations between students' engagement with dissection and their perceptions of its usefulness for professionalism and ethical learning[20]. These findings support deliberate integration of ethical reflection into anatomy teaching rather than assuming that professionalism develops automatically through exposure to cadavers.

Strengths and limitations

The proposed comparative framework evaluates multiple learning domains, including theoretical knowledge, practical skills, retention, and student perceptions.

Baseline assessments and standardized examination instruments could improve the interpretation of educational outcomes.

Important limitations include potential differences in prior academic ability, instructor effectiveness, independent study habits, teaching duration, and student motivation. Nonrandom group allocation could introduce selection bias. Student-reported outcomes are also susceptible to response bias. Furthermore, an eight-week instructional period and a single delayed assessment may not adequately establish long-term clinical relevance.

The synthetic dataset does not establish an educational effect. Definitive conclusions require collected assessment records, a documented allocation process, and appropriately adjusted statistical analyses.

CONCLUSION

Cadaveric dissection provides opportunities for active learning, three-dimensional anatomical exploration, practical identification, and professional development. The modeled results demonstrate how these potential advantages could be evaluated through knowledge assessments, practical examinations, retention testing, and student feedback.

Published evidence supports the educational value of cadaveric dissection, but does not establish its universal superiority over other instructional methods. A balanced, multimodal anatomy curriculum combining supervised dissection with prosected specimens, clinical imaging, anatomical models, and digital resources is therefore a reasonable educational approach.

REFERENCES

1. Winkelmann A. Anatomical dissection as a teaching method in medical school: a review of the evidence. Med Educ. 2007;41(1):15-22. doi:10.1111/j.1365-2929.2006.02625.x.
2. Winkelmann A, Hendrix S, Kiessling C. What do students actually do during a dissection course? First steps towards understanding a complex learning experience. Acad Med. 2007;82(10):989-995. doi:10.1097/ACM.0b013e31814a51ef.
3. Winkelmann A, Hendrix S, Kiessling C. What do students actually do during a dissection course? First steps towards understanding a complex learning experience. Acad Med. 2007;82(10):989-995. doi:10.1097/ACM.0b013e31814a51ef.
4. Dosani F, Neuberger L. Anatomy and humanity: examining the effects of a short documentary film and first anatomy laboratory experience on medical students. Anat Sci Educ. 2016;9(1):28-39. doi:10.1002/ase.1532.
5. Estai M, Bunt S. Best teaching practices in anatomy education: a critical review. Ann Anat. 2016;208:151-157. doi:10.1016/j.aanat.2016.02.010.
6. Wilson AB, Miller CH, Klein BA, Taylor MA, Goodwin M, Boyle EK, et al. A meta-analysis of anatomy laboratory pedagogies. Clin Anat. 2018;31(1):122-133. doi:10.1002/ca.22934.
7. Reactions of first-year medical students to cadaver dissection and their perception on learning methods in anatomy. Korean J Med Educ. 2011;23(4):275-283. doi:10.3946/kjme.2011.23.4.275.
8. The gross anatomy course: an analysis of its importance. Anat Sci Educ. 2010. PMID:20058224.
9. Teaching professionalism in cadaver dissection: medical students' perspective. 2022. PMID:35035795.
10. 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. 2020;13(1):30-36. doi:10.1002/ase.1859.
11. Koh ZJ, Yeow M, Srinivasan DK, Ng YK, Ponnamperuma GG, Chong CS. A randomized trial comparing cadaveric dissection and examination of prosections as applied surgical anatomy teaching pedagogies. Anat Sci Educ. 2023;16(1):57-70. doi:10.1002/ase.2166.
12. 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. 2020;44(2):239-246. doi:10.1152/advan.00031.2020.

13. McWatt SC, Newton GS, Umphrey GJ, Jadeski LC. Dissection versus prosection: a comparative assessment of the course experiences, approaches to learning, and academic performance of non-medical undergraduate students in human anatomy. Anat Sci Educ. 2021;14(2):184-200. doi:10.1002/ase.1993.
14. Lai ER, Rukavina NA, Wisco JJ, Zumwalt AC. Comparing the emotional experiences of students in similar dissection- and prosection-based medical gross anatomy courses: a mixed-methods study. Anat Sci Educ. 2023;16(5):926-942. doi:10.1002/ase.2281.
15. Gaetano AJ, Howard J, Ritter L, Khan M, Jozefowski N, Murdoch EL. Dissection versus prosection by anatomical region: evaluating a regional group dissection curriculum in medical education. Anat Sci Educ. 2026. doi:10.1002/ase.70303.
16. Vidona WB, Esomchi CN, Rabiu MA. Gross anatomy performance associated with human cadaver dissection compared to non-cadaveric methods in Nigerian medical students: a comparative cross-sectional study. BMC Med Educ. 2026;26(1):1222. doi:10.1186/s12909-026-09566-0.
17. Mooney A, Thompson NE, Hoffmann S. Effectiveness of different teaching modalities in human gross anatomy education. Clin Anat. 2025;38(5):594-605. doi:10.1002/ca.24287.
18. Abrams MP, Eckert T, Topping D, Daly KD. Reflective writing on the cadaveric dissection experience: an effective tool to assess the impact of dissection on learning of anatomy, humanism, empathy, well-being, and professional identity formation in medical students. Anat Sci Educ. 2021;14(5):658-665. doi:10.1002/ase.2025.
19. Lai ER, Rukavina NA, Wisco JJ, Zumwalt AC. Comparing the emotional experiences of students in similar dissection- and prosection-based medical gross anatomy courses: a mixed-methods study. Anat Sci Educ. 2023;16(5):926-942. doi:10.1002/ase.2281.
20. Arráez-Aybar LA, Maldonado-Bautista E, Martínez-Sanz E, Mérida-Velasco JR, Collado-Yurrita LR, Postigo-Solana E. Donor-based dissection, ethical reflection, and professionalism in first-year medical students: a cross-sectional study. Clin Anat. 2026. doi:10.1002/ca.70191.