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Regular Article

Extending the gift—utilizing residual human anatomical materials for training Pathologists' Assistants in surgical pathology techniques

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A B S T R A C T

This study investigates the effectiveness of using residual human anatomical materials, obtained from a gross anatomy course, for training Pathologists' Assistant (PathA) students in surgical pathology techniques. We utilized two surveys to assess the perceived efficacy of this approach: one survey targeted PathA students to evaluate their training experiences with both human and animal tissues, while the other assessed the impact of specimen collection on the educational experiences of gross anatomy course students.

Keywords: Grossing, Pathologists' assistants, Simulation, Surgical pathology, Training

Introduction

For individuals responsible for the macroscopic processing of surgical pathology specimens (i.e., "grossing"), it is essenmtial to possess not only the theoretical knowledge necessary to properly examine and assess each case but also to develop the tactile ability, procedural comfort, and analytical judgment required to effectively fulfill the objectives of this type of work.[1–3] A literature review reveals relatively little insight into successful teaching pedagogies for trainees in the macroscopic processing of surgical specimens.[1,3] Commonly, trainees transition from didactic instruction directly to clinical practice, where they develop their skills by processing surgical pathology cases in a clinical setting, on specimens from actual patients—essentially learning on-the-job.[1,2,4] The application of simulated laboratory experiences to aid in this transition is not well-documented.[2]

The literature focuses on trainees already in this stage of clinical training and does not specifically consider the training of Pathologists' Assistants (PathAs), emphasizing instead the training of other medical professionals, such as pathology residents.[1–3] The role of PathAs, when grossing, is the same as that of pathology residents, Pathologists, and others who may perform macroscopic specimen examination, and therefore, the training of PathAs demands significant consideration. Innovative and novel teaching strategies are required to prepare PathA students to serve as competent and confident additions to the pathology team, and simulated laboratory experiences provide an opportunity for students to safely grow into this role in a controlled environment.[4]

In our institution, students were previously trained using porcine organs to simulate grossing human surgical specimens. In this project, we have utilized cadaveric human-donor organs and tissues in place of porcine materials. These donor organs were procured from the teaching laboratory of a gross anatomy course, extending the generous gifts provided by donors while also providing an excellent learning experience for PathA students to hone their craft and organically confront common pathologies that may be present within the donor materials.[5–7] This project aims to showcase and compare these two surgical pathology training simulation modalities as a means of bridging the gap from theoretical learning to learning through work with actual patient specimens.

Materials and methods

To provide PathA students the opportunity to gain foundational experience in processing surgical specimens ("grossing"), the Eastern Virginia Medical School (EVMS) PathA Program utilizes a simulation training laboratory where students can gross specimens that mimic the characteristics of various surgical specimens. In our institution, this laboratory experience serves as a bridge between didactic learning of surgical pathology techniques and practice in a clinical environment with patient specimens. In the past, this has been accomplished with animal tissues and organs, primarily porcine materials because the size and anatomical features are closest to those found in humans and because such specimens are readily available from commercial sources. In either case, utilization of the preserved organs and tissues does not pose a risk of infection to the students, and there are no patient safety concerns as students gain initial experience in grossing.

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For this project, we were able to source human materials from the embalmed donors used in the Spring School of Health Professions gross anatomy course (Physician Assistant [PA], Surgical Assistant [SA], and PathA students). The students of the gross anatomy class were addressed to explain the aims of this effort and how materials would be collected in a manner that would not impact the structures being studied. Because tissues begin to desiccate and degrade after exposure via dissection, it was important to harvest the materials after the respective block examination was completed in order to ensure the specimens obtained were of the highest quality possible. In our institution, the anatomy course is broken into four blocks (in order): back and upper limb, head and neck, thorax and abdomen, and pelvis and lower limb. Since there is no cumulative practical examination for the anatomy course, this allowed us to obtain specimens in the best condition possible while not impacting the educational resources required by the anatomy students. For example, thyroid and submandibular glands were harvested after the block examination for the head and neck region, and the other specimens were harvested after the thorax and abdomen block examination.

Removed materials were stored in 80% ethanol until they could be used for surgical pathology training, and materials collected from each donor were stored in separate containers marked with the donor table number and identifying number. When utilized in the training laboratory, each student utilized materials from only one donor to practice grossing according to established protocols, and all materials were returned to the labeled container after each training lab session. In this way, the materials from each donor remained isolated from all other donor materials. No donor material was discarded, and all tissue and fragments from the training sessions were returned to the labeled donor containers. The bodies of each donor from which material was harvested were maintained in storage during the time that training labs were being conducted, and all donor materials used in the training lab sessions were returned to their respective donors so that complete donor tissues were dispositioned in their entirety.

Collected materials included the following: skin, spleen, lymph nodes, submandibular gland, thyroid, heart, lung (lobe), liver (partial), kidney, colon, gallbladder, and appendix. These specimens were selected according to two criteria: first, the integrity of the structures remained intact after all dissections in the Anatomy course were completed and second, the removed material accurately approximates a surgical specimen that may be encountered during the practice of surgical pathology. Based upon the extent of the anatomical dissections, the dissection techniques used in the anatomy course, and the condition of the tissues and organs within each donor, harvesting of other specimens is certainly possible. It is worth noting that some tissues (e.g.,. pancreas) may be autolyzed or degraded and are therefore not good candidates for harvesting. Other organs may frequently be absent in donor populations (some examples include uteri, fallopian tubes, ovaries, appendixes, and gallbladders). An assessment of the donors is necessary to determine the specimens available and appropriate for harvesting. The materials collected for this study and the surgical specimens to which they correspond are provided in Table 1.

To assess the value of residual human tissues obtained from a gross anatomy laboratory as training materials for surgical pathology grossing, two distinct survey tools were developed with approval from the EVMS Institutional Review Board (Exempt status IRB # 22-04-XX-0058). Study data were collected and managed using Research Electronic Data Capture\ electronic data capture tools hosted at EVMS.[8,9] Research Electronic Data Capture is a secure, web-based software platform designed to support data capture for research studies, providing 1) an intuitive interface for validated data capture; 2) audit trails for tracking data manipulation and export procedures; 3) automated export procedures for seamless data downloads to common statistical packages; and 4) procedures for data integration and interoperability with external sources. Surveys were distributed by email. Participation was voluntary and anonymous, and no incentives were provided.

Table 1
Collected donor materials and corresponding surgical specimens.

Donor Tissue	Corresponding Surgical Specimen
skin	various dermatological specimens - shave biopsy, punch biopsy, elliptical excision
spleen	splenectomy
lymph nodes	lymph node dissection/lymph node biopsy
submandibular gland	salivary gland resection
thyroid	thyroidectomy
heart	explant heart
lung (lobe)	lung lobectomy (partial pneumonectomy)
liver (lobe)	partial hepatectomy
kidney	Nephrectomy
colon	Colectomy
gallbladder	Cholecystectomy
appendix	Appendectomy

One survey was designed to query PathA students about their experiences in the EVMS PathA Program training laboratory as it relates to the effectiveness of the simulated specimens used in laboratory training sessions (Supplemental Material 1). In this survey, students were asked to respond to four statements using a five-point Likert scale from “Strongly Agree” to “Strongly Disagree.” These statements assessed the students' perceptions of the overall effectiveness of the training experience, the effectiveness of the specimens' ability to represent human anatomy, the specimens’ effectiveness in representing surgical specimens, and the effectiveness of the specimens as a mechanism for integrating foundational knowledge and the development of technical skills in grossing. Additionally, students were asked to describe their emotional response to using the simulated specimens, via a five-point Likert scale from “Strongly Positive” to “Strongly Negative.” Students were also allowed to provide additional comments if they desired to do so.

This survey was distributed to PathA students from the summer 2021 cohort and the summer 2022 cohort. Students who participated in laboratory sessions in 2021 were trained using porcine tissues and organs as the sources of training specimens, whereas the 2022 cohort was trained utilizing the residual human materials from gross anatomy.

The second survey used in this study was developed to assess the impact that specimen collection had on students taking the anatomy course from which these materials were harvested (Supplemental Material 2). In this way, we sought to ensure that there would be no ill effects on the students in this course. Because the anatomy course involved with this project included PA students, SA students, and PathA students, they were asked to identify to which program they belong. They were then asked to respond to three statements using a five-point Likert scale from “Strongly Agree” to “Strongly Disagree.” These statements assessed the students' overall understanding of the purpose of this project, their perception of the project's effect on their educational experience, and their feelings on this novel use of materials as an extension of donor wishes. Additionally, students were asked to describe their emotional response to the removal of selected organs and tissues from the donors via a five-point Likert scale from “Strongly Positive” to “Strongly Negative.” Students were also allowed to provide additional comments if they desired to do so.

All statistical analyses were conducted in collaboration with the EVMS-Research and Infrastructure Service Enterprise, utilizing SAS 9.4 (SAS Institute, Cary, NC). Descriptive statistics, including frequency, relative frequency, and percentage, were used to summarize all variables, providing a comprehensive overview of the dataset characteristics. For visual representation of the data, Power BI was utilized to generate graphs, which facilitated an intuitive understanding of the project's key findings.

All procedures were carried out in strict compliance with ethical standards, respecting donor generosity and adhering to relevant legal and institutional guidelines. The study's design ensured that donor materials were used respectfully and were returned to their respective donors, maintaining the integrity and dignity of the anatomical gifts.

Results

The data from the survey of PathA students demonstrate that both the 2021 (n = 6, cohort size = 23, Fig. 1) and 2022 (n = 14, cohort size = 23, Fig. 2) cohorts felt that their experience in the training laboratory was overwhelmingly positive. No negative responses were reported by either group, and only a few responses were neutral. In comparing the results, while cohort 2022 seems to show more strongly positive responses than cohort 2021, the only statistically significant difference was for Question 4 ("The specimens utilized in the surgical pathology laboratory sessions were effective in representing human anatomy.") (Table 2). In this instance, cohort 2022 (human donor materials) reported a significantly larger proportion of strongly positive responses, whereas cohort 2021 (porcine materials) had more positive responses and fewer strongly positive responses.

Comments provided by students from both cohorts expressed a high level of satisfaction with the simulation experiences. Of note, one student commented, "So cool to find actual human pathology in the specimens!" This reflects an additional benefit of utilizing human donor organs; unanticipated findings were encountered in a number of specimens. Examples include macroscopic presentations consistent with chronic passive congestion of the liver, possible lymphoma in a spleen, and gallbladders with calculi.

Survey results from the students in gross anatomy (n = 97, cohort size = 136, response rate = 71.32%, Fig. 3) indicate a very high level of support and understanding of the project, without negative effects on students' educational experiences or emotional wellbeing. In the anatomy course, there were 136 students, including 90 PA students, 23 SA students, and 23 PathA students. Of these, only 10 total negative responses were reported (from all questions), whereas there were 90 positive and 260 strongly positive responses. Comments were provided by only two of the students reporting a negative response, with comments indicating that they did not comprehend the process by which organs would be removed in one case, and in the other instance, the student indicated that they observed "large parts of the body removed," which is not consistent with the extent of the materials harvested. Other comments provided were supportive of the project, as one student stated, "I think it is a wonderful way to utilize everything our donors have gifted us. It also gives a more real-life experience for performing surgical techniques. It's a win-win! I felt it was very respectful, and it did not hinder my dissection lab and anatomical learning in any way."

Discussion

Results of this study demonstrate that utilizing residual donor materials for simulation training in the macroscopic processing of surgical specimens is perceived by PathA students as an effective instructional tool, with advantages over other techniques also noted. Survey data from PathA students in surgical pathology simulation laboratory sessions demonstrate a high level of satisfaction, regardless of whether specimens were derived from animal or human sources. The percentage of strongly positive responses seems to be somewhat greater for sessions conducted with human materials, though only one significant difference was reported. Perhaps unsurprisingly, students reported that human-donor-derived specimens were more effective in representing human anatomy than those obtained from animal materials. As mentioned, human-donor-derived specimens also presented students with occasional unanticipated findings, reflecting a reality of clinical practice that is not seen when using animal-derived specimens.

It is worth noting that both the human-derived anatomical materials and those derived from animals have been fixed prior to utilization in the laboratory. Whether embalmed or fixed in a commercial fixative (most commercially available animal organs are preserved in formalin and but

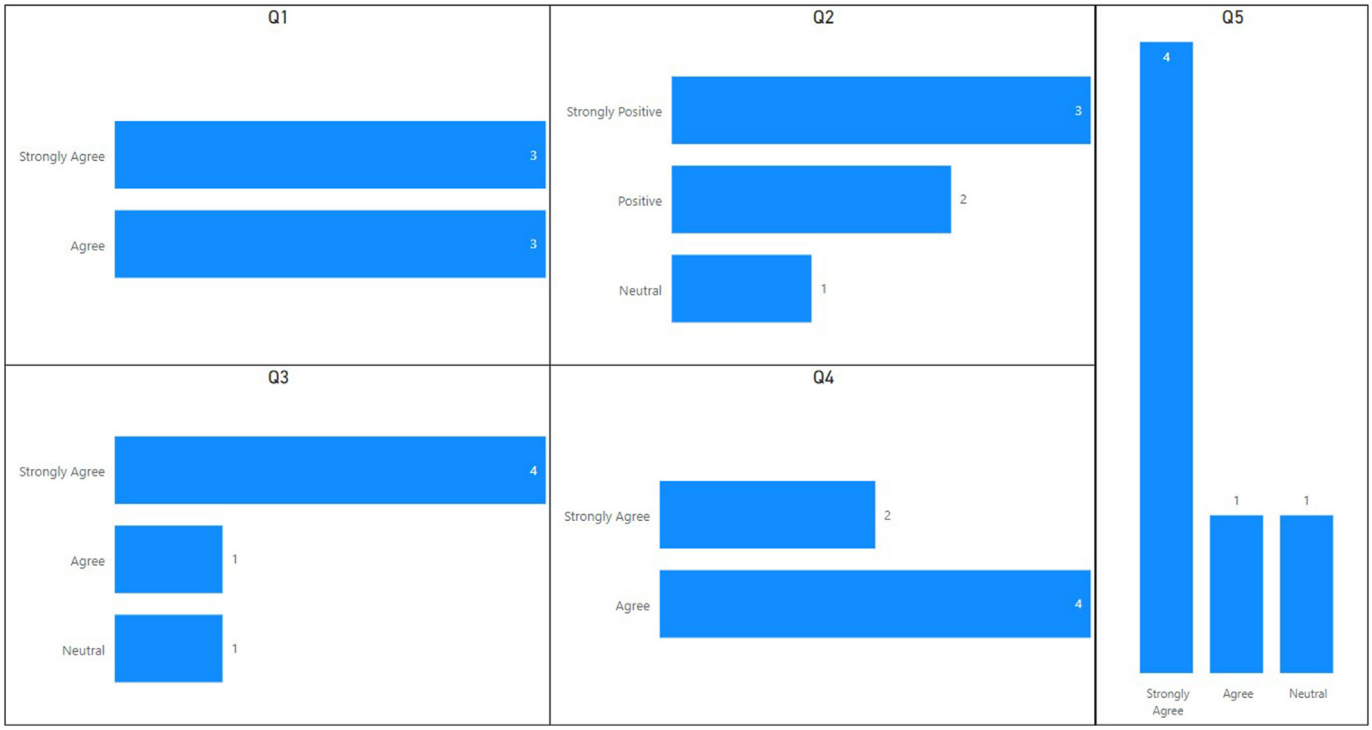

Fig. 1. PathA student perceptions of training—animal materials.
Q1 – The specimens utilized in the surgical pathology laboratory sessions provided an effective training experience.
Q2 – The specimens utilized in the surgical pathology laboratory sessions were effective in representing human anatomy.
Q3 – The specimens utilized in the surgical pathology laboratory sessions were effective representation of surgical specimens.
Q4 – The specimens utilized in the surgical pathology laboratory sessions supported the integration of foundational knowledge and technical skills in preparation for clinical practice.
Q5 – My emotional response to the specimens utilized in the surgical pathology laboratory sessions can best be described as follows:PathA: Pathologists' Assistant.

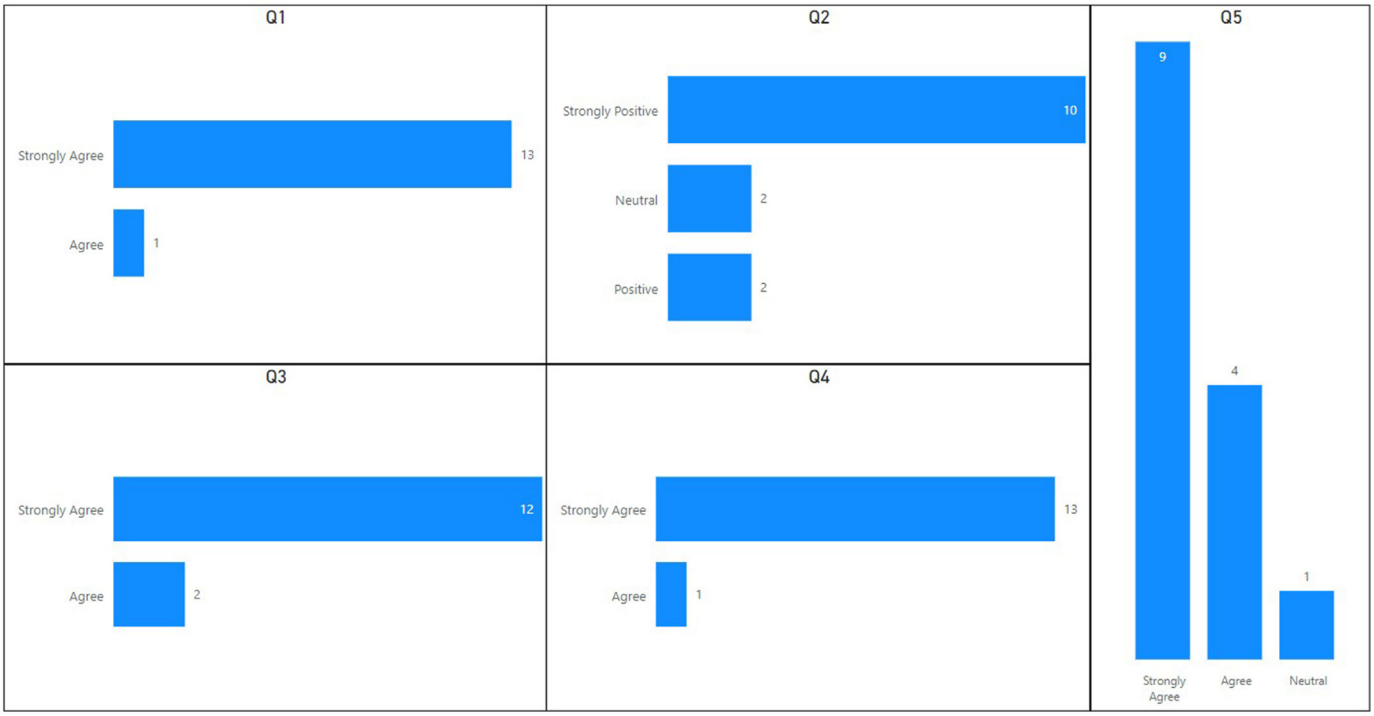

Fig. 2. – PathA student perceptions of training—human-donor materials.
Q1 – The specimens utilized in the surgical pathology laboratory sessions provided an effective training experience.
Q2 – The specimens utilized in the surgical pathology laboratory sessions were effective in representing human anatomy.
Q3 – The specimens utilized in the surgical pathology laboratory sessions were effective representation of surgical specimens.
Q4 – The specimens utilized in the surgical pathology laboratory sessions supported the integration of foundational knowledge and technical skills in preparation for clinical practice.
Q5 – My emotional response to the specimens utilized in the surgical pathology laboratory sessions can best be described as follows:PathA: Pathologists' Assistant.

others may be fixed by other means, including a proprietary fixative solution in one case), the color, texture, and overall appearance are affected by fixation, making the materials less like fresh tissue removed during a surgical procedure. However, because most grossing is performed on tissues and organs after fixation, the materials used in this project remain faithful models of specimens grossed in a surgical pathology setting.

While the relatively small number of PathA student participants is certainly a limitation for this study, we suggest that the use of residual human anatomical material obtained from a gross anatomy course is perceived by students to be at least as effective as animal-derived materials for training Pathologists' Assistant students in surgical pathology grossing techniques among these two cohorts. Human-derived specimens better represent human anatomy compared to specimens obtained from

Table 2
Comparison of PathA student perceptions of training—cohort 2021 (animal materials) and cohort 2022 (human-donor materials).

		2021 n (C%/R%)[a]	2022 n (C%/R%)[a]	P value[b]
Q1	Agree	3 (50%/75%)	1 (7.14%/25%)	0.06089
	Strongly Agree	3 (50%/18.75)	13 (92.86%/81.25%)	
Q2	Neutral	1 (16.67%/33.33%)	2 (14.29%/66.67%)	0.58436
	Positive	2 (33.33%/50%)	2 (14.29%/50%)	
	Strongly Positive	3 (50%/23.08%)	10 (71.43%/76.92%)	
Q3	Agree	1 (16.67%/33.33%)	2 (14.29%/66.67%)	0.28088
	Neutral	1 (16.67%/100%)	0 (0%/0%)	
	Strongly Agree	4 (66.67%/25%)	12 (85.71%/75%)	
Q4	Agree	4 (66.67%/80.00%)	1 (7.14%/20.00%)	**0.01393**
	Strongly Agree	2 (33.33%/13.33%)	13 (92.86%/86.67%)	
Q5	Agree	1 (16.67%/20.00%)	4 (28.57%/80.00%)	0.73245
	Neutral	1 (16.67%/50.00%)	1 (7.14%/50.00%)	
	Strongly Agree	4 (66.67%/30.77%)	9 (64.29%/69.23%)	

Bold text indicates a statistically significant P value.
Q1: The specimens utilized in the surgical pathology laboratory sessions provided an effective training experience.
Q2: My emotional response to the specimens utilized in the surgical pathology laboratory sessions can best be described.
Q3: The specimens utilized in the surgical pathology laboratory sessions supported the integration of foundational knowledge and technical skills in preparation for clinical practice.
Q4: The specimens utilized in the surgical pathology laboratory sessions were effective in representing human anatomy.
Q5: The specimens utilized in the surgical pathology laboratory sessions were effective representation of surgical specimens.
[a] C%: column percentage; n: count; PathA: pathologists' assistant; R%: row percentage.
[b] [2 × 2]-Fisher's Exact,if At least one cell had an expected value less than 5; Pearson's Chi-Square if not.

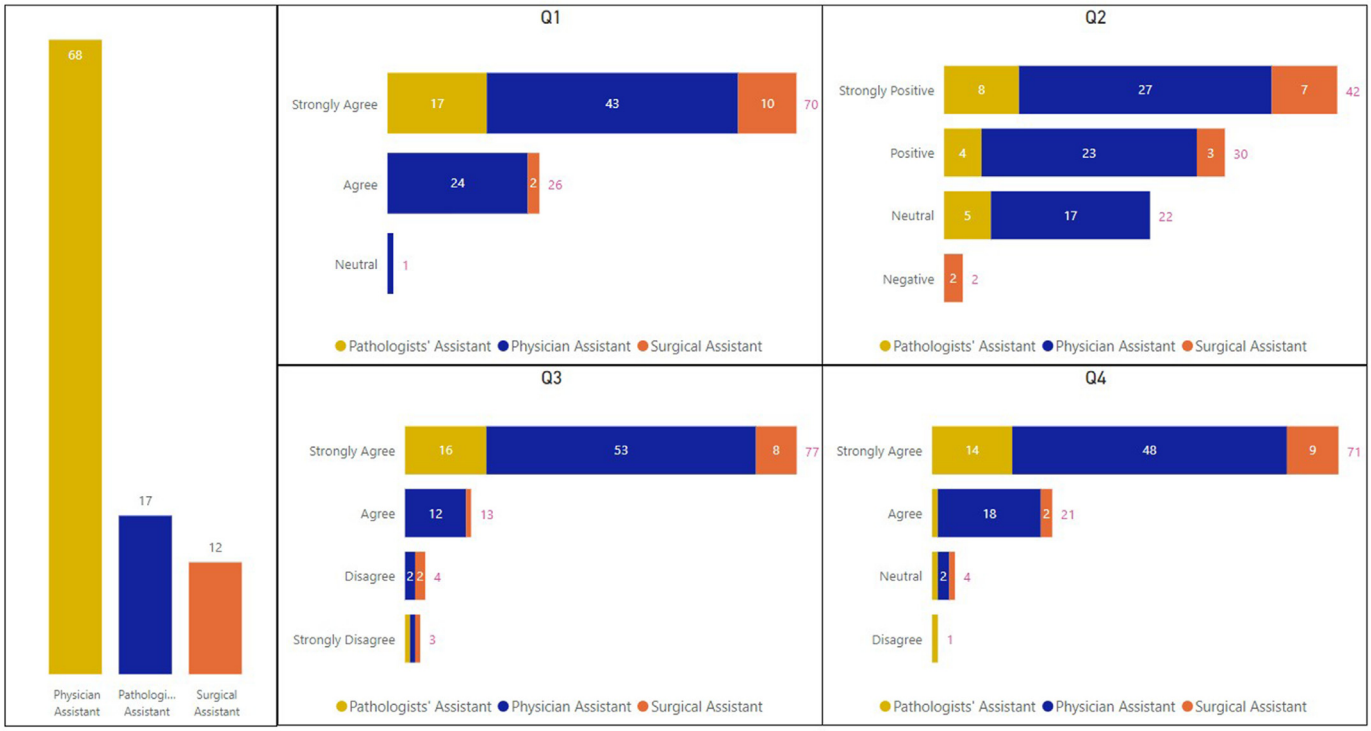

Fig. 3. – Anatomy student impact.
Q1 – I understand the purpose of the "Extending the Gift" project to utilize remaining organs and tissues from gross anatomy for training Pathologists' Assistant students in Surgical Pathology techniques.
Q2 – The removal of organs and tissues from the donors after the related dissections and examinations were completed, DID NOT affect my educational experience in the gross anatomy course.
Q3 – The use of donor organs and tissues as surgical pathology training specimens (after related dissections and examinations were completed) is an extension of the donor's wishes to provide this anatomical gift.
Q4 – My emotional response to the removal of organs and tissues from the donors after the related dissections and examinations were completed, can be best described as follows:

animal tissues and organs. Moreover, human-derived specimens provide the additional benefit of occasionally presenting human pathology that is not encountered in specimens derived from animals. In this way, we suggest that human-derived training specimens may be preferable to animal-derived specimens. Furthermore, considering the common altruistic motivation of many anatomical gift donors, it stands to reason that additionally using their organs for the educational purpose we propose in this paper optimizes the educational value of the gifts provided by each donor.[5–7]

Conclusion

The study's findings suggest that human anatomical materials derived from a gross anatomy course are perceived by PathA students to be as effective as animal models in training surgical pathology techniques. This supports the educational value of these materials, which aligns with donors' altruistic intentions.[5,7] The use of human tissues offers a more realistic representation of human anatomy and exposes students to human pathology they may encounter in their future PathA duties and which is not available in animal-derived specimens. This approach has significant implications for medical education, particularly in pathology training. It underscores the potential of utilizing residual human anatomical materials as a sustainable, ethically sound resource that enhances learning experiences while honoring the generosity of donors. Furthermore, the absence of any negative impact on gross anatomy students during the collection of these materials suggests a viable, respectful way of extending the educational impact of donated anatomical gifts.

Future studies could investigate the long-term impact of training with human anatomical materials on the clinical competencies of PathA students. Research in this area might assess whether such training leads to superior skills, confidence, and professional effectiveness compared to training with animal tissues or synthetic models. Additionally, a systematic comparison between different types of training materials could provide definitive evidence on their relative effectiveness, incorporating objective measures of skill acquisition, retention, and application in clinical settings.

The emotional and psychological effects on students of working with human-donor materials also merit further investigation. It would be beneficial to understand how this exposure influences students' perceptions of death, their formation of professional identity, and their approach to patient care. Alongside, the ethical and legal implications of expanding the use of human anatomical materials in medical training present a critical area for additional research. This could include examining donor consent processes, ethical considerations from the community perspective, and the implications of regulatory changes on the availability and utilization of these materials.

Exploring new methods and technologies for preserving and presenting human anatomical materials could also enhance the educational value of these resources. Research might investigate how virtual reality, augmented reality, and other digital tools can be combined with actual human tissues to create immersive and interactive learning experiences. Furthermore, understanding societal and cultural attitudes toward body donation for medical education, and how these impact donation rates and consent processes, could inform strategies to encourage more donations. This research could also delve into the effects of cultural competence training on students' perceptions and utilization of human anatomical materials.

By addressing these topics, the academic and medical communities can continue to refine and enhance the use of human anatomical materials in PathA and other medical training programs. Such efforts will not only honor the altruistic gifts of donors but also ensure that future healthcare professionals are thoroughly prepared to meet the demands of their roles.

Limitations

This study, while insightful, is limited by its relatively small and potentially non-representative sample size, which may impact the generalizability of the findings. A small cohort size (23 students in each PathA student class) was further impacted by response rates of 26.09% (6/23) for the 2021 cohort (trained with animal-derived specimens) and 60.09% (14/23) for the 2022 cohort (trained with human-derived specimens). Reflecting on the disparity of responses between the two groups, we believe that the response rate was greater for the 2022 cohort because they completed the simulated training course just before the survey was given and were also members of the anatomy course involved in this project. The 2021 cohort completed training with animal-derived specimens nearly a year prior to the survey and were invited to complete the survey during the time they were conducting clinical rotations. The reasons may explain why the 2022 cohort had a lower response rate than the 2021 cohort.

Additionally, the reliance on survey methodology may introduce potential biases such as self-reporting and response bias, potentially skewing the data. Furthermore, the study primarily assesses short-term outcomes relating to study perceptions of training techniques and does not account for the long-term retention of skills or the emotional and psychological impacts on students, which are crucial aspects of educational efficacy and the development of competency in grossing. Addressing these limitations in future research is essential for providing a more comprehensive understanding of the educational methodologies in surgical pathology.

Legal and ethical considerations

We are deeply committed to the respectful and ethical treatment of donors whose contributions support instructional purposes, scientific research, and practical training for physicians, surgeons, and healthcare professionals. The procurement, maintenance, care, and dispositioning of our donors are conducted safely and respectfully in accordance with all laws and regulations of the Commonwealth of Virginia and our institutional protocols, implementing the most current best practices and procedures of our institution and the Virginia State Anatomical Program (VSAP).

The procedures described in this manuscript are permitted under the consent granted by donors to the VSAP.[10] In accordance with our institutional rules and regulations, we have taken additional steps to ensure that all materials harvested from donors remain traceable and isolated from any other anatomical materials. At the conclusion of the training laboratory sessions, all materials were returned to the appropriate donor bodies to allow the donors to be cremated with all tissues and organs included.

Other institutions interested in the application of anatomical gifts as described in this paper must be aware of the laws and regulations in their region as they may vary from one locality to another. The generous and selfless gifts made by our anatomical donors cannot be appreciated enough, and as stewards of these materials, we must be respectful, grateful, and diligent in protecting and honoring these gifts.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.acpath.2024.100142.

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