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Original Research

Clinical Anatomy and Ultrasound Bootcamp for Anesthesiology Residents: A Pilot Study and Lessons Learned

Adarsh Menon, MD
Rijul Asri, MD
Jeremy J. Grachan, PhD
Jean D. Eloy, MD
George Holan, PT, DPT, GCS, NCS

Introduction

Within anesthesiology, ultrasound has become a highly utilized tool for regional anesthesia and ultrasound-guided peripheral nerve blocks.[1,2] Over the last century, anesthesiology has evolved from simple topical anesthesia to specific regional nerve blocks, and this has allowed for lower general anesthesia and opioid requirements for surgical and acute pain patients.[3–6] However, although effective, the use of regional anesthesia also poses the risk of accidental intravascular injection of local anesthetic, potentially producing devastating side effects and complications.[7,8] These can include block failure (5%–20%), block-associated hematomas (0.67%), and local anesthetic systemic toxicity (0.18%).[9] Efforts to reduce block failure and iatrogenic injuries have led to the development of modalities for prevention, including nerve stimulators, as well as ultrasound-guided techniques.[10–12]

Given the increase in use of ultrasound in anesthesiology for safer patient care, anesthesiologists in training will continue to require high-quality technical training in this discipline. Hands-on training related to ultrasound-guided techniques on patients presents unique challenges as the patient may be in pain from a preexisting pathology, be unable to tolerate prolonged pain from the needle stick, and may suffer from general anxiety surrounding surgery.[13–15] The amount of learning at the bedside also often depends on the surgical volumes during their minimum required 1 month of residency training for acute pain and regional anesthesia.[16–18] Additionally, as of 2023, the Accreditation Council for Graduate Medical Education outlines program requirements for residency training in regional anesthesia and acute pain medicine, which includes competence in ultrasound use for neuraxial and peripheral nerve blocks [IV.B.1.b).(2).(c)] and knowledge of how to safely operate ultrasound to localize and anesthetize peripheral nerves [IV.B.1.c).(2).(a).(iii)].[19]

The use of human anatomical donors (ie, cadavers) for education of ultrasound-guided regional techniques is a useful modality to provide a safer and more relaxed environment to demonstrate appropriate anatomy and attempt proper ultrasound-guided methods for delivering regional anesthesia.[20,21] Both the American Society for Regional Anesthesia and the European Society of Regional Anesthesia and Pain Therapy conduct donor-based review sessions and workshops annually for diverse groups of learners. For residents and trainees in particular, the use of previously dissected anatomical donors to separately review anatomy and demonstrate ultrasound-guided needle placement for nerve blocks has been shown to increase resident confidence.[21,22]

The purpose of this study was to expand on previous studies that explored the perceived value and confidence of the anesthesiology residents and to also explore the knowledge of residents prior to and after an educational session with anatomical donors. The study also explores a method that utilizes previously dissected and undissected anatomical donors to complete a clinical anatomy review and ultrasound-guided technique practice session with the donors side by side for comparison. The session was offered as a pilot for residents in their clinical base year (CA-0) or first clinical anesthesia year (CA-1) at Rutgers New Jersey Medical School and covered 3 anatomical regions and 5 regional anesthesia blocks: the brachial plexus and its relationship to the interscalene nerve and supraclavicular nerve blocks, the lumbosacral plexus and its relationship to the femoral nerve block and sciatic nerve block, and the anterolateral abdominal wall and its relationship to the transversus abdominis plane block. These blocks were specifically chosen as they are the most common blocks performed in our program.

Materials and Methods

Clinical Anatomy and Ultrasound Review Session Overview

A new session was held as a collaboration between the anatomy teaching team from the Rutgers New Jersey Medical School's Office of Education and the Department of Anesthesiology for CA-0 and CA-1 anesthesiology residents (n = 18). The 2-hour session was required for all CA-0 and CA-1 residents as an early morning

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weekday session in May 2024 unless they were on call. The session involved the anesthesia residents being divided into 3 groups (ie, there were 3 groups of 6) and rotating through 3 stations focusing on different regional peripheral nerve blocks: brachial plexus–related blocks (45 minutes), lumbosacral plexus–related blocks (45 minutes), and a transversus abdominis plane block (30 minutes). Each station included an anatomy review and an ultrasound component. For the anatomy review, 1 of the anatomy teaching staff walked through high-yield structures related to the specific region and the peripheral nerve blocks being discussed utilizing a prosected anatomical donor. The credentials of the anatomy teaching staff included 1 PhD in anatomy and 1 Doctor of Physical Therapy, who has been teaching anatomy full time for more than 5 years. For the ultrasound component, students were first given a demonstration of the ultrasound imaging process related to the different blocks on an undissected anatomical donor by 1 of the anesthesiology faculty, who are both fellowship trained in regional anesthesiology and acute pain, followed by a time for the students to practice acquiring the ultrasound image with immediate feedback from the faculty member or fellow. A summary of the topics discussed at each of these stations can be found in Table 1.

Evaluations of the Residents and Session

This study was approved as exempt by Rutgers, The State University of New Jersey's Institutional Review Board (Pro2024000420). A presurvey and postsurvey were developed and utilized to evaluate the residents' perceptions of the session. Additionally, an 8 multiple-choice question pretest and posttest were developed. The survey was developed collaboratively between 1 of the anatomy faculty and 1 of the anesthesiology faculty. The survey was then reviewed by 4 individuals, including 2 residents who were not participating in the session, an additional anatomy faculty member, and an additional anesthesiology faculty member. All comments from these individuals were minor phrasing edits to improve the readability of the questions.

The presurvey asked about demographic information related to their previous experience with anatomy and ultrasound. Additionally, the residents were asked to rate their comfort level on a scale from 1 (*very uncomfortable*) to 5 (*very comfortable*) for performing various levels of procedures that can or typically involve ultrasound. They were asked about 3 procedure levels: minor procedures (ie, techniques expected of intern-level residents, such as central lines, arterial lines, and intravenous lines), moderate procedures (ie, techniques expected of late intern/early anesthesia residents, such as echocardiography and focused assessment with sonography for trauma or FAST examinations), and major procedures (ie, techniques in which senior residents are expected to be proficient, including regional nerve blocks). The presurvey also asked how the residents anticipated this session would improve their performance on board exams, ultrasound probe placement, and patient positioning for probe placement by reporting their level of agreement on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). Last, the residents were asked about their confidence of anatomy knowledge related to the abdominal wall, brachial plexus, and lumbosacral plexus and their confidence levels related to ultrasound probe placement for the discussed peripheral nerve blocks related to each anatomical region listed above using a 4-point Likert scale (*1: not at all confident* and *4: very confident*).

At the conclusion of the session, the residents completed a postsession survey asking many of the same questions as the presurvey, including those to gauge their comfort levels using ultrasound, their confidence of anatomy knowledge, and their confidence levels related to peripheral nerve blocks. Additional questions were also asked about their opinions on the review session and what they would like to see more of in similar sessions.

Data Analysis

All data was analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 29. The data was screened for normality using the Shapiro-Wilk test, and all participants (n = 18) were used in the analyses. For pairwise comparisons, a Wilcoxon signed-rank test was used as all data points were found to be not normal. For each analysis, the data were considered statistically significant when $p < .05$. Open-ended responses were reviewed by 2 independent reviewers and coauthors on this paper to extract common qualitative themes. At the end of coding, discrepancies in themes were discussed and solved by consensus.

Results

Demographics and Anatomy Background

Of the 18 resident physicians that participated in this session, 7 were first-year residents completing their clinical base year training and 11 were second-year residents completing their first year of anesthesia training. The median amount of time elapsed since participants took a gross anatomy course was 4.00 years (interquartile range = 5–3) with responses ranging from 3 to 18 years. Nearly all of the participants (N = 17) indicated that their last gross anatomy course was a preclerkship anatomy course, and all of these participants reported that this course was the last time they learned utilizing human body donors.

Residents' comfort levels performing various levels of procedures that can or typically involve ultrasound can be seen in Figure 1. For minor procedures (eg, central lines, arterial lines, and intravenous lines), the average level of comfort was 3.28 (SD = 1.4). For moderate procedures (eg, echocardiography and FAST examinations) using ultrasounds, the average level of comfort was 1.94 (SD = 0.9). When asked to rate their comfort level performing major procedures using ultrasounds (eg, regional nerve blocks), the average level of comfort was 1.72 (SD = 1.2).

Finally, participants were asked about the nature of any of their previous ultrasound training and were able to select multiple options (Figure 2). A majority of participants (13, 72.2%) cited hands-on experience for previous ultrasound training during their graduate medical education.

Perceived Value of the Session

Most participants initially agreed that this session would help them improve their performance on future board examinations, and the average level of agreement did not change significantly after the session (pre: M = 4.28, SD = 0.6; post: M = 4.33, SD =

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1.0; $p = .366$). Similarly, most participants initially agreed that this session would help them improve their proficiency with ultrasound placement, and the average level of agreement did not significantly change after the session (pre: M = 4.28, SD = 0.6; post: M = 4.28, SD = 0.75; $p > .999$). Finally, most participants initially agreed that this session would help them improve their proficiency with optimal patient placement for ultrasound probe placement, and the average level of agreement did not significantly change after the session (pre: M = 4.11, SD = 0.8; post: M = 4.28, SD = 1.0; $p = .405$).

Overall, 15 participants (83.3%) felt the session was *very useful* and the remaining 3 participants (16.7%) felt that it was *moderately useful*. Similarly, 15 participants (83.3%) felt it was *very useful* and 3 participants (16.7%) felt it was *moderately useful* for visualizing relevant anatomical structures. All the participants (18, 100%) felt it was *very useful* having undissected anatomical donors side by side to dissected ones during the session. When asked what participants liked most about the session, some common themes that arose were the multidisciplinarity of the teaching team (eg, anatomists and anesthesiologists), the 2-donor model, the level of interaction, and the ability to visualize anatomical structures. When asked what participants liked least about the session, some common themes included limited preparatory material, limited practice and session time, and miscellaneous facility limitations (eg, number of handwashing stations in the lab, number of available donors, age of donors). Finally, when asked what participants would like to see in the future, some common themes included more practice time, more supplementary materials, similarly structured sessions for airway and intubation content, and the use of other teaching modalities (eg, dissection, live ultrasound demonstrations).

Confidence

Participant confidence increased across all domains and increased significantly across the 14 domains. These data are summarized in Table 2.

Additionally, participants were asked to self-rate their comfort level performing major procedures (eg, regional nerve blocks) using ultrasounds after the session on a scale from 1 (*very uncomfortable*) to 5 (*very comfortable*). In the presession survey, the average level of comfort was 1.72 (SD = 1.2), and this increased significantly to 3.17 (SD = 1.0, $p < .001$) after the session.

Knowledge

Prior to the session, the average score on these questions was 3.2 points (SD = 1.0) out of 8 possible points or 40% correct. After the session, the average score was 4.5 points (SD = 1.0) out of 8 possible points or 56% correct, and this represented a significant increase in knowledge ($p = .003$). These knowledge-level questions covered either anatomical (3 questions) or ultrasound (5 questions) content. Prior to the session, the average score on the anatomy questions was 0.83 points (SD = 0.8) out of 3 possible points, and this significantly increased to 1.33 points (SD = 0.8) after the session ($p = .046$). Prior to the session, the average score on the ultrasound questions was 2.39 points (SD = 0.8) out of 5 possible points, and this significantly increased to 3.17 points (SD = 0.9) after the session ($p = .013$). Individual question performance also improved after the session though not significantly, and these data are summarized in Table 3.

Discussion

This study evaluated a supplemental learning activity for anesthesia resident physicians in their clinical base year and first clinical anesthesia year that integrated anatomical donors into hands-on ultrasound training for various regional procedures. With the increasing use of regional nerve blocks for surgery and acute pain, anesthesiology residency programs have been incorporating learning activities involving anatomical donors and ultrasound practice to improve resident comfort and proficiency.[23] This activity mirrors some of these existing activities but with the important addition of measuring the knowledge levels of the residents in the study as well as completing and discussing the procedures alongside previously dissected donors and having an undissected anatomical donor alongside it on which to practice the procedure.

Session Utility and Value

Overall, the participants found this learning activity valuable and useful. Prior to participating in the activity, most participants either *agreed* or *strongly agreed* that it would have theoretical (eg, board examinations) and practical (eg, ultrasound placement, patient positioning) utility. For adult learners, perceived utility is an important aspect of effective curriculum design.[24] Evolving residency training requirements have pushed programs to include more learning activities for their residents, and this may lead to educational inflation and burnout.[25] However, trainees are often more engaged and less burdened by activities that they feel are useful to their professional advancement.[26] High-value resident curricula should incorporate activities that have proven efficacy and perceived utility, such as the activity herein described, to create a manageable educational experience.

After completing this learning activity, participants still believed that it was theoretically and practically useful. When further asked to specify, all the participants noted that having undissected donors with prosected ones—the novel aspect of this activity—was very useful. With this approach, residents could compare the ultrasound image to the physical anatomy and apply this added knowledge to their approach for the peripheral nerve block. Through open-ended responses, many participants shared that they would like more time to practice in this setting and that they would like to practice other nonultrasound guided procedures, notably intubation, using this 2-donor model. Additionally, some participants noted that having a multidisciplinary teaching team, which, in this case, was composed of nonclinical anatomy teaching faculty and practicing anesthesiologists, was a positive aspect of this learning activity. Other learning activities for regional anesthesia techniques have used prosected anatomical donors and ultrasound in a variety of ways with documented success.[21,22] The incorporation of the undissected donor for ultrasound imaging alongside a dissected donor could represent a logical bridge between the prosected donor and the living patient, which may help contextualize the activity for residents who see patients daily or for those who did not have much

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exposure to ultrasound or anesthesiology prior to residency.

Confidence and Knowledge

In addition to generally perceiving this session as useful, participants noted that the learning activity improved their confidence with anatomical content across all 3 body regions. Specifically, participants noted that their confidence in recognizing key anatomical relationships, structures on donors, and structures on ultrasound images increased significantly after the session. Participants also reported a significant increase in confidence with ultrasound probe placement and with performing major procedures, such as nerve blocks, after the session. Whereas self-perceived confidence does not necessarily translate directly to better procedural outcomes, several studies throughout medicine demonstrate that the confidence of the proceduralist is correlated with better patient outcomes.[27,28] Allowing resident physicians to develop this confidence in a supervised and controlled environment, such as through this activity, is an important aspect of high-value clinical training.[13]

When exploring confidence and knowledge related to the use of ultrasound, it is important to also consider previous training related to point-of-care ultrasound (POCUS), especially as the participants in this study mostly noted that exposure did not begin until residency. Ultrasound has quickly become an essential tool for modern medicine, but education on the subject is still somewhat lacking in undergraduate medical education settings.[29–31] Longitudinal ultrasound courses are still uncommon despite the utility across various fields of medicine.[32,33] In a recent study exploring POCUS curricula in allopathic medical schools in the United States (n = 154), more than half of the schools had an approved POCUS curriculum, whereas only 10 offered a longitudinal 4-year curriculum.[34] This can have a major effect on the preparedness of recent medical graduates as they enter residency training in a variety of specialty fields, especially with current guidelines requiring no minimums on the number of needed POCUS exams during residency training. As such, the value for workshops similar to that presented in this study could be of great value to younger residents or even as boot camps in the later years of medical school.

Further, whereas there was no follow-up with the participants to explore retention from this session, the overall increase in participant knowledge after this activity is an important indicator of the utility of this session to clinical education. It is also notable that this learning activity appropriately emphasized basic anatomy content and clinical ultrasound content to the extent that knowledge in both spheres significantly improved. The low pretest score highlights the importance of the need for review of clinical anatomy prior to residency, and whereas there was a significant increase, this was still only to 56% accuracy. These integrated activities are important tools in medical education to better impact learner behavior and clinical practice.[35–37] It is also important to highlight that, with the significant change in performance on the knowledge assessments, that students should longitudinally revisit foundational basic science content, especially that related to the field of medicine they are entering and as the US Medical Licensing Examination step 1 exam has transitioned to pass/fail grading. Similar sessions could be used for elective courses in undergraduate medical education and boot camps for those who are going to begin an anesthesiology residency.

Limitations and Future Directions

The first limitation with this study is that this was a single session with a smaller sample size. There was also no long-term follow-up with the residents on knowledge retention, which is an area for future exploration. Additionally, whereas this activity focused on younger anesthesia residents, future iterations of it could target more advanced residents and more complex procedures. Another limitation of this study arose from the activity being somewhat resource limited compared with the number of participants; this resulted in some participants not getting as much time to explore a donor than others. Even though the participant perceptions of the activity were positive overall, this inconsistency may have skewed some responses. Future iterations of this activity could include, if available, more donors for practice or a structure that allows for consistent practice time among participants. Donor shortage can also limit the ease of procurement for these types of sessions, and it is important to maximize their gift. As such, for this pilot session, the prosected donors were from a dissection course that was previously taught and that the anatomy faculty further prepared for a clean prosection, and the undissected donors were those received for a dissection course scheduled to begin shortly after this anesthesiology session. The ultrasound imaging component of the session could also be done on living standardized patients. For the practice of the ultrasound and needle placement on the undissected donors, additional teaching faculty or more advanced residents could allow for more practice time and a better student-to-faculty ratio. Also, whereas this session gave all participants a chance to practice ultrasound related to peripheral nerve blocks, there was no formative or summative objective structured clinical examination to measure performance. Collectively, additional resources would give students more hands-on time with the probes and to be able to interpret the ultrasound images to review the anatomy, which could possibly further improve the knowledge acquired from the session. Overall, the pilot session was positively received and has been scheduled to be repeated in the future for CA-0 and CA-1 residents as well as CA-2 and CA-3 residents.

Additionally, given the feedback from participants during this study, a future direction for this work could be the use of the undissected-prosected anatomical donor model to provide learning experiences for other procedures within and beyond anesthesiology, including intubation, airway blocks, lumbar puncture, and chest tube placement. Finally, an important next step for this particular study is to interrogate the participants' confidence and proficiency with regional nerve blocks in their clinical practice with living patients.

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The authors are at the Rutgers New Jersey Medical School in Newark, NJ. ***Adarsh Menon*** *is a Resident Physician in the Department of Anesthesiology;* ***Rijul Asri*** *is a Resident Physician in the Department of Psychiatry;* ***Jeremy J. Grachan*** *is an Assistant Professor in the Department of Medicine;* ***Jean D. Eloy*** *is the Clinical Vice Chair of the Department of Anesthesiology;* ***George Holan*** *is an Assistant Professor in the Departments of Medicine and Surgery.*

Corresponding author: *Jeremy J. Grachan, PhD, Office of Education, Department of Medicine, 185 South Orange Avenue, MSB B-517, Newark, NJ 07103.*

Email address: *Jeremy J. Grachan: Jg1916@njms.rutgers.edu*

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Abstract

Background: Ultrasound is a modern foundational tool used by anesthesiologists for peripheral nerve blocks. Clinicians performing hands-on ultrasound training on patients presents unique challenges, and the use of human anatomical donors has become a common substitute. With that, whereas ultrasound training sessions are common, they do not often include basic science anatomy reviews. This study explores an anatomist-led clinical anatomy review and physician-led ultrasound training session for first (n = 7) and second (n = 11) year anesthesiology residents.

Methods: Residents attended a 2-hour anatomy review on prosected anatomical donors by anatomists prior to physicians facilitating an ultrasound-guided peripheral nerve block training session on undissected donors. The session covered the interscalene, supraclavicular, femoral, sciatic, and transversus abdominis plane ultrasound-guided peripheral nerve blocks. Data was collected using presurveys and postsurveys and assessments and analyzed.

Results: The session was found to be useful and significantly improved the residents' confidence across 14 domains related to the anatomy and approach to ultrasound for the given peripheral nerve blocks. All the participants (18, 100%) felt it was very useful having undissected anatomical donors side by side to dissected ones during the session. Knowledge acquisition also improved based on the significant increase in score on the 8-question assessment (p = .003).

Conclusions: The residents found this activity valuable and useful, especially learning from both undissected and prosected donors. With this approach, residents could compare the ultrasound image to the physical anatomy, which led to an increase in the residents' knowledge and confidence.

Keywords: Gross anatomy, ultrasound, anesthesiology residency, anatomical donors, peripheral nerve blocks

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Figures

Figure 1. *Self-reported levels (n = 18) of comfort completing minor (eg, central lines, arterial lines, venous lines), moderate (eg, echocardiography, FAST examinations), and major (eg, regional nerve blocks) ultrasound-based procedures prior to participating in the session.*

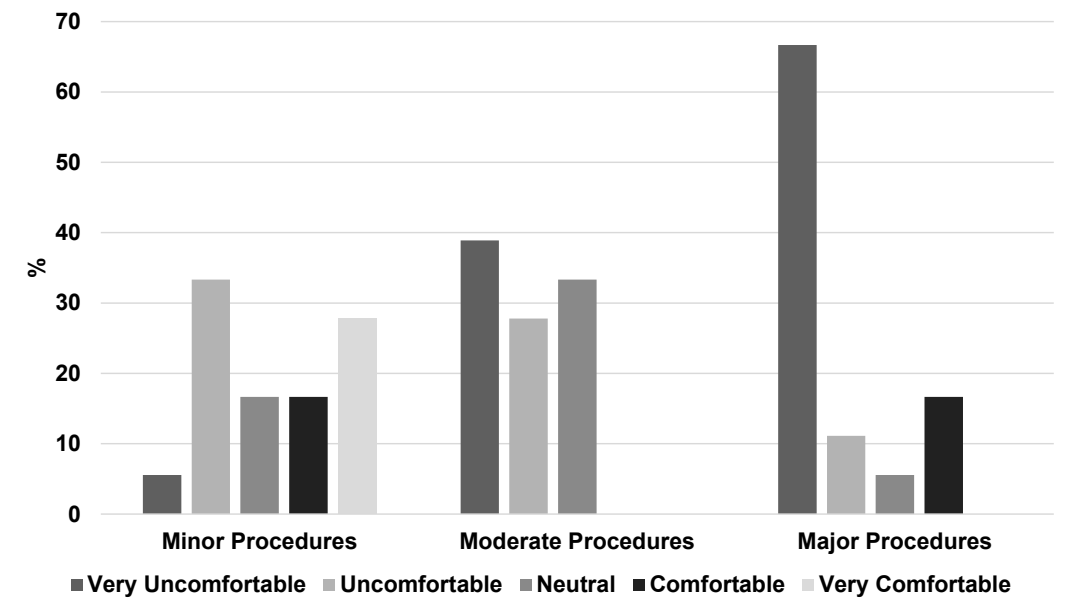
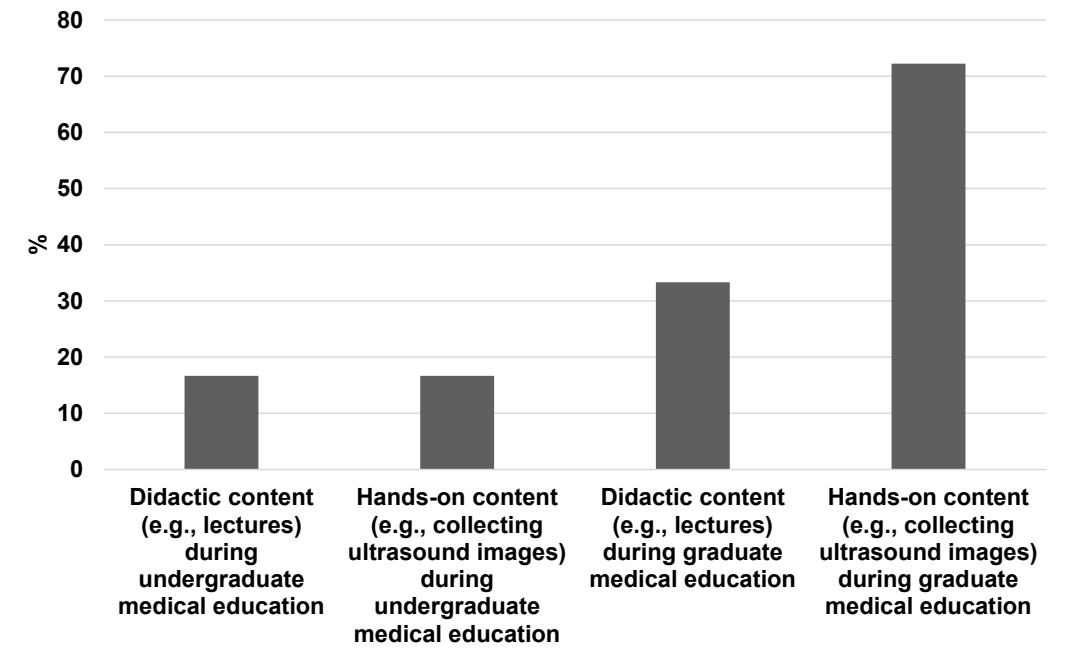


Figure 2. *Sources of previous ultrasound training experience for this specific participant group (n = 18). Participants could select all that applied.*



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Tables

Table 1. *Overview of Clinical Anatomy and Ultrasound Review Session*

Station	Anatomical Structures	Prosections	Peripheral Nerve Blocks	Clinical Anatomy Highlights	Ultrasound Structures
Brachial Plexus	Brachial plexus roots, trunks, divisions, cords, and branches; upper limb muscular compartment; major cutaneous nerves	One whole body donor with the limbs prosected, the left side prosected to show each part of the brachial plexus (anterior scalene muscle removed), and the right side showing the brachial plexus emerging from the interscalene triangle	Interscalene block	Cervical nerve root anesthesia that does not reach C7 or C8; primarily targets proximal arm and shoulder; phrenic nerve is at risk	Anterior scalene, middle scalene, common carotid artery, vertebral artery, brachial plexus, transducer position on lateral neck
			Supraclavicular block	Primarily targets the midarm and forearm; less consistent coverage of the shoulder	Clavicle, apical pleura, innominate and subclavian artery, brachial plexus
Lumbosacral Plexus	Lumbar plexus; sacral plexus; femoral triangle and its contents (eg, femoral nerve); lower limb muscular compartment and gluteal region; major cutaneous nerves	Donor #1: supine, limbs prosected, left side prosected to show each part of the lumbar plexus (psoas major muscle removed) and the right side showing the lumbar plexus branches and their positions in situ (psoas major intact); donor #2: supine, pelvis bisected; 1 limb prosected to show the sacral plexus; other limb in a prone position to show the sciatic nerve and its branches	Femoral nerve block	Femoral nerve block targets anterior and medial thigh and a strip of skin on the medial leg and foot; femoral nerve is the most lateral structure within the femoral triangle	Femoral nerve, artery, vein; sartorius muscle; pectineus muscle; adductor magnus; adductor longus; saphenous nerve; iliopsoas
			Sciatic nerve block	Sciatic nerve block targets the posterior aspect of the lower limb with the exception the saphenous nerve territory; posterior aspect of the thigh is supplied by the posterior femoral cutaneous nerve, which branches from the sciatic nerve proximal to the level of the anterior nerve block approach and is, therefore, not blocked	Transducer position: anterior approach: transverse on the proximal medial thigh • Trans gluteal approach: transverse on the posterior buttock, between the ischial tuberosity and greater trochanter • Subgluteal approach: transverse on the gluteal crease

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Tables *continued*

Abdominal Wall	Muscular and connective tissue layers of the abdominal wall from superficial to deep; major cutaneous nerves, namely the iliohypogastric and ilioinguinal nerves	One whole body donor with the abdominal cavity opened and each muscle of the anterior abdominal wall dissected out to highlight structures from superficial to deep; subcostal, iliohypogastric, and ilioinguinal nerves	Transversus abdominis plane (TAP) block	TAP block is a dermatomal sensory block of the lower thoracic and upper lumbar afferents to anesthetize the anterior abdominal wall on the respective side; cutaneous nerves typically travel between the internal abdominal oblique and transversus abdominis muscles; parietal peritoneum is the deepest layer and the needle piercing it is unacceptable	• External oblique • Internal oblique • Transversus abdominis • Peritoneum

Table 2. *Changes in Self-Reported Confidence Across a Variety of Anatomical and Ultrasound Knowledge-Based Domains*

Domain	Presurvey			Postsurvey			p^a
	M	SD	95% CI	M	SD	95% CI	
Brachial Plexus Content							
Key regional relationships of anatomical structures	1.94	0.7	[1.58, 2.31]	2.44	0.5	[2.19, 2.70]	.013
Identifying anatomical structures on donors	1.94	0.6	[1.63, 2.26]	2.56	0.6	[2.25, 2.86]	.002
Identifying anatomical structures on US imaging	1.89	0.8	[1.51, 2.27]	2.61	0.7	[2.26, 2.96]	<.001
Ultrasound placement for interscalene nerve block	1.56	0.9	[1.13, 1.98]	3	0.8	[2.62, 3.38]	<.001
Ultrasound placement for supraclavicular nerve block	1.33	0.7	[0.99, 1.67]	2.78	0.9	[2.34, 3.21]	<.001
Lumbosacral Plexus Content							
Key regional relationships of anatomical structures	1.56	0.8	[1.17, 1.95]	2.39	0.5	[2.14, 2.64]	.002
Identifying anatomical structures on donors	1.5	0.6	[1.19, 1.81]	2.33	0.6	[2.04, 2.63]	<.001
Identifying anatomical structures on US imaging	1.5	0.7	[1.15, 1.85]	2.44	0.7	[2.09, 2.79]	<.001
Ultrasound placement for femoral nerve block	1.83	0.9	[1.41, 2.26]	2.78	0.6	[2.46, 3.10]	.002
Ultrasound placement for sciatic nerve block	1.39	0.6	[1.09, 1.69]	2.61	0.8	[2.22, 3.00]	<.001
Abdominal Wall Content							
Key regional relationships of anatomical structures	1.83	0.7	[1.48, 2.18]	2.89	0.8	[2.51, 3.27]	<.001
Identifying anatomical structures on donors	1.72	0.7	[1.39, 2.05]	2.83	0.8	[2.44, 3.22]	.001
Identifying anatomical structures on US imaging	1.89	0.7	[1.55, 2.23]	2.94	0.7	[2.58, 3.31]	<.001
Ultrasound placement for transversus abdominis plane block	2.06	0.8	[1.66, 2.45]	2.94	0.7	[2.58, 3.31]	.001

Abbreviations: CI, confidence interval; US, ultrasound.

[a] Comparisons interrogated using Wilcoxon signed rank tests (n = 18).

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Tables *continued*

Table 3. *Changes in Knowledge Represented by Individual Question Performance Changes and Overall Knowledge-Check Changes*

Question	Presurvey			Postsurvey			*p*[a]
	M	SD	95% CI	M	SD	95% CI	
Brachial Plexus Content							
Which of the following is correct regarding the brachial plexus and its branches?	0.17	0.4	[-0.02, 0.36]	0.44	0.5	[0.19, 0.70]	.059
In most cases, which of the following nerve roots would not be anesthetized using an interscalene block?	0.28	0.5	[0.05, 0.51]	0.5	0.5	[0.24, 0.76]	.157
In most cases, which of the following regions would not be anesthetized using a supraclavicular nerve block?	0.44	0.5	[0.19, 0.70]	0.67	0.5	[0.43, 0.91]	.104
Lumbosacral Plexus Content							
Which of the following is correct regarding the lumbosacral plexus and its branches?	0.17	0.4	[-0.02, 0.36]	0.33	0.5	[0.09, 0.57]	.257
In most cases, which of the following regions would not be anesthetized using a femoral nerve block?	0.33	0.5	[0.09, 0.57]	0.39	0.5	[0.14, 0.64]	.655
In most cases, which of the following regions would not be anesthetized using a sciatic nerve block?	0.44	0.5	[0.19, 0.70]	0.67	0.5	[0.43, 0.91]	.157
Abdominal Wall Content							
Which of the following is correct regarding the anterolateral abdominal wall?	0.5	0.5	[0.24, 0.76]	0.56	0.5	[0.30, 0.81]	.564
In most cases, which of the following dermatomes would not be anesthetized using a transversus abdominis plane block?	0.89	0.3	[0.73, 1.05]	0.94	0.2	[0.83, 1.06]	.317
Total performance	0.40	0.1	[2.72, 3.72]	0.56	0.1	[3.98, 5.02]	.003

[a] Comparisons interrogated using Wilcoxon signed rank test (n = 18).