A Regional Anesthesia Cadaver Dissection Laboratory

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Introduction:

Success in regional anesthesia is dependent upon three-dimensional insight and well developed eye-hand coordination, in order to place a needle accurately into the proximity of unseen nerves or nerve plexuses. Reliable delivery of local anesthetics to target nerves requires thorough understanding of the involved anatomic structures (1). A cadaver dissection laboratory was created for the University of Pittsburgh School of Medicine Anesthesiology Residency in order to improve residents' understanding of anatomy relevant to upper and lower extremity peripheral nerve blockade, and neuraxial anesthesia. This educational study was developed to assess the impact of the laboratory experience on residents' knowledge base in anatomy, through comparison of pretest and posttest scores, as well as resident responses to a feedback survey.

Materials and Methods:

This educational exercise is conducted with the approval and assistance of the department of anatomy at the University of Pittsburgh School of Medicine. Before participation, each resident participant is required to read an educational investigation script, defining the purpose of the study and assuring anonymity if publication of results should occur. The script allows any concerned individual to decline participation in the investigation, and makes clear that this decision will not affect the individual's participation in the laboratory itself. These considerations are in concert with the requirements of the University of Pittsburgh Institutional Review Board, which evaluated and approved this educational investigation.

In order to provide a more thorough instruction in anatomy related to regional anesthesia, and inculcate anatomy principles presented in the didactic curriculum of the regional/ambulatory anesthesia resident rotation, a cadaver dissection laboratory was instituted. The laboratory, held once each quarter, is a one-day exercise in dissection of the neck, pectoral girdle, upper and lower extremities and spine.

Cadavers are obtained from the University's Human Gift program, which manages donations of bodies for anatomic study. The specimens utilized for the laboratory are recently deceased (within two to three weeks), and preserved with formalin. After the laboratory, the specimens are cremated.

The resident participants in the laboratory are those who have rotated on the regional/ambulatory month (our core rotation) or those who have rotated through the elective advanced regional month (having previously completed the core rotation) within the prior three months. All of the residents have received similar baseline instruction in anatomy during the core rotation, including the areas covered on the test before and after the laboratory exercise. During the core rotation, residents are assigned to the operating room for primarily orthopedic cases, and they provide preoperative nerve blocks for their cases. The number of blocks performed ranges from from 60 to 100, consisting of interscalene, femoral, popliteal fossa, sciatic and axillary blocks. During the elective, advanced, regional month, residents are part of a block/acute pain team, providing blocks and inserting catheters for management of postoperative pain in surgical inpatients, without responsibilities in the operating room.

Before each dissection lab is begun, the resident participants are assembled for a brief presentation on dissection techniques, safety issues and the itinerary for the day. The structures to be isolated are outlined. The educational research script is then distributed, and residents take an eight question, fill-in-the-blank pre-test, comprised of questions based upon anatomy teachings stressed during the didactic portion of the core regional anesthesia/ambulatory anesthesia rotation (see Appendix).

Dissection is carried out by the residents in teams of two. Sharp and blunt dissection are used to reflect the skin and superficial fascia, and then to enter investing fascia, revealing the neurovascular bundles, nerve plexuses, or their connective tissue sheaths. Two pairs of residents dissect either side of the neck, and the pectoral girdles and arms, while two other pairs of residents dissect the femoral triangle, anterior thigh and anterior ankle on both legs simultaneously. After several hours, the exposed structures of the upper and lower extremity are reviewed by the entire group. After a mid-day break, the cadaver is placed prone, and two teams of residents dissect the gluteal and upper thigh region, while two other teams explore the popliteal fossa, calf area and posterior ankle. Thereafter, the thoracic and lumbar spines are dissected. Details of the areas dissected, structures sought and nerve block correlates are shown in Table 1A, in the appendix.

Throughout the exercise, faculty instructors help the residents with dissection and recognition of pertinent structures. Participants have the opportunity to practice lumbar and thoracic epidurals, subarachnoid needle placement and peripheral nerve catheter placement, dissecting to the level of the needle or catheter to appreciate which tissues are traversed by the needle, and which local structures provide resistance. A prosected, preserved catheter from prior dissections by the author is on display in the same area to allow ongoing example and instruction. In this specimen, the author has dissected on one side the interscalene and supraclavicular regions, the infraclavicular and axillary areas, and the femoral, gluteal and popliteal fossa regions. In addition, anatomy specimens and anatomic models of the anatomy department's "museum" are accessible nearby, allowing comparison of dissection to labeled, pre-dissected specimens. Atlases, anatomy textbooks and dissection manuals are all provided as well.

As the day progresses, anatomy concepts are reviewed by the faculty mentors. The subject areas covered by the pretest are reviewed, among many others. These subjects relate to pertinent anatomy points made in regional anesthesia atlases and to the didactic curriculum of the regional anesthesia core rotation.

At the conclusion of the dissection, a debriefing meeting is held between the residents and the faculty mentors. After all concerns are addressed, the residents then take an eight question post-test. These questions are identical to the questions on the pretest, though the residents have not been made aware of this. A satisfaction survey for the course is completed by participants after the post-test is completed. This is comprised of five evaluation questions, to be scored using a five point scale (one equates to an evaluation of "least favorable" and five to "most favorable"). No other anchors were used for this scale.

Scores on the pre-tests and post-tests are compared for significant differences. The evaluators are blinded to the residents' identities. A test of proportions has been used to evaluate for significant differences.

Results:

To this point, the quarterly cadaver dissection laboratory has been held four times with a total of 30 resident participants. Of these, 24 had participated in the core rotation, and six had elected the advanced rotation, having previously experienced the core rotation. On the anatomy pre-test, out of eight questions, the average score was 2.6 (+/-1.3, SD; range 0-4) correct. After participation in the dissection exercise, scores on the post-test improved significantly to a mean of 6.3 (+/-1.3, SD; range 4-8) correct responses out of 8 ($p<.05$).

The results of the resident satisfaction survey are presented in Table 1 as the numerical score out of a possible five in each category. In general, residents rated the quality of this educational experience highly.

Discussion:

The impact of regional anesthesia techniques on outcome is favorable in a variety of ways, including pain control, postoperative recovery, earlier discharge from the hospital, and reduced side effects of opioids (2). Surveys of teaching programs suggest that 30% of anesthetics delivered in the U.S. incorporate regional anesthetic techniques (3). However, teaching the skills and knowledge of regional anesthesia is difficult, and involves a protracted learning curve (4). Some studies suggest that residencies in this country do not provide sufficient exposure to regional anesthesia, in particular peripheral nerve blockade (5).

Proficiency in regional anesthesia must rest firmly on a foundation of the understanding of anatomy (6), as these techniques presuppose an understanding of the relationship of target structures and surrounding tissues. Current trends in medical schools are to reduce the time spent dissecting in gross anatomy, in order to make room in the undergraduate medical curriculum for the teaching of new therapies and concepts (7). This change in focus in anatomy education has resulted in application of novel means of instruction, utilizing imaging, prosection and electronic media to improve the efficiency of education in this area. (8). Attempts to optimize instruction in regional anesthesia may benefit from a return to the anatomy lab, allowing residents to focus on anatomic relationships and the three dimensional arrangements of the nerves to be anesthetized (7). Whether actual dissection is superior to viewing of prosected specimens and anatomic models is uncertain. The laboratory exercise described here requires a full day of instruction and dissection, but other, more efficient exercises may also be possible. For instance, prosected and plastinated specimens, along with computer-aided instruction aids, such as three-dimensional virtual reality anatomy simulations could be utilized (9).

The use of dissection, prosection and anatomic study with cadavers have proven valuable in other specialties. Surgeons have successfully utilized cadaver models for training house staff in surgical techniques and invasive procedures, such as laparoscopy (10). Radiology residents benefit from imaging studies performed on cadavers and which are then compared to the prosected anatomy (11).

In this study, the residents evaluated had relatively poor retention of anatomic principles presented to them in the prior months (during the regional anesthesia rotation), as assessed on an eight question pre-test. After spending one day dissecting a cadaver, along with ongoing instruction in anatomy by faculty members, performance on a post-test was significantly improved. Resident feedback on a 5 point evaluation scale suggests that the laboratory experience was valuable, with a perceived enhancement of anatomic relationships and a predicted improvement in performance.

A number of limitations of this study warrant discussion. In order to directly compare performance on the pretest and post-test, the same questions were used before and after the laboratory. This can lead to learning from the questions themselves, with improved performance on the post-test, as opposed to a generalized improvement in knowledge base. And, while an immediate improvement in anatomy knowledge is suggested by the results of this study, it is not clear that this will translate into improved nerve block skills in the clinical realm. Further, re-testing the residents three or six months after the laboratory exercise would reflect long-term retention, which is not addressed in this study. Comparison of the test scores achieved by participants to those of a control group of non-participants (who had undergone testing but no dissection laboratory) may also provide insight into the value of this educational experience.

In order to address some of these limitations, the resident regional anesthesia anatomy experience will be modified in the future. Plans include an incorporation of the laboratory time into the core rotation itself, so that participants are not months removed from the initial anatomy teaching. Rather than utilizing an entire cadaver, individual limbs will be prosected, and kept frozen between sessions. As anatomy concepts are presented, they will be reviewed on the prosected limbs in three dimensions. Ultrasonography will also be incorporated into the laboratory, to allow residents to review the expected appearance of peripheral nerves at various sites of blockade, and to practice needle guidance to target structures. Rather than dedicating an entire day to the anatomy lab, residents will spend multiple one-hour sessions learning anatomy during the rotation, at the end of the clinical day.

Conclusion:

A cadaver dissection laboratory was instituted in our residency program in order to enhance resident knowledge of regional anesthesia-related anatomy. Evaluation suggests that there is significant short-term enhancement of anatomy knowledge after participation in the one-day exercise. Residents' perceptions of the value of the experience are highly favorable. Initial experience with the dissection laboratory has led to the incorporation of specific improvements and learning processes in the future.

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Table 1. Resident Satisfaction Survey Scores (1= least favorable, 5=most favorable)

Survey Question	**Mean Response Score**
How would you rate the quality of teaching?	4.96 (+/-0.19, SD)
Was knowledge of anatomy improved?	4.55 (+/-0.34, SD)
Were skills in nerve blockade enhanced?	4.50 (+/-0.44, SD)
Was patient safety favorably affected?	4.65 (+/-0.43, SD)
Would you recommend the lab to others?	4.96 (+/-0.19, SD)

Appendix

Table A1. Dissection Goals for Resident Participants in the Cadaver Laboratory

Region of Dissection	Structures to be Exposed	Nerve Block Correlate
Lateral Neck	Nerve Roots C5-T1	Interscalene Block
	Brachial Plexus Trunks	
	Carotid Sheath	
	Scalene Muscles	
	Superficial Cervical Plexus	
Supraclavicular Fossa	Brachial Plexus Divisions	Supraclavicular Block
	Subclavian Artery, Vein	
	First Rib	
	Lung Apex	
Infraclavicular Fossa	Clavicle, coracoid process	Infraclavicular Blocks
	Axillary Vessels	
	Cords of Brachial Plexus	
	Terminal Nerves of Plexus	
Axilla	Axillary Artery/Vein	Axillary Block
	Terminal Nerves of Plexus	
	Fascial Neurovascular Sheath	
Medial Humerus	Intermuscular Septum	Midhumeral Block
	Axillary Artery/ Vein	
	Median, Ulnar Nerves	
	Musculocutaneous Nerve	
	Radial Nerve	
	Humeral Shaft	
Elbow	Biceps Tendon	Peripheral Blocks at the Elbow

Table A1. *Continued*

	Brachioradialis Muscle	
	Radial Nerve	
	Brachial Artery, Vein	
	Median Nerve	
	Sulcus Ulnaris	
Femoral Triangle	Fascia Lata and Iliacus	Femoral, Lateral Femoral
	Femoral Vascular Sheath	Cutaneous, Obturator Blocks
	Femoral Artery, Vein	
	Saphenous Vein	
	Femoral Nerve	
	Lateral Femoral Cutaneous	
	Nerve	
	Obturator Nerve	
	Saphenous Nerve	
	Nerves to Sartorius	
Ankle	Peroneal Tendons	Ankle Block
	Tibialis Tendon	
	Extensor Hallicus Longus	
	Tendon	
	Medial/Lateral Malleolus	
	Superficial Peroneal Nerve	
Ankle	Deep Peroneal Nerve	Ankle Block
	Posterior Tibial Nerve	
Gluteal	Gluteal Muscles, Vessels	Sciatic Block
	Ischial Tuberosity	
	Greater Trochanter	
	Posterior Iliac Spines	

Table A1. *Continued*

	Sciatic Nerve	
	Pyriformis Muscle	
Popliteal Fossa	Biceps Femoris Tendon	Popliteal Block
	Semitendinosus Tendon	
	Popliteal Vein, Artery	
	Tibial Nerve	
	Common Peroneal Nerve	
Thoracic Spine	Spinous Processes	Thoracic Epidural
	Epidural Space	
Lumbar Spine	Spinous Processes	Lumbar Epidural
	Laminae	Subarachnoid Block
	Transverse Processes	Lumbar Paravertebral
	Paravertebral Space	Lumbar Plexus Block
	Epidural Space	
	Dura Mater	
	Subarachnoid Space	
	Lumbar Nerve Roots	
	Psoas Muscle	
	Lumbar Plexus	

Table A 2. Pretest/Posttest Questions for Anatomy Laboratory Exercise

1. Which trunk of the brachial plexus is usually stimulated during the interscalene block?
2. Where is the subclavian artery in relation to the brachial plexus, at the level of the interscalene groove.
3. Which cords contribute to the formation of the median nerve?
4. What two terminal nerve branches does the posterior cord give rise to?
5. Name the two overlying fascia planes covering the femoral nerve below the inguinal ligament.
6. What motor branch arises from the superficial portion of the femoral nerve?
7. What is the approximate distance of the sciatic nerve from the midline at the level of the mid-gluteal cleft, in most patients?
8. What sensory nerve runs with the sciatic nerve as it exits the pelvis?