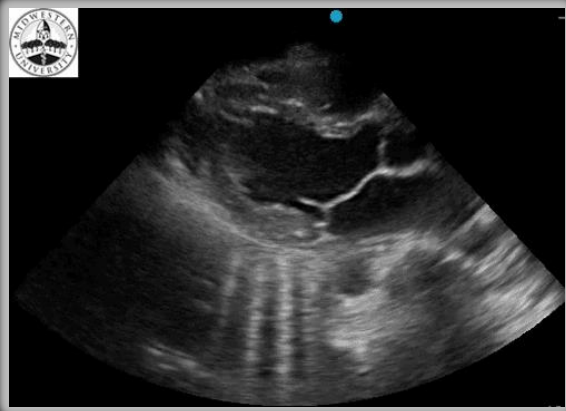


Ultrasound in the First Two Years of Medical School: Enhanced Anatomical Learning via Clinically-Based, Hands-On Workshops

A presentation at the 2020 American Association for Anatomy meeting, Experimental Biology



Randall L. Nydam, PhD*; Charles Finch, DO*; Erin L. R. Simons, PhD*†; K.E. Beth Townsend, PhD*†; Wade Grow, PhD*†

*Arizona College of Osteopathic Medicine, Midwestern University; †College of Graduate Studies, Midwestern University

CONTACT: rnydam@midwester.edu





AZCOM Ultrasound education—The development of a preclinical curriculum

PRIOR TO FALL 2017...

Ultrasound instruction in preclinical osteopathic medical education was restricted to a single workshop in the Introduction to Clerkship course at the end of the second year. There was also infrequent use of imagery in a small number of lectures in clinical courses.

We now have numerous courses in the first and second year curriculum that provide our students with a variety of hands-on ultrasound education and training ([see page 25](#)). This permits a greater use of clinical scenarios to reinforce course objectives.

What follows is a brief description of the process, timeline, and resulting curriculum with an emphasis on the anatomy course and the associated survey of students of that course.

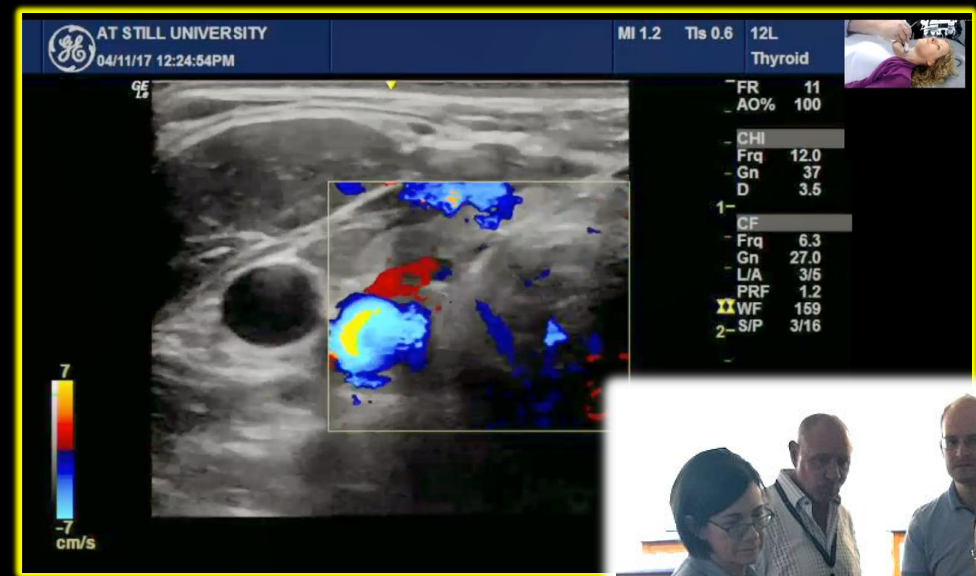
December 2016—First meeting of the Ultrasound Development Subcommittee

January 2017—Begin meetings of *faculty for both pre-clinical and clinical education* to determine how US will be taught in these portions of the curriculum. Early conclusion is need for faculty training in ultrasound before development of curriculum. [See page 5.](#)

February 2017—Collaborative (A.T. Still-SOMA, MWU-AZCOM) monthly faculty development series begins—*faculty presented demonstrations and hands-on exercises with ultrasound examinations*. Determined that real ultrasound machines should be used most aspects of early student education.

March–July 2017—Faculty development series continues. *Clinical and Pre-clinical working groups discuss and develop US-based curricular changes to specific course disciplines*. Primary goal is integration of USMED into existing curriculum; preferred to adding a new course(S) to the curriculum, or, making broad scale changes to the overall curricular structure.

August 2017—Preclinical portions of the new *ultrasound curriculum launch* in the MS1 Anatomy; Introduction to Clinical Medicine (ICM) I, II; Osteopathic Manipulative Medicine (OMM) I, II. [See page 8.](#)



Ultrasound in medical education (USMED) has a demonstrated positive impact on student performance.



- Dinh, V. A., J. Y. Fu, S. Lu, A. Chiem, J. C. Fox, and M. Blaivas. 2016. *Integration of Ultrasound in Medical Education at United States Medical Schools*. Journal of Ultrasound in Medicine 35:413-419. 10.7863/ultra.15.05073
- Gogalniceanu, P., Y. Sheena, E. Kashef, S. Purkayastha, A. Darzi, and P. Paraskeva. 2010. *Is Basic Emergency Ultrasound Training Feasible as Part of Standard Undergraduate Medical Education?* Journal of Surgical Education 67:152-156. <http://dx.doi.org/10.1016/j.jsurg.2010.02.008>
- Heinzow, H. S., H. Friederichs, P. Lenz, A. Schmedt, J. C. Becker, K. Hengst, B. Marschall, and D. Domagk. 2013. *Teaching ultrasound in a curricular course according to certified EFSUMB standards during undergraduate medical education: a prospective study*. BMC Medical Education 13:84. 10.1186/1472-6920-13-84
- Hoppmann, R. A., V. V. Rao, M. B. Poston, D. B. Howe, P. S. Hunt, S. D. Fowler, L. E. Paulman, J. R. Wells, N. A. Richeson, P. V. Catalana, L. K. Thomas, L. Britt Wilson, T. Cook, S. Riffle, F. H. Neuffer, J. B. McCallum, B. D. Keisler, R. S. Brown, A. R. Gregg, K. M. Sims, C. K. Powell, M. D. Garber, J. E. Morrison, W. B. Owens, K. A. Carnevale, W. R. Jennings, and S. Fletcher. 2011. *An integrated ultrasound curriculum (iUSC) for medical students: 4-year experience*. Critical Ultrasound Journal 3:1-12. 10.1007/s13089-011-0052-9
- Mason, N. L., J. Puglisi, A. Mullen, and B. Kim. 2017. *Evaluation of a New Temporally and Fiscally Economical Ultrasound Training Program for First-Year Medical Students*. The FASEB Journal 31:581.13.
- Swamy, M., and R. F. Searle. 2012. *Anatomy teaching with portable ultrasound to medical students*. BMC Medical Education 12:99. 10.1186/1472-6920-12-99
- Teichgräber, U. K. M., J. M. A. Meyer, C. P. Nautrup, and D. B. von Rautenfeld. 1996. *Ultrasound anatomy: a practical teaching system in human gross anatomy*. Medical Education 30:296-298. 10.1111/j.1365-2923.1996.tb00832.x



3. JANUARY 2017: MWU AZCOM faculty examined possible modalities for ultrasound integration
 - a. Determined best strategy was incorporation into existing courses
 - i. Eliminates need for additional courses in an already dense curriculum
 - ii. Ultrasound used to meet/reinforce existing course objectives
 - iii. Allowed for a continual experiences through preclinical years (not just 1-2 courses)
 - b. Not all courses appropriate for ultrasound (e.g., biochemistry, microbiology, pharmacology)
 - c. Ultrasound in Anatomy was, of course, a logical course in which to include ultrasound
 - i. Many published examples of ultrasound instruction in anatomy...

Some with limited regional coverage (e.g., ≤ 3 body regions).

Bell III, F. E., F. H. Neuffer, T. R. Haddad, J. C. Epps, M. E. Kozik, and B. C. Warren. 2019. *Active Learning of the Floor of Mouth Anatomy with Ultrasound*. *Anat Sci Educ* 12:310-316. 10.1002/ase.1839

Brown, B., S. Adhikari, J. Marx, L. Lander, and G. L. Todd. 2012. *Introduction of Ultrasound into Gross Anatomy Curriculum: Perceptions of Medical Students*. *The Journal of Emergency Medicine* 43:1098-1102.
<http://dx.doi.org/10.1016/j.jemermed.2012.01.041>

Swamy, M., and R. F. Searle. 2012. *Anatomy teaching with portable ultrasound to medical students*. *BMC Medical Education* 12:99. 10.1186/1472-6920-12-99

Teichgräber, U. K. M., J. M. A. Meyer, C. P. Nautrup, and D. B. von Rautenfeld. 1996. *Ultrasound anatomy: a practical teaching system in human gross anatomy*. *Medical Education* 30:296-298. 10.1111/j.1365-2923.1996.tb00832.x

Some with more extensive regional coverage (e.g., > 3 body regions).

- Dreher, S. M., R. DePhilip, and D. Bahner. 2014. *Ultrasound Exposure During Gross Anatomy*. The Journal of Emergency Medicine 46:231-240. <http://dx.doi.org/10.1016/j.jemermed.2013.08.028>
- Hoppmann, R. A., V. V. Rao, M. B. Poston, D. B. Howe, P. S. Hunt, S. D. Fowler, L. E. Paulman, J. R. Wells, N. A. Richeson, P. V. Catalana, L. K. Thomas, L. Britt Wilson, T. Cook, S. Riffle, F. H. Neuffer, J. B. McCallum, B. D. Keisler, R. S. Brown, A. R. Gregg, K. M. Sims, C. K. Powell, M. D. Garber, J. E. Morrison, W. B. Owens, K. A. Carnevale, W. R. Jennings, and S. Fletcher. 2011. *An integrated ultrasound curriculum (iUSC) for medical students: 4-year experience*. Critical Ultrasound Journal 3:1-12. [10.1007/s13089-011-0052-9](https://doi.org/10.1007/s13089-011-0052-9)
- Luetmer, M. T., B. A. Cloud, J. W. Youdas, W. Pawlina, and N. Lachman. 2018. *Simulating the multi-disciplinary care team approach: Enhancing student understanding of anatomy through an ultrasound-anchored interprofessional session*. Anat Sci Educ 11:94-99. [10.1002/ase.1731](https://doi.org/10.1002/ase.1731)
- Rao, S., L. van Holsbeeck, J. L. Musial, A. Parker, J. A. Bouffard, P. Bridge, M. Jackson, and S. A. Dulchavsky. 2008. *A pilot study of comprehensive ultrasound education at the Wayne State University School of Medicine: a pioneer year review*. J Ultrasound Med 27.
- Smith, J. P., J. L. Kendall, and D. F. Royer. 2018. *Improved medical student perception of ultrasound using a paired anatomy teaching assistant and clinician teaching model*. Anat Sci Educ 11:175-184. [10.1002/ase.1722](https://doi.org/10.1002/ase.1722)

4. JULY 2017: Launch of ultrasound workshops in Anatomy course
 - a. Used established workshop schedule: A, B, C groups that each attend lab one day per week
 - b. Added ultrasound workshop day to unit (1 day every ~3 weeks)
 - c. Set up groups for 10 per station. Changed to 5 per station with addition of more machines in 2018.
 - d. Credit hour concern: reduced each exam unit by one lecture hour to accommodate additional contact hours of workshop
 - By 2018 this resulted in net reduction of contact hours by 0.5 for each quarter, but associated increase in active-learning, hands-on activity.

THE ANATOMY COURSE—summary of delivery

2 quarters (13-week fall quarter; 10-week winter quarter)

- ~290 students (integrated AZCOM-AZPOD)

- 8 regional exam units (4 per quarter; non-cumulative)

- Dissection-based; 3 non-overlapping dissection groups (A, B, C)

 - EXAMPLE: If A in dissection then B + C on open study time

 - This system provided a natural opening ultrasound workshops



Ultrasound workshop organization

1. Uses dissection A, B, C groups (approximately 95 students each); each group split in half (A1, A2, B1, B2, etc.) for six workshop groups
2. 10 ultrasound machines (5 students per machine)
3. 1-hour workshop per exam unit; three days, twice per day to accommodate all six groups
4. Workshops placed near end of unit to maximize anatomical knowledge prior to scanning
5. Students sign waiver stating scanning is educational only, not diagnostic. Need to see their physician if concerned about scan.



Fall Quarter Ultrasound Workshops



Exam Unit	Lecture Hours	Dissection Hours	Ultrasound Workshop Clinical Scenario	Anatomy Orientation/Identification Objectives	Notes
Back & Scapular Region	8	15	Lumbar Puncture	Lumbar vertebra, anterior/posterior complexes, ligamentum flavum, interlaminar space, epidural space, subarachnoid space, erector spinae muscles.	<p>Introduction of basic function, operation, image orientation. Orientation and identification of vertebral and muscular anatomy in transverse and sagittal planes.</p> <p>Artifacts: ring-down, acoustic shadow.</p> <p>Continued in OMM course with back muscles.</p>
Upper Extremity	8	15	<p>Carpal Tunnel Syndrome</p> <p>Shoulder Assessment</p>	<p>Carpal bones, FPL, FDS, FDP tendons, flexor retinaculum, median & ulnar nerves, ulnar artery.</p> <p>Proximal humerus, acromion, biceps brachii, SITS muscles, regional ligaments.</p>	<p>Anatomy of carpal tunnel in transverse and sagittal planes; anatomy of glenohumeral region and SITS tendons. Measurement of the cross-sectional diameter and area of median nerve, Doppler assessment of vasculature.</p> <p>Artifacts: anisotropy, acoustic shadow.</p> <p>Continued in OMM course with shoulder and elbow.</p>
Thorax	7	15	Cardiac Assessment	Cardiac anatomy (ventricles, atria, valves, septa), pericardium, pericardial space. Ascending, proximal descending aorta.	<p>Orientation to cardiac anatomy in <i>apical</i>, <i>PLAX</i>, <i>PSAX</i>, and <i>subxiphoid</i> views.</p> <p>Artifacts: acoustic enhancement, acoustic shadowing.</p> <p>Continued in physiology and ICM courses.</p>
Abdomen	7	15	<p>Biliary Colic</p> <p>Celiac and SMA Assessment</p>	Liver, portal triad, portal vein, gall-bladder (measure wall thickness), celiac trunk (“seagull sign”), SMA (“nutcracker”), aorta, IVC, diaphragm, vertebrae.	<p>Measure wall thickness of gall bladder, “seagull sign” of celiac trunk, “nutcracker” sign of SMA, Doppler assessment of vasculature.</p> <p>Artifacts: mirroring, acoustic enhancement, acoustic shadow, dirty shadow.</p>

Winter Quarter Ultrasound Workshops



Exam Unit	Lecture Hours	Dissection Hours*	Ultrasound Workshop	Anatomy Orientation/Identification Objectives	Notes
Posterior Abdominal Wall, Pelvis, Perineum	8	15	Abdominal Aortic Aneurism FAST exam	Aorta, common iliac arteries, IVC, lumbar vertebrae. Morison's pouch, pelvic pouches, splenorenal pouch, kidneys, spleen, liver, urinary bladder, female reproductive organs, prostate.	AP and transverse measurements of aorta diameter. Confirm position of bifurcation of aorta. Lung portion of E-FAST is part of second year curriculum (Intro to clerkship course). Review of common spaces for fluid accumulation. Assess uterus position. Color Doppler. Artifacts: acoustic enhancement, dirty shadow, acoustic shadow. Bladder continued in physiology course.
Lower Extremity	8	12	Tarsal Tunnel Plantar fasciitis, calcaneal tendonitis	Muscle tendons (FDL, FHL, TP), posterior tibial AV, tibial N, medial malleolus, calcaneus, talus, calcaneal tendon, plantar fascia, medial and lateral plantar neurovascular bundles.	Plantar fascia and calcaneal tendon in transverse and longitudinal views. Measure plantar fascia at calcaneal attachment. Orientation to tarsal tunnel anatomy. Color Doppler of vasculature. Artifacts: acoustic shadow, anisotropy. Continued in OMM course with knee.
Head & Neck I	8	15	Increased intracranial pressure (orbit) Thyroid Assessment/Visceral neck	Eye anatomy, optic nerve sheath. Thyroid, carotid, IJV, SCM, infrahyoid muscles, trachea	Measure optic nerve sheath diameter. Review thyroid, longitudinal and transverse views of carotid and IJV, Valsalva IJV, color Doppler of vessels. Artifacts: acoustic enhancement, acoustic shadow Continued in OMM course with scalene gap assessment.
Head & Neck II	9	12	Carotid stenosis	Carotid artery, vertebral artery, IJV, vertebral vein.	Measurement (Doppler) of flow velocity in carotid artery, assessment of intima, color Doppler of vessels (particularly vertebral artery/vein). Artifacts: acoustic shadow, acoustic enhancement, aliasing.



Teaching staff:

1. Faculty of anatomy department that have undergone at least one year of faculty development in ultrasound.
2. AZCOM MS2 student TA's—hired based on skills in workshop, interest, availability
3. Weekly teaching meetings to practice, review, and plan for workshops.

History: Peer instructors in FA17 were student members of the ultrasound interest group (now the Ultrasound Club). Their volunteer participation was fundamental to the start of the program.

Examples of workshop cases and materials



ANATG 1510/1513

Ultrasound workshop 3

FALL 2017

ANATOMY US WORKSHOP 3

An Introduction to Diagnostic Ultrasound

Visualization of Heart and Pericardial sac—*Cardiac Assessment*

CLINICAL CASE: A 54-year-old man, is brought to the ED with complaints of shortness of breath (SOB = dyspnea) that has become progressively worse over the past two days and worsens substantially with exertion (even walking a few blocks). In the ED he is found to be tachycardic (elevated heart rate) and hypotensive (abnormally low blood pressure). The history taken does not provide any specific indications for the symptoms and a focused bedside echocardiogram procedure is performed to assess cardiac function.

CLINICAL RELEVANCE: For patients presenting with symptoms that indicate possible cardiac concerns, an ultrasound-based assessment of the heart and associated structures (aorta, IVC, vessels, and even femoral & popliteal veins of the lower extremity) can provide valuable diagnostic information quickly, inexpensively, and without needing to move the patient out of the ED. The standardized assessments performed for cardiac assessment specifically (four of which we will workshop). Additionally, cardiac assessment—usually to determine if pericardial perfusion is part of the FAST (focused assessment with sonography for trauma) exam.

ULTRASOUND WORKSHOP 3—CARDIAC ASSESSMENT



CLINICAL CASE: A 54-year-old male brought to ED

—Complaints:

- **SOB (dyspnea) progressive over past two days, worsens with exertion**

—Examination:

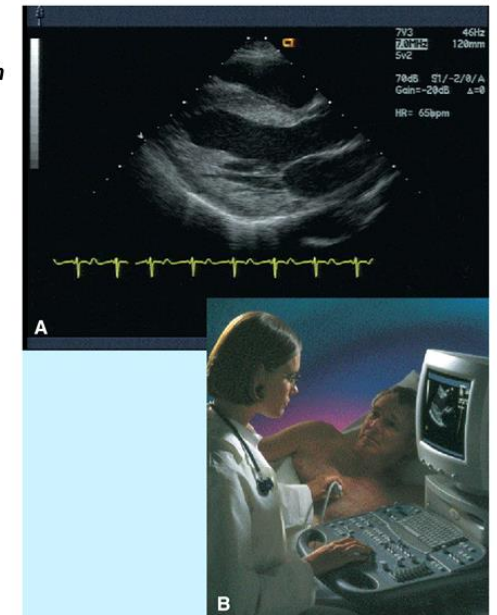
- **Tachycardic (elevated heart rate)**
- **Hypotensive (low BP)**

—Patient history:

- **No specific indicators revealed**

You are concerned about cardiac health.

To confirm you perform an US examination of the heart to better evaluate cardiac performance.



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MDA B1.23

Examples of workshop:



ANATG 1510/1513 Ultrasound workshop 3 FALL 2017

iv. CAPTURE AND CONFIRM (see end of this handout):

1. Freeze the ultrasound images that best demonstrate the anatomical features on the structure list and identify features for one of the proceptors.
2. The orientation for the phased array probe in this exercise will be as follows (on many machines, but not all, the indicator dot will be on the right side of the screen; see anatomy to confirm orientation):

GENERAL ANATOMY REVIEW:

Grant's Atlas image 042 (for orientation) MDA Fig 1.62

Lang et al. 2005-Fig. 8—more detail than needed but good orientation

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USE ALL OF THE FOLLOWING STANDARD CARDIAC ASSESSMENT VIEWS DURING THE COURSE OF THIS WORKSHOP (NOT NECESSARILY ON THE SAME "PATIENT").

Apical view: probe placed at point approximating the apex of heart. To find palpate for the strongest surface expression of the heartbeat, also known as the PMI (point of maximum impulse or ictus cordis). Typically, PMI is in 5th intercostal space at the midclavicular line. This approximates (but does directly correspond) to the apex of the heart.

Capture from <https://www.youtube.com/watch?v=58Q8R1d7Nq>

From Yale Atlas of Echocardiography

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Parasternal long axis (PLAX) view: probe placed at 3rd, 4th, or 5th intercostal space with marker directed to right shoulder. Good for assessing cardiac function, perfusion, valve function.

Captures from <https://www.youtube.com/watch?v=18Q8R1d7Nq>

Expectations/Objectives

CAPTURE AND CONFIRM: using your understanding of the anatomy of the cardiac region please locate the following structures and demonstrate in the exercise (multiple structures may be shown on single image).

STRUCTURE/FEATURE	confirmed	STRUCTURE/FEATURE	confirmed
APICAL VIEW		PSAX VIEW	
Left ventricle		Right ventricle	
Right ventricle		Left atrium	
Left atrium		Left ventricle	
Right atrium		Interventricular septum	
Interventricular septum		Left ventricular outflow tract (LVOT)	
Interatrial septum		Mitral valve	
Right, left AV valves		Fish lips sign	
Aorta		Chordae tendineae	
Pericardium		Papillary muscles	
		Aortic semilunar valve	
PLAX VIEW		Mercedes Benz sign	
Right ventricle		Pericardium	
Left atrium			
Left ventricle		SUBCOSTAL VIEW	
Interventricular septum		Left lobe of liver	
Left ventricular outflow tract		Left ventricle	
Mitral valve		Right ventricle	
Anterior leaflet		Interventricular septum	
Chordae tendineae		Pericardium	
Papillary muscles			
Aortic semilunar valve			
Pericardium			

Also, answer these questions:

1. Why is the phased array probe the better choice for these procedures?
2. How does the orientation for cardiac assessment differ from most other ultrasound assessment modalities?
3. Which view(s) give best opportunity to assess the function of the left atrioventricular valve? Aortic semilunar valve?
4. **CHALLENGE QUESTIONS:**
 - a. What is concern if ventricular tissue is not contracting symmetrically in the PSAX view?
 - b. In a healthy heart does the anterior leaf of the mitral valve touch the interventricular septum when it opens?
 - c. What would be the US indicators of pericardial effusion? What view is best to assess this condition?
 - d. Why turn the patient to left lateral decubitus position (on left side) to improve image?

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Parasternal short axis (PSAX) view: Probe in same position as with PLAX, but marker towards left shoulder. Tilt probe superiorly to view aortic semilunar valve, inferiorly to view papillary muscles of mitral valve, or hold upright to view mitral valve (change intercostal space used as needed). Good for assessing cardiac function and valve function.

View of papillary muscles View of mitral valve View of Aortic semilunar valve

Parasternal Echocardiogram Views

PLAX: Long Axis
PSAX: Short Axis

Summary of Parasternal axis views

Orientation

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Subcostal (Substernal) view (optional): select phased array probe and "Cardiac(Crd) exam". Probe placed under xiphoid process (carefully; this can be painful) and marker directed to patient LEFT side; this is different than our normal convention. *Note: ask patient to relax to permit pushing the probe deeper for better view.* Good for assessing cardiac function and cardiac perfusion.

Captures from <https://www.youtube.com/watch?v=18Q8R1d7Nq>

All images in documents are appropriately cited

AZCOM/AZPOD MS1 students examining upper extremity.

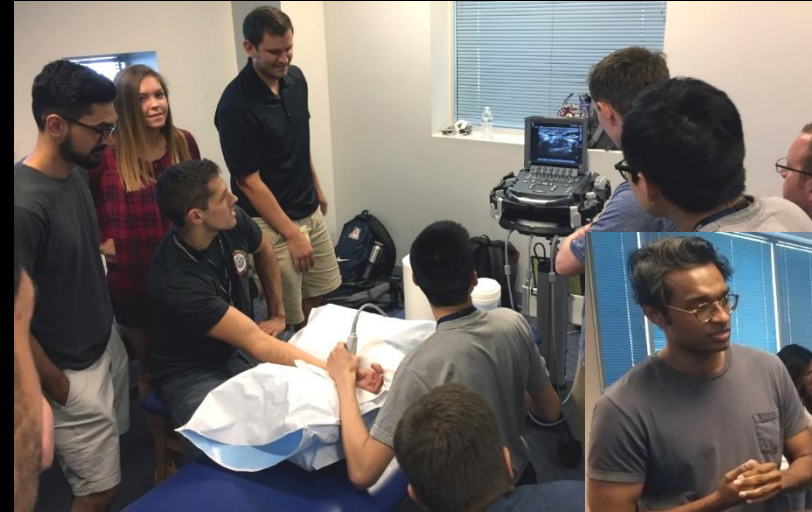
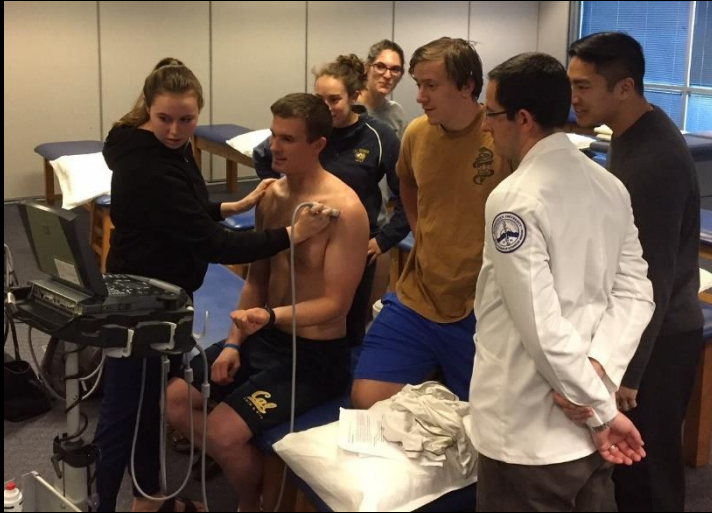
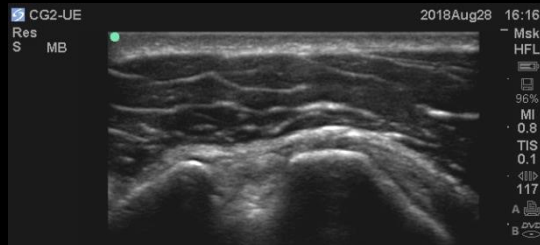
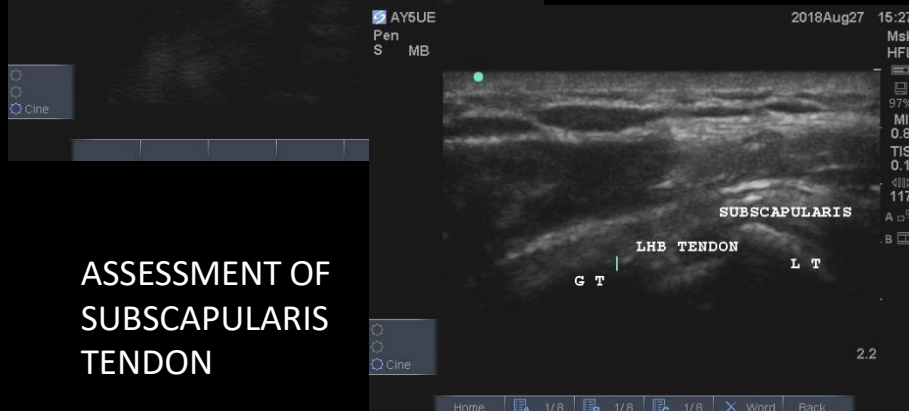


Photo by Brian C. Strain



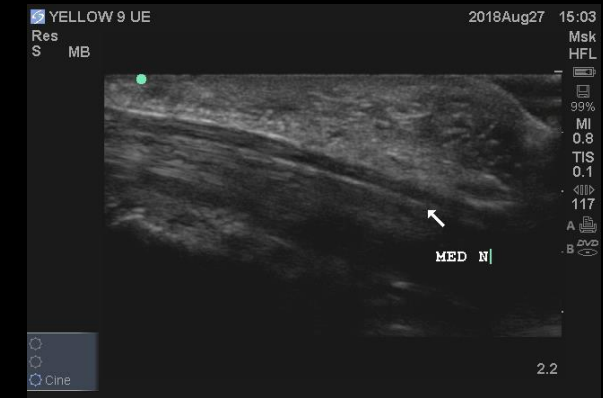
LONG HEAD OF BICEPS BRACHII ASSESSMENT



ASSESSMENT OF SUBSCAPULARIS TENDON

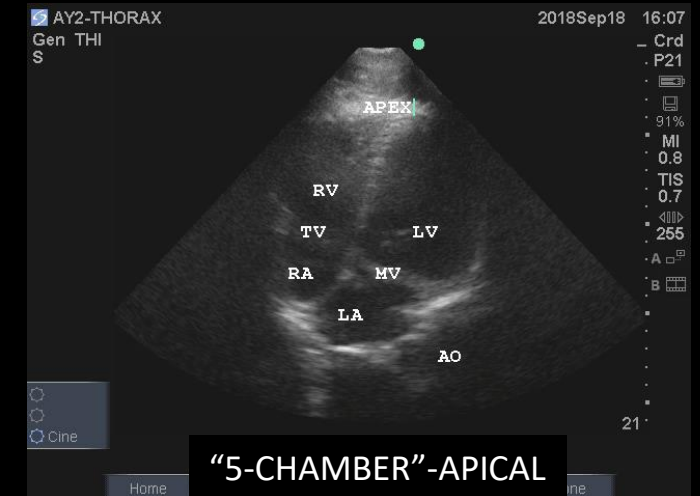
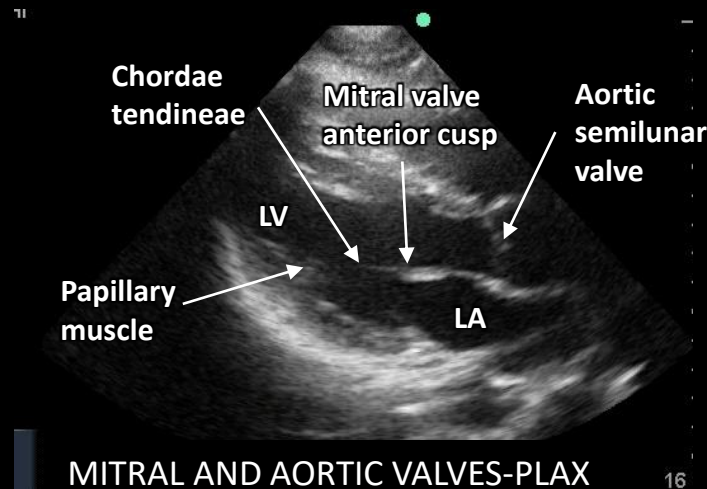
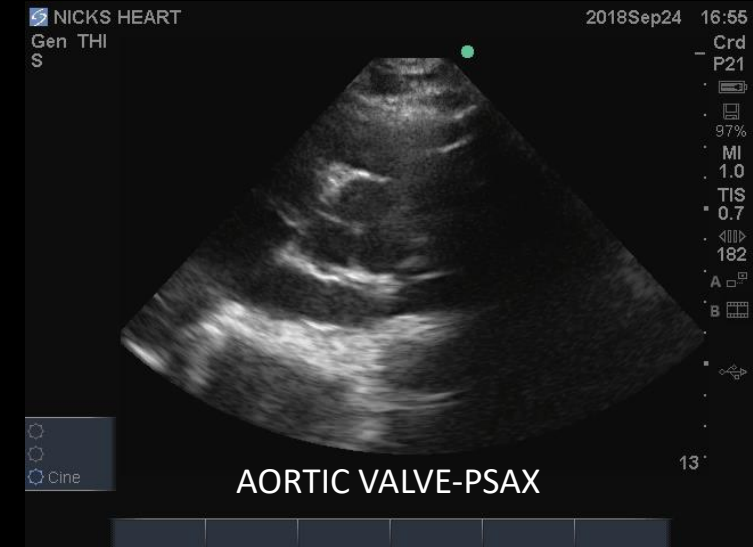


CROSS-SECTIONAL AREA ASSESSMENT OF MEDIAN NERVE



LONGITUDINAL MEDIAN NERVE AND FLEXOR TENDONS

AZCOM/AZPOD MS1 students performing cardiac exams.



Assessment Portion

Unit exam questions now include US

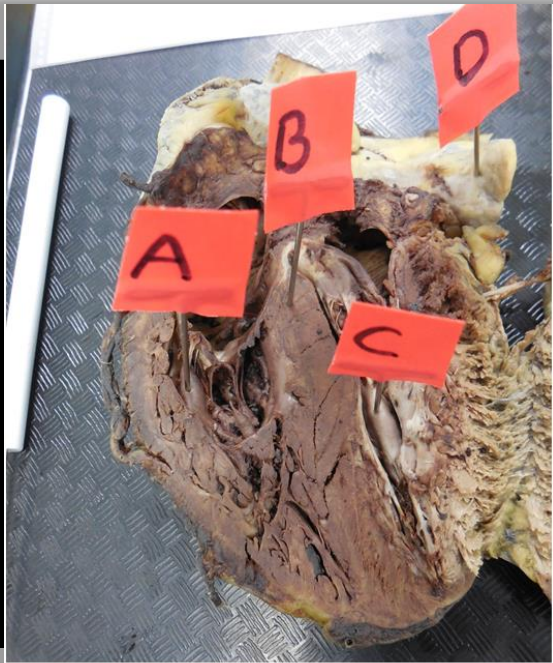
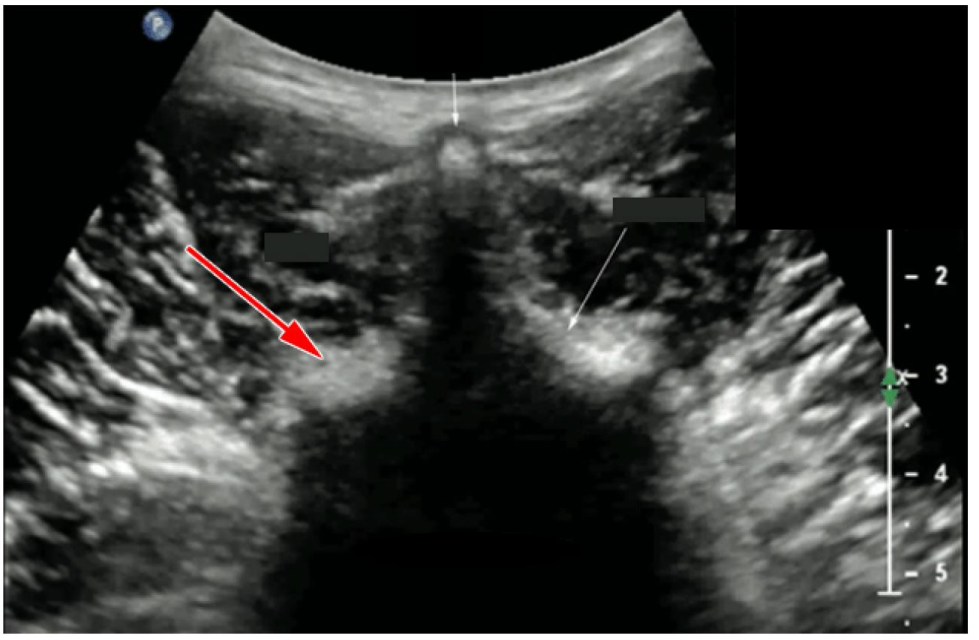
- Function/Use
- Anatomical orientation/ID
- Written and Practical portions

Student images used for study guides and exam questions.

Which of the following controls on an ultrasound machine, when adjusted for an increased setting, can improve image quality, but reduces depth of penetration of the soundwaves?

- A. Exam
- B. Freeze
- C. Frequency
- D. Gain

Identify the indicated feature (red arrow) on the image provided.



Papillary muscle in left ventricle



Which of the following structures tagged in red on the heart corresponds to the structure indicated by the red arrows on the ultrasound image?

- A. A
- B. B
- C. C
- D. D

BONUS C: What is the most likely clinical scenario demonstrated in this image?

- A. Coarctation of aorta
- B. Pericardial effusion
- C. Pericarditis
- D. Stenosis of LAD



SURVEY OF STUDENTS

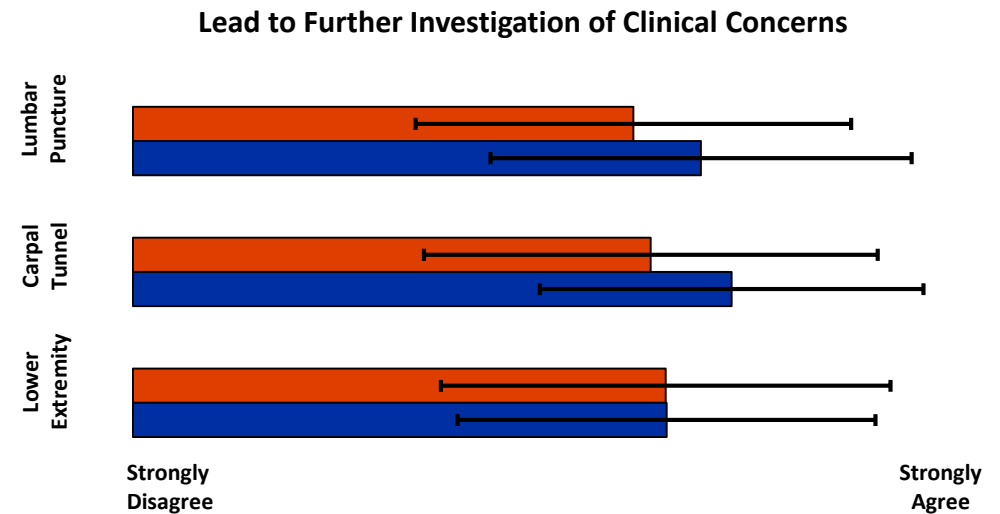
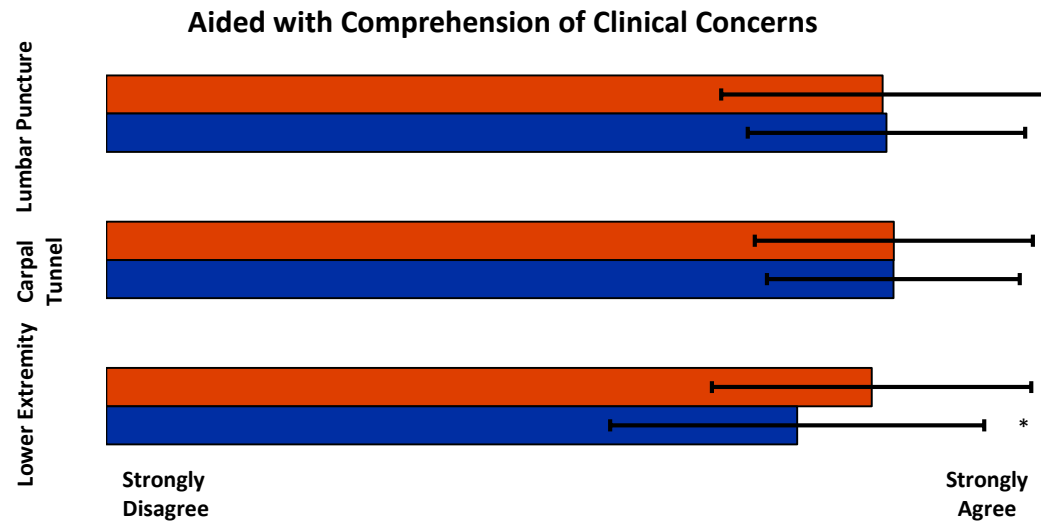
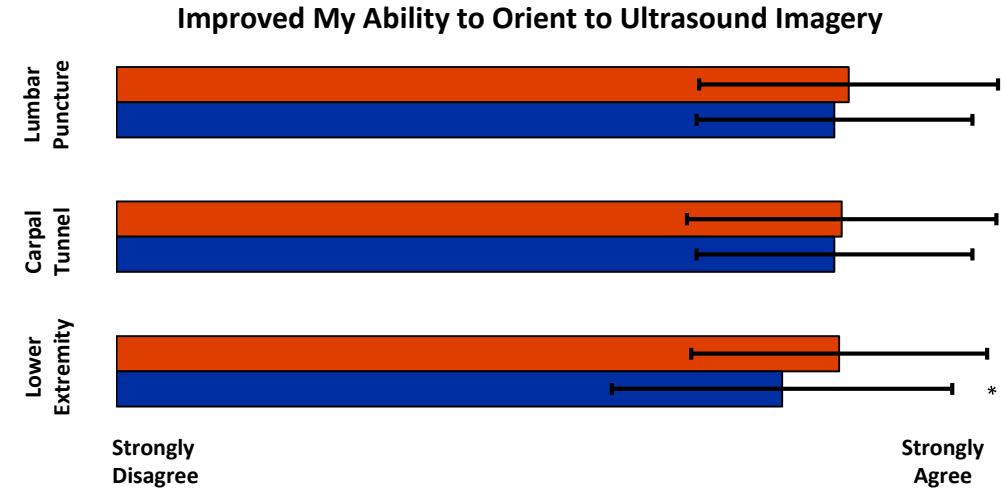
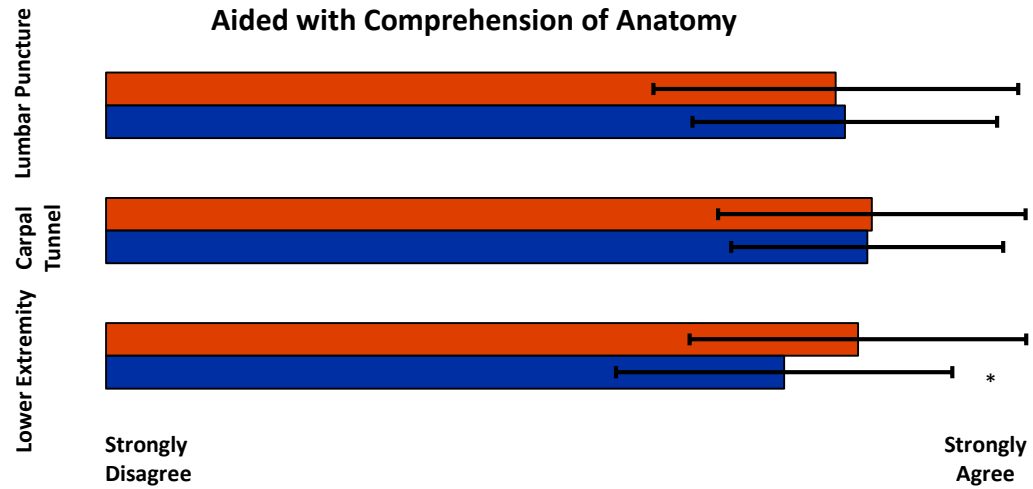


1. Likert and open answer survey given to students at end of anatomy course in 2017-2018, 2018-2019.
 1. Demographics: gender, program
 2. Likert (agreement) questions: value of ultrasound in preclinical training, value of workshop packet, value of demo presentation, workshop improved anatomy orientation/identification skills, workshop improved clinical appreciation of regional anatomy, workshop improved ultrasound image orientation, undertaking of independent study of clinical concerns.
 3. Open questions: best aspects of ultrasound workshops, least appreciated aspects of workshops, suggestions for improvement, comments.

Response rate is approximately 40%

No discrimination between AZCOM and AZPOD populations. Some areas of discrimination by gender...

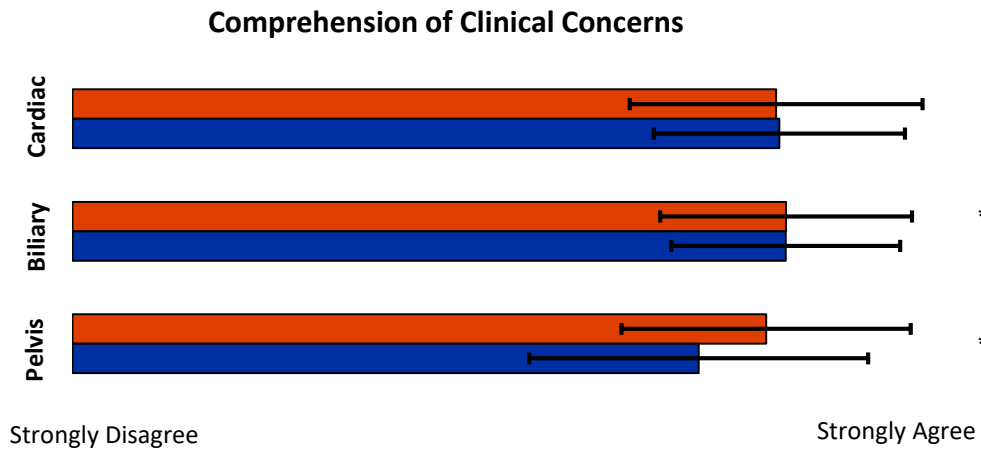
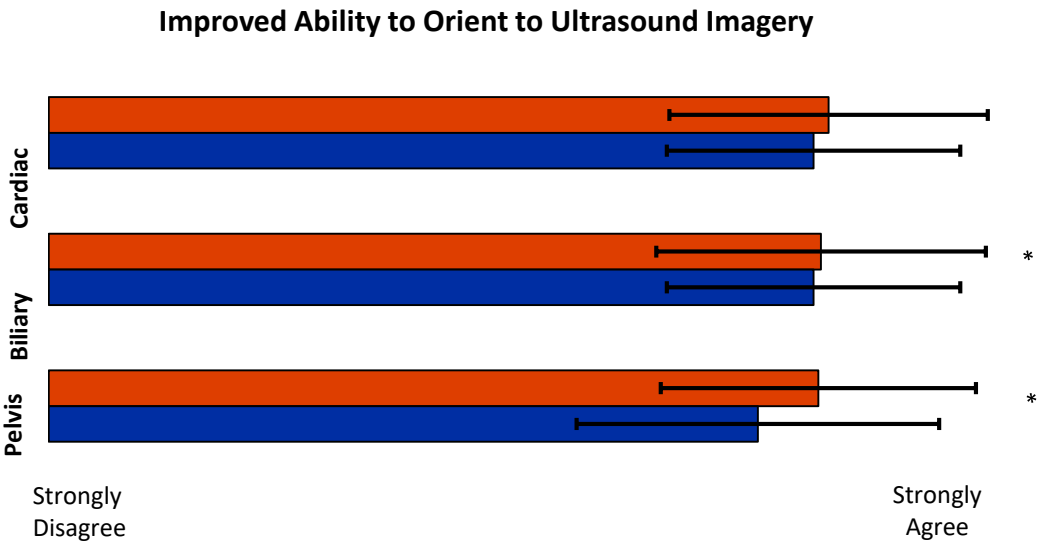
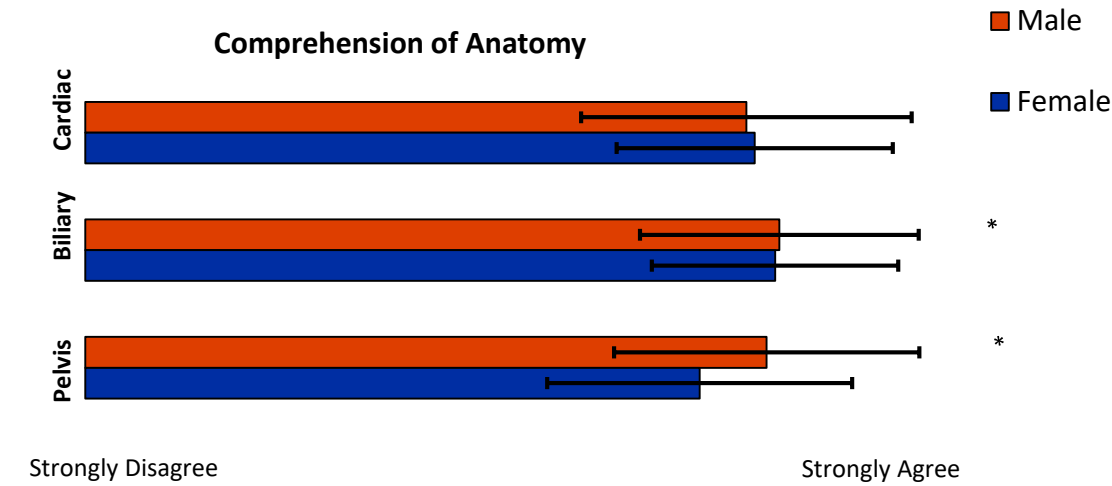
Findings: strong agreement with educational benefits of workshops (significant difference between genders in LE workshops). Notable that nearly 2/3 of students indicated that they independently undertook further investigation after workshops.



Body cavity-based workshops

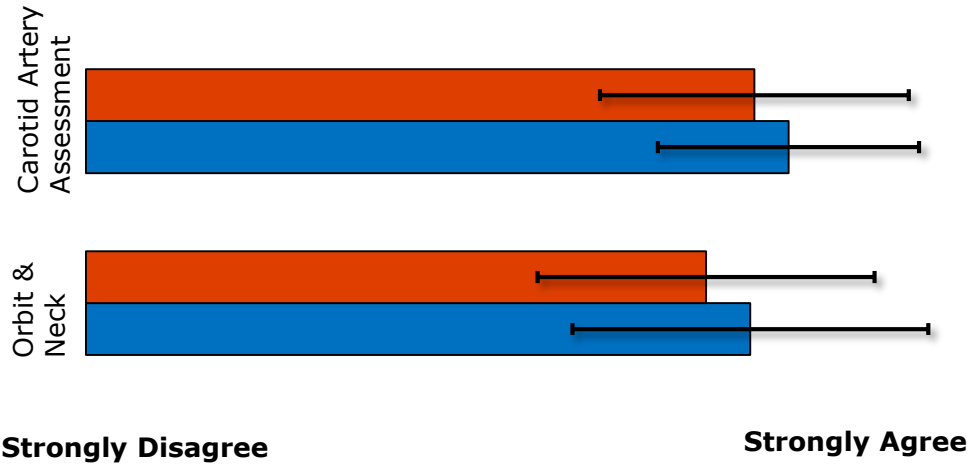


Findings: strong agreement with educational benefits of workshops (significant difference between genders in Biliary and Pelvis workshops). Notable that nearly 2/3 of students indicated that they independently undertook further investigation after workshops.

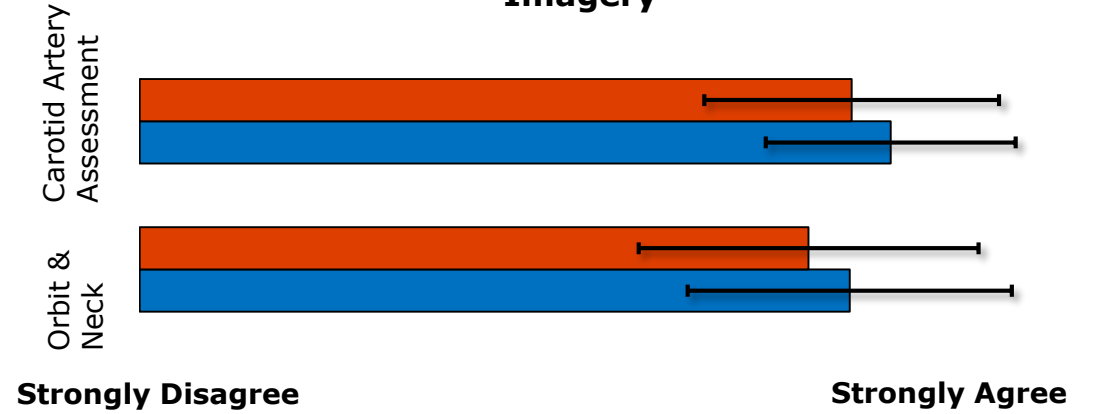


Findings: strong agreement with educational benefits of workshops (significant difference between genders in carotid artery workshops independent investigation). Notable that nearly 2/3 of students indicated that they independently undertook further investigation after workshops.

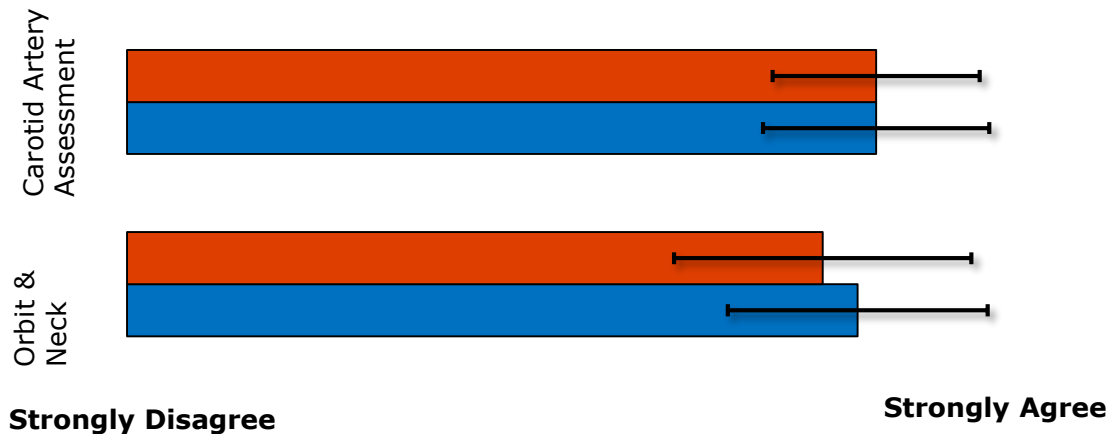
Comprehension of the Anatomy



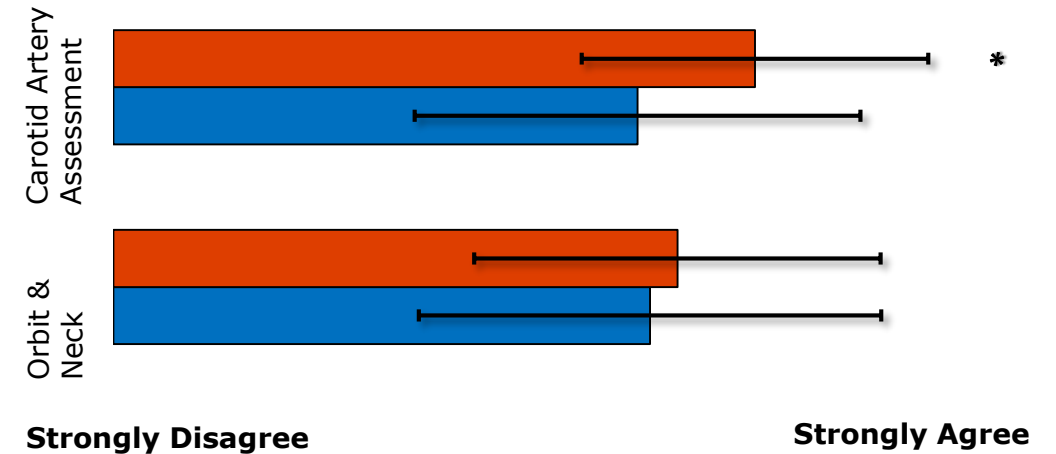
Improve Ability to Orient to the Ultrasound Imagery



Comprehension of the clinical concerns



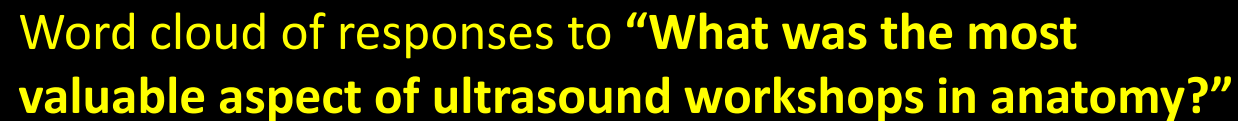
Further investigation of Clinical Concerns



"I am very grateful for the experience ...the physicians I shadowed, prior to medical school, use ultrasound extensively to improve quality of care. I also think it is helpful so early in our curricula...."

"I have really enjoyed the opportunity to get hands-on experience with ultrasound machines this early in my medical training. It will be a vital skill as I enter clinical rotations and residency! ...the workshops have coincided nicely with the topics we are covering in lecture and dissection workshop..."

A very small minority of respondents noted that they felt ultrasound training should be delayed to clinical years



(“Anatomy”, “ultrasound”, and “machine” deleted)

CONCLUSIONS OF STUDY

1. Students overwhelmingly enjoyed and found value in the ultrasound workshops in the anatomy course.
2. Particularly for improved anatomical orientation, clinical appreciation of anatomy, and orientation to ultrasound imagery.
3. While not as high in agreement, we are particularly excited by the number of students undertaking independent investigation into the clinical correlations used in the ultrasound workshops. This meets our goal of helping students develop into lifelong medical learners.

Clinical application of skills



AZCOM 2021 were the first to have ultrasound workshops in anatomy. In their OMS III year we asked for information of if and how they have applied their ultrasound skills in clinical rotations. Here are some of the responses:

"At two rotations, my OB/GYN and an urgent care (pseudo ED), my preceptors quickly recognized my ability to use ultrasound and frequently allowed me to scan the patients first."

"The residents and attendings were impressed with my knowledge of the ultrasound machine. I quickly gained their trust to do my own work-up of triage patients...the residents taught me more advanced techniques."

"...my cardiology rotation involved plenty of TTEs and TEEs. I think the ultrasound workshops in addition to the excellent anatomy lectures helped me identify the structures and the findings of these images"

"I would really like to highlight is my experience on my general surgery/trauma rotation. From Day 1 on the rotation, I was able to perform FAST exams in the trauma bay and trusted to do so thanks to the U/S curriculum incorporated at school. The medical students from other programs that were rotating through did not initially know how to perform them, so it was cool to be given an opportunity to teach as well."

The current (2019-2020) integration of ultrasound into the AZCOM preclinical curriculum:



ANATOMY MS I	PHYSIOLOGY MS I	OSTEOPATHIC MANIPULATIVE MEDICINE MS I, MSII (2 PER YEAR)	INTRO TO CLINICAL MEDICINE I MS I	INTRO TO CLINICAL MEDICINE II MS II	INTRO TO CLERKSHIP MS II	OPTIONAL ULTRASOUND ELECTIVE MS II
Lumbar Puncture	Measure Cardiac Ejection Fraction	MS I—scalene Gap	Ocular (Demo)	Echo, Aorta, Celiac/SMA	E-FAST	Knobology, US Principles and Instrumentation
Cardiac Assessment	Measure Urinary Bladder Release	MS I—thoracolumbar MSK		Central Line		Thoracoabdominal (3 weeks)
Carpal Tunnel & Rotator Cuff Assessment		MS II—rotator Cuff & Elbow		Aorta, IVC, Pelvic Organs		Vascular access
Cholecystitis & Celiac/SMA Assessment		MS II—knee		RUSH (Rapid Ultrasound For Shock And Hypotension)		Pelvic & obstetrics (2 weeks)
Abdominal Aortic Aneurysm & Fast Exam						Shoulder
Plantar Fasciitis, Calcaneal Tendonitis, Tarsal Tunnel Syndrome						MSK (other)
Carotid Artery Stenosis, Thyroid						Small Parts (orbit, testes, etc.)
Increased Intracranial Pressure (Ocular), Oral Cavity Assessment						

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Overall Considerations:

1. Ultrasound should be part of a broader curricular experience to reinforce and maintain skills in preclinical training
2. Cooperation of basic-science and clinical faculty is fundamental to success
 1. Development of faculty in appropriate ultrasound understanding and skillset for instruction is NOT DIFFICULT (monthly sessions, online content, practice opportunities will suffice)
 2. Substantial resources are available for faculty development online, but support of home institution is crucial for sustained success
3. Ultrasound workshops provide an additional active learning alternative to didactic lecture

MODIFICATIONS TO ANATOMY ULTRASOUND WORKSHOPS FOR 2019-2020 (Simons and Townsend):

1. Addition of 10 Butterfly pocket ultrasound devices to anatomy ultrasound workshops
2. Addition of ventral view oral cavity assessment to head and neck 1 workshop.

Future directions:

1. Our current **FACULTY DEVELOPMENT** series (now in its 3rd year) is more focused on developing the ultrasound skills of our associated clinical faculty that are preceptors for our 3rd and 4th year students as well as faculty of our sponsored residencies.
 1. Sessions are geared to prepare participants to take and pass certifications exams for regional and/or procedural ultrasound.
2. **CURRICULAR DEVELOPMENT** continues with ongoing modifications to preclinical courses and ongoing development of clinical rotation curricula (via faculty development).
3. **RESEARCH**
 1. Several research projects with an emphasis on ultrasound are now ongoing. These include curricular assessment, clinical applicability, and preceptor perceptions.
 2. Projects have been initiated by faculty and students alike.
4. For more information please contact Dr. Nydam (rnydam@Midwestern.edu) or Dr. Finch (cfinch@Midwestern.edu).

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1. We wish to recognize the leadership and support of **Dr. Lori Kemper, Dean of AZCOM** for the years of support to this initiative.
2. We also thank our partner sonographers **Malka Stromer** and **Jeannine Noble** for their ongoing help with faculty development, teaching of the elective course, and unwavering support of the ultrasound stakeholders at MWU.
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4. Student research assistants **Jay Olson, Casey Brown, Morgan Pinto, James Pasalo, Janelle Lopez, Amanda Mark, Victoria Smith, Chandresh Nandani, Samantha Rudy, Shalynn Arrington, Miles Orantia, Rachel Krzeczowski, Nicholas Gannon, and Danielle Garner**. These individuals are currently drafting the manuscripts to publish our findings with MSK, Body Cavity, and Head & Neck ultrasound workshops in anatomy.
5. We also wish to recognize the staff of the MWU Clinical Skills and Simulation Center for support and financing of ultrasound machines and ultrasound simulators (for clinical and pathology instruction).
6. Lastly, we recognize the funding received via a grant from the HonorHealth Phoenix General Hospital Osteopathic Education Foundation.