Integration of Ultrasound Examinations of Thoracic and Abdominopelvic Anatomy Increases Student Confidence of Associated Anatomical and Clinical Concepts

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OVERVIEW

In the fall of 2017, Midwestern University Arizona College of Osteopathic Medicine (AZCOM) integrated ultrasound into the gross anatomy curriculum as part of a larger integration of ultrasound into the four year medical curriculum. This includes use of ultrasound imagery in lectures and hands-on ultrasound workshops. The goal of this study is to assess students' value of ultrasound modules of the abdominopelvic and thorax body cavities using a Likert type survey of student perceptions and performance on ultrasound-based questions on regional anatomy exams.

BACKGROUND

Ultrasound is an increasingly ubiquitous part of procedural and diagnostic medical practice[1,2,3]. In conjunction with the growing use of ultrasound in medical practice, there has been an **increase in the interest and implementation of ultrasound education in medical education**[4,5]. The efficacy of ultrasound within an UGME curriculum has been demonstrated through comparative evaluation of student performance in various measures of aptitude[4,6] and the **place of ultrasound in the medical school curriculum has been recently summarized and critically evaluated** by both the European Federation of Societies for Ultrasound in Medicine and Biology[7] and the World Federation for Ultrasound in Medicine and Biology[1].

In the fall of 2017, AZCOM initiated a **comprehensive integration of ultrasound** into the four year UGME curriculum including substantial exposure in the anatomy course—all basic science courses are also taken by students in the Arizona School of Podiatric Medicine (AZPOD). The anatomy course has eight regional exam units. In each exam unit we added a **one-hour clinically-based, hands-on ultrasound workshop**. These workshops focus on reinforcing the primary anatomy learning objectives of **identification, orientation, and relationship of anatomy of each unit in the context of a clinical concern of that region** for which ultrasound is used to improve accuracy of diagnosis or efficacy of procedure.

Student learning is assessed through an oral quiz at the end of each workshop, evaluation of saved images, and multiple choice questions on the written and practical portions of each unit exam.

METHODS

Ultrasound workshops were developed with the aid of clinical providers who frequently use the technology. The goal of each workshop is to use hands-on, real-time ultrasound scanning to reinforce the learning objectives of the regional exam unit: 1) identify internal anatomy, 2) appreciate anatomical relationships, 3) improve understanding of the clinical significance of the anatomy.

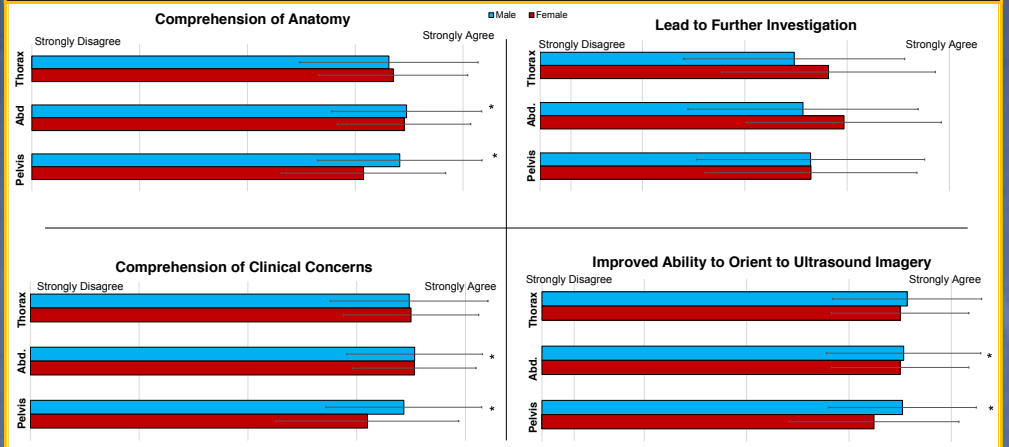
In the **thorax unit** students performed 4-point cardiac assessment—apical, subxiphoid, parasternal long axis (PLAX), and parasternal short axis (PSAX). Assessment includes identification of the heart chambers, heart valves and associated structures, heart function, and relationship of the heart to the pericardial sac and associated structures.

In the **abdomen unit** students are required to locate and measure the wall of the gallbladder and identify the associated portal triad structures and biliary ducts. For the vessels students needed to locate, orient to, and identify the celiac trunk and SMA and associated structures.

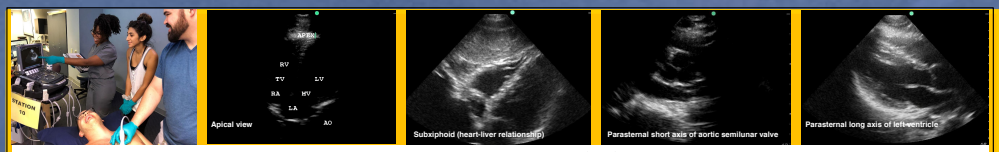
In the **posterior abdominal wall-pelvis-perineum unit** students performed an assessment of the abdominal aorta (AAA) and as part of the FAST exam locate the right kidney-liver relationship, left kidney-spleen relationship, and the bladder-uterus-vagina and bladder-prostate relationships in female and male colleagues.

At the end of the course, students were sent an **anonymous survey** to investigate perceptions of the ultrasound workshops. This survey includes perceptions of impact on their comprehension of **anatomy,** comprehension of **clinical concerns**, **ability to orient** to the ultrasound images, and if they were interested in **pursuing further investigations**. Responses to **Likert questions were converted to numerical values** and averages were compared using independent t-tests utilizing SPSS software.

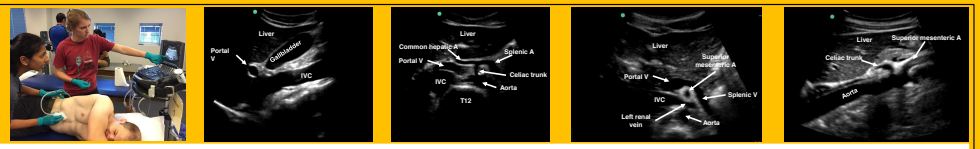
RESULTS



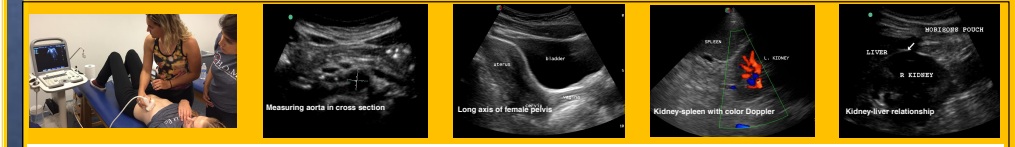
WORKSHOPS (student captured images shown)



THORAX: Cardiac assessment. **Primary anatomical features:** Surface palpation to confirm ictus cordis, 3rd & 4th parasternal intercostal space, heart chambers, heart valves, papillary muscles, chordae tendineae, left ventricular outflow tract, aortic semilunar valve, aorta, pericardium, liver, lung. **Ultrasound:** B-mode/Doppler scan, enhancement artifact.



ABDOMEN: Cholecystitis assessment, celiac and superior mesenteric artery assessment. Student captured images are shown.
Primary anatomical features: Gallbladder, portal triad, portal vein, liver, celiac trunk, common hepatic artery, splenic artery/vein, superior mesenteric artery, left renal vein ("nutcracker"), aorta, IVC. **Ultrasound:** B-mode/Doppler scan, measurement of gallbladder wall thickness, dirty shadow (bowel gas), enhancement artifact.



POSTERIOR ABDOMINAL WALL, PELVIS: Aortic aneurysm assessment, abdominal trauma assessment, FAST exam. Student captured images shown.
Primary anatomical features: Aorta, vertebral bodies, common iliac arteries, IVC, kidney-liver relationship (Morison's pouch), kidney-spleen relationship (splenorenal pouch), bladder, uterus, vagina, prostate. **Ultrasound:** B-mode/Doppler scan, measurement, enhancement, dirty shadow, acoustic shadow artifacts.

TESTIMONIALS (Fall 2019-OMS III students)

These are recently received testimonials from the current (2019-2020 academic year) third year students. These were the first AZCOM students to have the integrated ultrasound curriculum.

"...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."

"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."

CONCLUSION

- There was **no difference** ($p > 0.5$) **between AZCOM and AZPOD or Male and Female** on the perceived value of the ultrasound workshops for body cavity anatomy.
- Response to the ultrasound modules for the body cavities was **overwhelmingly positive**.
- A large majority of students **strongly agreed** that ultrasound improved anatomical understanding, with response values of 1.60, 1.73, 1.75 for the thorax, abdomen, and pelvis units, respectively. No difference between males and females ($p > 0.5$).
- Similar **strong agreement** for improved clinical comprehension through participation in the ultrasound modules; 1.50, 1.60, 1.72 for the thorax, abdomen, and pelvis units, respectively. No difference between males and females ($p > 0.5$).
- **A majority of students responded that the ultrasound experience led to further independent investigation**, particularly for the cardiac region (Mean Score = 2.16)
- There was also strong agreement that the hands-on workshops **improved the ability of the students to orient to the ultrasound images** with mean scoring of 1.47, 1.48, and 1.53 for the for the thorax, abdomen, and pelvis units, respectively.
- Students clearly feel that they have greatly benefited from participation in hands-on, clinically focused body cavity ultrasound workshops in the anatomy course.
- Forthcoming studies are examining the impact of these modules on exam performance.

REFERENCES

1) Dietrich, C., Bamber, J., Berzigotti, A., Bota, S., Cantisani, V., Castera, L., ... Thiele, M. (2017). EFSUMB Guidelines and Recommendations on the Clinical Use of Liver Ultrasound Elastography, Update 2017 (Long Version). *Ultraschall in Der Medizin - European Journal of Ultrasound*, *38*(04). doi: 10.1055/s-0043-103952
2) Stawicki, S. P., & Bahner, D. P. (2014). Modern sonology and the bedside practitioner: evolution of ultrasound from curious novelty to essential clinical tool. *European Journal of Trauma and Emergency Surgery*, *41*(5), 457–460. https://doi.org/10.1007/s00068-014-0464-x
3) Rippey, J. C. R., & Royse, A. G. (2009). Ultrasound in trauma. *Best Practice & Research Clinical Anaesthesiology*, *23*(3), 343–362. https://doi.org/10.1016/j.bpa.2009.02.011
4) Wilson, S. P., Mefford, J. M., Lahham, S., Lotfipour, S., Subeh, M., Maldonado, G., ... Fox, J. C. (2016). Implementation of a 4-Year Point-of-Care Ultrasound Curriculum in a Liaison Committee on Medical Education-Accredited US Medical School. *Journal of Ultrasound in Medicine*, *36*(2), 323–325. https://doi.org/10.7863/ultra.16.03068
5) Baltarowich, O. H., Di Salvo, D. N., Scoutt, L. M., Brown, D. L., Cox, C. W., DiPietro, M. A., ... Dubinsky, T. J. (2014). National Ultrasound Curriculum for Medical Students. *Ultrasound Quarterly*, *30*(1), 13–19. https://doi.org/10.1097/ruq.0000000000000066
6) Boulger, C., Liu, R. B., De Portu, G., Theyyunni, N., Lewis, M., Lewiss, R. E., ... Bahner, D. (2018). A National Point-of-Care Ultrasound Competition for Medical Students. *Journal of Ultrasound in Medicine*, *38*(1), 253–258. https://doi.org/10.1002/jum.14670
7) Cantisani, V., Dietrich, C., Badea, R., Dudea, S., Prosch, H., Cerezo, E., ... Gilja, O. (2016). EFSUMB Statement on Medical Student Education in Ultrasound [long version]. *Ultrasound International Open*, *02*(01), E2–E7. https://doi.org/10.1055/s-0035-1569413

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