

Effectiveness of a Short Course on Undergraduate Medical Students' Acquisition of Basic Ultrasound Skills: Findings from a Saudi University

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Abstract

Background: Medical schools in Saudi Arabia generally do not integrate ultrasound training in undergraduate medical study despite its widespread use.

Objective: To determine the efficiency of a short course in acquiring basic ultrasound skills at the undergraduate medical level.

Subjects and Methods: Fourth-year medical students of Jazan University (2016/2017; $N = 118$) were divided into 13 groups. A radiology expert provided each group with a 50-min lecture on "ultrasound in clinical practice" and a 2-h hands-on ultrasound training session. Then, the students were invited to participate in the study by completing a questionnaire eliciting data regarding their opinion, experiences, and satisfaction level for the session and then undertaking skill assessment using two OSCE stations.

Results: Eighty-one students (68.6%) were enrolled in the study (male: 42; female: 39). The mean scores were high for handling the probe (4.33 ± 1.01) and identifying kidney (4.46 ± 1.08) and liver (4.22 ± 0.97), and moderate for identifying spleen (3.89 ± 0.75), aorta (3.35 ± 0.44), and hepatorenal pouch (3.05 ± 0.35). The students were highly satisfied with the course (4.37 ± 1.01). In the first OSCE station that assessed ultrasound techniques, the mean score was 14.96 (of 18 points; 83.11%) for males and 15.40 (85.56%) for females. In the second station that used static ultrasound image with common pathology, the mean score was 2.4 (of 2.5 points) for both males and females.

Conclusion: Undergraduate medical students in this study gained adequate skills and satisfaction in terms of using ultrasound and identifying anatomy following the short course. This study highlights the benefits of introducing programs dedicated to ultrasound for undergraduate medical students in Saudi Arabia.

Keywords: Point-of-care ultrasound, radiology, Saudi Arabia, training, ultrasound, undergraduate medical education

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INTRODUCTION

Ultrasound (US) has been a useful diagnostic imaging modality since its invention. It is safe, radiation-free,

and portable, unlike other radiological modalities. US is routinely used as a diagnostic tool not only by radiologists but also other specialists such as cardiologists,

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obstetricians, emergency medicine physicians, and gastroenterologists.^[1]

In addition to its clinical uses, point-of-care US (POCUS) is increasingly being utilized as a bridge between theoretical knowledge and practical applications to assist in the education of anatomy, physiology, physical examination skills, pathology, and procedural skills.^[2,3] The incorporation of POCUS and other assistive technology, such as those in medical curriculum, might enhance patient care by emphasizing evidence-based physical examination techniques.^[4]

US technology is increasingly being integrated in undergraduate medical education in addition to also becoming more commonly available in primary health care centers (PHC), small private clinics, or in practice. However, despite the widespread usage of this imaging modality, there is a limit to the formal undergraduate teaching and training in US.^[5,6]

Individual studies have found that incorporating US into undergraduate medical education is both feasible and beneficial to medical students.^[7] A one-day course can influence medical students' knowledge, attitudes, and comfort with using US for procedural guidance.^[8] Students learn US techniques in hands-on laboratories that cover all body regions and systems.^[9] However, a systematic review found that introducing ultrasound training in undergraduate medical education did not result in significant improvement in students' understanding of anatomy.^[2]

To the best of our knowledge, no medical school in Saudi Arabia integrates US into its undergraduate medical study. At most, US is considered a postgraduate clinical tool, as there is more emphasis on its teaching at that level. Therefore, this study was conducted with the main objective of evaluating the efficacy of a short hands-on training model in acquiring the targeted basic US skills at the undergraduate medical level.

SUBJECTS AND METHODS

Study design, setting, and participants

This is an observational cross-sectional study that included fourth-year medical students registered for the 2016/2017 academic year at Jazan University, Jazan, Saudi Arabia. The study was approved by the institutional Research Ethics Committee. Jazan University is a leading educational institution in the Southwest region of Saudi Arabia.

Outcomes

The primary outcome of the study was to evaluate the usefulness of a hands-on training using a questionnaire

and a test at OSCE stations. The secondary objective was to determine if there were gender-related differences in performance.

Study procedures

As per the curriculum plan of the Jazan University, Faculty of Medicine, these students group attended an official radiology course (2 credit hours) that ran longitudinally with the surgery course in an integrated manner and as an exclusive entity for 1 day (conducted across 10 weeks for the chosen batch each week). None of the students had received any previous hands-on US training, except during the preclinical phase as static anatomical-oriented US images in an appropriate anatomy course.

In this course, a newly designed training model consisting of both theoretical and hands-on training on US was implemented. The theoretical part included a 50-minute lecture on the topic "ultrasound in clinical practice," in which multiple US images were used. The practical part was a 2-hour comprehensive hands-on US training session.

A total of 118 students (51 male and 67 female) were eligible for this study and were divided into 13 groups: 10 groups comprised 4 males and 5 females, two groups comprised 4 males and 6 females, and one group comprised 3 males and 5 females. Each group were further subdivided into two subgroups. During the session, the instructor led the students. For the practical sessions, the subgroups alternated between looking at the actor and looking at the monitor connected to the US instrument. Healthy individuals were used as models; these models provided their written informed consent and were scanned before the practical session to ensure no incidental pathological abnormality.

During the theoretical lecture, the application of US in clinical practice was discussed. To help students correlate their anatomical knowledge, anatomical slides of static US images were demonstrated followed by some examples of the most common diseases that can be diagnosed using US. More concentration was applied to the abdominal emergency cases. There are also other static US images, which were discussed during other theoretical and clinical radiology course activities. In the hands-on session, the students were divided into small groups. They viewed the US examination on the screen and monitor. The abdomen was the targeted scanning area.

The instructor, who is an Assistant Professor of Radiology and a Board-certified radiology expert in the US, taught the students how to introduce themselves to the patient, the importance of explaining the procedure, and obtaining

consent from the patients. The proper way of dealing with the US machine, exam selection, US-probe selection and handling, organs identification, and acquiring images of the liver, gallbladder, kidneys, hepatorenal pouch, spleen, urinary bladder, abdominal aorta, and inferior vena cava were also taught. Finally, the students also learnt simple maneuvers that would help them to identify certain structures. Each student then used the US machine to find these structures under the direct supervision of the instructor with direct feedback.

Data collection and study instruments

After completion of the theoretical and practical sessions, the students were invited to complete the hard copy of a questionnaire that elicited their opinion, experiences, and satisfaction level for the session. Students were informed that participation was voluntary, and that response would be considered consent for participation in the study. The study used a previously validated questionnaire.^[5] In brief, this was a 13-item questionnaire, of which 6 items each assessed the perception of gained US skills and soft skills, and 1 item assessed satisfaction. The questionnaire used a five-point Likert-scale, where 1 = strongly disagree and 5 = strongly agree.^[5] At the end of the questionnaire, an open-ended item (qualitative data) requested students to provide any opinion they may have. Response to all questions were mandatory, and only completed questionnaires were analyzed.

The second study instrument was a two-phase assessment using OSCE stations. The first phase was designed to test the basic US skills gained using a simulation mannequin. At this station, we used a previously designed checklist for assessment [Box 1]. In the second stage, a static US image with a clinical scenario and short-answer questions were used. Both stages were completed together.

Data analysis

The SPSS version 20 (SPSS Inc, Chicago, IL, USA) was used for data analysis. Statistical analysis involved descriptive statistics and inferential statistics. Descriptive statistics included a simple tabulation, frequencies, proportions for categorical variables including cross-tabulations. Continuous variables were presented as mean \pm standard deviation (SD). Categorical variables were further compared for significance using the Mann–Whitney test to determine gender-related scoring differences. $P < 0.05$ was used to indicate statistical significance.

RESULTS

A total of 81 students (68.6%) completed the questionnaire, of which 42 (51.8%) were male and 39 were female (48.2%).

Following the theoretical and practical US sessions, participants had high scores for being able to handle the probe (4.33 ± 1.01) and in identifying kidney (4.46 ± 1.08) and liver (4.22 ± 0.97), and moderate scores in identifying spleen (3.89 ± 0.75), aorta (3.35 ± 0.44), and hepatorenal pouch (3.05 ± 0.35) [Table 1]. When analyzed based on gender, females rated their satisfaction in handling probes marginally higher than males, and similar findings were noted in terms of identification of all organs; none of these differences were statistically significant [Table 2].

Box 1: Hands-on ultrasound checklist

Item

Greet the patient
Introduce himself/herself
Explain the procedure to the patient
Take consent
Ensure privacy
Make sure that the patient is fasting (8–12 h)
Put the patient in dorsal position
Expose the abdomen up to xiphisternum
Put machine on the right side of the patient near his head
Check that the machine is ready
Select patient and exam type on machine
Choose appropriate probe
Apply gel
Orient probe with screen (dot being superior, pointer in screen right hand side)
Put probe in longitudinal direction in epigastric area
Rotate anti clockwise to transverse direction
Give patient tissue to remove gel
Allow the patient to dress
Thank the patient
Document your findings

Table 1: Students perception regarding some skills gained from the training (n=81)

Statement	Mean \pm SD
I can handle the probe appropriately	4.33 \pm 1.01
I can identify the liver	4.22 \pm 0.97
I can identify the right kidney	4.46 \pm 1.08
I can identify the hepatorenal pouch	3.05 \pm 0.35
I can identify the spleen	3.89 \pm 0.75
I can identify the abdominal aorta	3.35 \pm 0.44

SD – Standard deviation

Table 2: Students perceptions about the basic skills according to gender (n=81)

Statement	Gender	Mean \pm SD	P*
I can handle the probe appropriately	Male	4.26 \pm 0.95	0.587
	Female	4.59 \pm 1.20	
I can identify the liver	Male	4.19 \pm 0.87	0.918
	Female	4.26 \pm 1.10	
I can identify the right kidney	Male	4.38 \pm 1.01	0.262
	Female	4.54 \pm 1.18	
I can identify the hepatorenal pouch	Male	3.00 \pm 0.41	0.803
	Female	3.10 \pm 0.32	
I can identify the spleen	Male	3.79 \pm 0.68	0.251
	Female	4.00 \pm 0.84	
I can identify the abdominal aorta	Male	3.21 \pm 0.50	0.240
	Female	3.49 \pm 0.51	

*Mann–Whitney test. SD – Standard deviation

In terms of other US and soft skills (communication skills with the patient), the overall scores were high for all parameters except in their ability to set the patient (3.59 ± 0.53) [Table 3]. Further, there were no gender-related significant difference in any of these parameters, except female students scoring significantly higher in communicating with patients to take deep inspiration (4.54 ± 1.15 vs. 4.14 ± 0.88 , respectively; $P = 0.04$) [Table 4]. The study participants were highly satisfied with the inclusion of hands-on US training in clinical teaching activities of medical imaging courses (4.37 ± 1.01) [Table 3].

In the first OSCE station that assessed US techniques, of the total 18 point, the mean score was 14.96 (83.11%) for males and 15.40 (85.56%) for females. In the second station that used static US image with common pathology, of a total 2.5 points, the mean score was 2.4 for both males and females.

In total, 22% males and 27% females had an excellent performance in the first station; only 1 male and 5 female students performed poorly [Figures 1 and 2]. In the second station, 71.4% and 72% of female and male students, respectively, had an excellent performance, while four females and males each had poor performance.

Table 3: Students perception about specific ultrasound skills and overall satisfaction (n=81)

Statement	Mean±SD
I can ask patient taking deep inspiration	4.33±0.99
I can tilt patient to the right or the left	3.94±0.72
I can set the patient	3.59±0.53
I can introduce myself	4.51±1.14
I can explain the procedure	4.06±0.86
I can take the consent	4.37±1.01
Satisfaction about US training model	4.37±1.01

US – Ultrasound; SD – Standard deviation

Table 4: Students perception about specific ultrasound skills according to gender (n=81)

Statement	Gender	Mean±SD	P*
I can ask patient taking deep inspiration	Male	4.14±0.88	0.04
	Female	4.54±1.15	
I can tilt patient to the right or the left	Male	3.90±0.68	0.67
	Female	3.97±0.79	
I can set the patient	Male	3.71±0.59	0.41
	Female	3.46±0.48	
I can introduce myself	Male	4.57±1.20	0.51
	Female	4.44±1.08	
I can explain the procedure	Male	4.07±0.93	0.48
	Female	4.05±0.84	
I can take the consent	Male	4.45±1.07	0.48
	Female	4.28±0.95	
Satisfaction about US training model	Male	4.33±0.98	0.30
	Female	4.41±1.07	

*Mann-Whitney test. SD – Standard deviation

DISCUSSION

There is an increasing demand in the use of POCUS by radiologists and nonradiologists given its utility in diagnosis and patient care. However, US is operator-dependent, and thus there is a need to develop the basic US skills through courses at the undergraduate medical education level. In Saudi Arabia, US is generally not integrated in undergraduate medical study, despite evidence suggesting that doing so enhances student knowledge and may have a positive impact on patient care in the future.^[10-13] Studies have also shown that the use of portable or handheld US devices are active learning tools to obtain real-time visual information and that feedback broadens medical students' horizons and increases their motivation to learn.^[14,15] In line with this, in the 2020 statement from the Canadian Ultrasound Consensus for Undergraduate Medical Education Group, 85 curricular elements were recommended for inclusion in teaching in Canadian medical school-focused US curricula.^[16]

To the best of the author's knowledge, the current study is the first study from Saudi Arabia that has shown the usefulness of a short-term US training in improving the fundamental US abilities of undergraduate medical students. The effectiveness of a short course utilized in this study is in accordance with findings from a previous study, wherein short simulation-based training programs were found to be adequate for medical students to learn how to perform ultrasonography.^[17] Future studies in Saudi Arabia can be conducted using a comprehensive US curriculum using the peer-teaching concept^[18] or through a comprehensive 2-week program for final year medical students that incorporates hands-on US experience with live patients proctored by radiologists.^[19]

In previous studies, US has been used to teach anatomy, musculoskeletal diseases, and physical examination skills.^[20] However, our present US training was more clinically oriented, in which, in its theoretical and practical parts, we integrated and reinforced anatomical and clinical

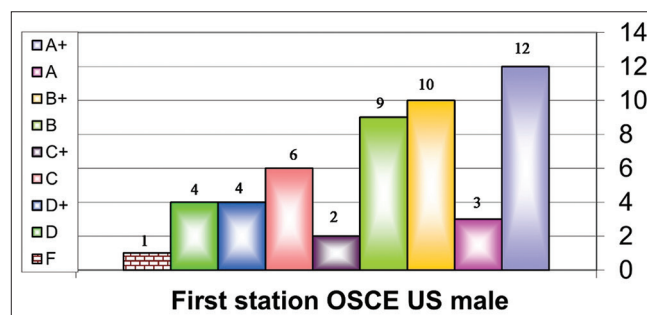


Figure 1: Results of male students in OSCE station

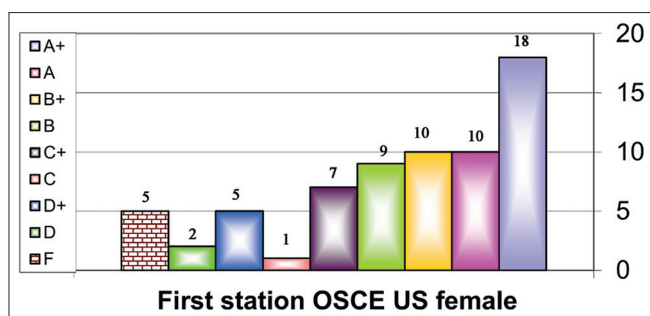


Figure 2: Results of female students in OSCE station

knowledge as well as the importance of this diagnostic modality. Such training should provide students with the ability to solve and interpret different clinical problems they might face in the future. They will also be able to combine their basic knowledge with their clinical skills. Using didactic and small group hands-on sessions, US can be effectively integrated into the existing medical school curriculum, as was demonstrated in a study where medical students viewed POCUS training to be beneficial in terms of understanding human anatomy and learning physical examination skills.^[21]

The majority of the study participants had high scoring in the US OSCE stations (the US of acute cholecystitis), which can be correlated to the effectiveness of the program in raising the basic anatomy knowledge and clinical skills application of the students. Integration of the US into the undergraduate curriculum has shown to improve the knowledge of anatomy in several studies.^[22-24] The US showed real-time visualization of blood flow, peristalsis, and the effect of respiratory movements; it provided a direct clinical application of anatomical knowledge and demonstrated anatomical variation. It also supplemented traditional anatomy instruction, which had previously been done on cadaveric, non-live subjects.^[23] Another advantage was introducing students to living anatomy, which can be easily demonstrated using US machines. One of the most important advantages is also studying the surface anatomy and interrelated anatomy of the body in a clinical context.^[22,24] However, it should be noted that none of these studies, including the current, had a comparator condition, which would have provided a more accurate understanding of the effectiveness of such programs. In contrast, a systematic article that identified five such studies that used comparators, mostly cadaver-based dissection, no difference in the anatomy knowledge or skills were noted between the two methods of teaching.^[2] Therefore, the findings of the current study need to be considered in this light, and future

studies from Saudi Arabia should include a comparator condition to provide a more robust understanding of the usefulness of introducing US for enhancing the anatomy skills of undergraduate medical students.

Adoption of POCUS curriculum has been demonstrated to not only improve the learning outcomes in undergraduate medical programs but also satisfaction.^[25] Similarly, students in the present study had high levels of satisfaction about the US model, which also correlated with their high scoring in OSCE stations. This finding is supported by those of Wlodarkiewicz *et al.*,^[12] who demonstrated that the majority of students felt comfortable using the portable US units, indicating that they were capable of obtaining and interpreting US images. The ability to accurately identify and interpret US images is an important aspect of medical training, and thus medical students must feel comfortable with these skills.

Limitation

A limitation of this study is that it was conducted across a single batch of students from a single university in Saudi Arabia, which limits the samples representativeness. Further, the study used a short-term course with an immediate assessment; therefore, the longer-term recall performance through using such a course could not be assessed. The current study used a single instructor, which provided coherency and avoided inter-instructor differences; however, conducting short-term programs would be dependent on the skills of the instructor, and this should be considered at the implementation process of such processes. To determine feasibility, future studies could also assess the impact of a comprehensive program on the US knowledge and skill levels of undergraduate students in Saudi Arabia.

CONCLUSION

This study found that undergraduate medical students who completed a short course comprising theoretical and hands-on training on US gained adequate knowledge and satisfaction in terms of using US and identifying anatomy. This is the first such study from Saudi Arabia and highlights the benefits of introducing programs dedicated to US for undergraduate medical students, especially given the increasing US skill requirement.

Ethical considerations

The study was approved by the Research Ethics Committee of Jazan University, Jazan, Saudi Arabia (Protocol No. 104-2017; dated: September 28, 2017). Responding to the questionnaire was considered consent for participation

in the study. The study adhered to the ethical principles mentioned in the Declaration of Helsinki, 2013.

Data availability statement

The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Peer review

This article was peer-reviewed by three independent and anonymous reviewers.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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