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ORIGINAL ARTICLE

Simulation-Based Training on Basic Obstetrics and Gynecology Ultrasound Skills During COVID Pandemic

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Abstract

Background COVID-19 pandemic led to an alarming rise in sickness absenteeism among the radiologists. Anticipating a continued shortage of experienced radiologists in future COVID waves, it is essential to train the medical professionals in basic skills related to ultrasonography to enable them to perform basic Obstetrics and Gynecology (OG) scans safely in emergencies. Virtual reality simulation training is an alternative to conventional ultrasound training.

Methods A cross-sectional study was conducted during 8-day-long workshop to identify the trainees' basic, after training knowledge and skills in OG ultrasound and to document their perceptions of the training. Statistical analysis was done using descriptive statistics (percentages and mean standard deviations) and paired t test for comparisons.

Results A total of 80 health care professionals underwent ultrasound simulation training. It was found that the post-test score in the knowledge domain, instrument handling, basic gynecological skills, and first-trimester antenatal ultrasound skills in the practical domain was significantly higher than the pre-test score (P-value < 0.0001). Out of 80 participants, 45 (56.25%) agreed that ultrasound simulation is an ideal method of teaching and training basic OG skills to the novice. Sixty-six out of 80 (82.5%) felt that the principles of handling a human mannequin are the same as those of real patients. Forty-eight participants out of 80 (60.0%) felt that ultrasound simulation can be used as an ideal tool for self-assessment of health care professionals.

Conclusion The study showed that ultrasound-based simulation can provide a realistic setting for training and assessment of novices in learning basic skills.

Keywords COVID-19 · Virtual reality simulation training · Ultrasonography · Skill assessment

Background

Modern Obstetrics and Gynecology (OG) practice is virtually impossible without the use of ultrasonography [1]. The uses range from performing basic tasks like detection of the fetal heart to carrying out invasive procedures like an ultrasound-guided transfusion for fetal anemia. Performing ultrasonography not only requires specialized equipment but also the availability of an expert round the clock. COVID-19 pandemic had a widespread impact on radiologists, increasing their workload and exposure to the virus leading to an alarming rise in sickness absenteeism [2]. In certain parts of the world, this led to delays in appointments, long waiting times for imaging studies, and delays in diagnosis and initiation of treatment, significantly affecting the patient care. With three waves of COVID pandemic in recent years, uncertainty about the future and anticipating a continued shortage of experienced radiologists, it is very essential to train all medical professionals in basic skills related to ultrasonography. The purpose is to enable all

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the trainees to perform basic OG scans safely in emergencies during the COVID-19 pandemic.

A novice in ultrasonography requires planned and sustained, in-person, hands-on training under the supervision of an expert. The basic skills to be taught during the training should include identification and handling of the probes, identification of correct planes, orientation of side and space and basic knowledge to interpret the dynamic image produced by 3-dimensional probes [3]. Conventional ultrasound training is time-consuming and requires extensive teaching resources [4] and is practically not feasible in busy clinical settings. In addition to this, a trainee in the initial phases of conventional training faces the challenge of being refused by the patient for examination. Thus, providing efficient training while maintaining patient safety [5] has become one of the biggest obstacles in teaching ultrasound skills conventionally.

Many alternate ways have been proposed to teach basic OG ultrasound skills to medical professionals. Virtual reality simulation training [6] is one such approach that trains a novice in a shorter period of time. It allows repeated practice in an environment simulating a clinical one with the trainer having direct control over the trainee which is not feasible in a busy clinical setting [7, 8]. In addition, the skills that are obtained after simulation-based training can be retained for a longer duration [9]. Ultrasound simulators are integrated equipment consisting of a human simulation model, a mock probe connected directly to a computer monitor that displays the ultrasound image depending upon the position and movement of the probe. Virtual reality simulators have simulator metrics that may be used to assess the performance in a simulated setting [10]. A variety of performance standards may be used to discriminate the competent from non-competent performers. [11]

ESIC Medical College is a tertiary health care medical institution, where simulation training is not a part of the OG curriculum. Simulation training when used in conjunction with clinical training can significantly improve the basic skill acquisition in ultrasonography at this institute.

Hence, this study was conducted.

- To identify the trainees' basic knowledge and skills in OG ultrasound.
- To determine the acquired knowledge and skills after the ultrasound simulation training.
- To document their perceptions to the simulation-based ultrasound training program.

Methodology

Study site and study period: A cross-sectional study was conducted by the Department of Radiodiagnosis in collaboration with the Department of Obstetrics and Gynecology, ESIC Medical College, Hyderabad, Telangana, between July 9, 2021, and July 16, 2021, as a part of 8-day Obstetrics and Gynecology ultrasound simulation training workshop.

Inclusion and Exclusion criteria: All the health care professionals (junior residents/senior residents/faculty/specialists) working in the institute and who consented to participate were included in the study. Professional radiologists, medical undergraduates, interns and health care professionals from other hospitals were excluded from the study.

Institutional Ethical Clearance was taken (Ref No: 799/U/IEC/ESICMC/F0389/09/2021). After assuring confidentiality, informed consent was taken from the study participants.

Methodology in detail: A cross-sectional study was conducted during the 8-day-long workshop on Obstetrics and Gynecology ultrasound simulation training. As a part of the workshop, a simulation module was tailored to train the health care professionals in instrument handling (selection of appropriate transducer/awareness regarding freezing and unfreezing the image/switching on the color mode/taking measurements and orientation of side and space), basic gynecology (using sagittal and coronal planes of uterus, cervix and ovaries) and normal early pregnancy ultrasound scan (identifying gestational sac/yolk sac/cardiac activity and measuring crown-rump length).

Data collection tool: A self-administered, predesigned questionnaire was made; peer-reviewed, internally validated (Cronbach's alpha score = 8.1) was used for data collection. The questionnaire included 4 parts: demographic details, 4 items related to trainees' basic knowledge in ultrasonography (knowledge domain), 4 items related to trainees' practical skills in ultrasound (skill domain) and 10 items related to perceptions of the trainees to the simulation module (perception domain). Basic demographic details like age, gender and profession were taken from all the study participants.

The workshop was conducted for 8 h in a day enrolling 10 candidates per session. At the beginning of the workshop, all the participants had an hour-long didactic lecture on basics of ultrasound simulation technology and its role in clinical practice. Two US mentor medical simulators (Simbionix 3D systems from Vishal Surgical Equipment Co, Hyderabad, Telangana) with a realistic probe switch and a true-to-life complex ultrasound image, were used for the ultrasound simulation training. All the participants were introduced to the simulator by three mentors (trainee: trainer ratio of 10:3).The trainees were assessed in instrument handling and basic gynecology and the first-trimester antenatal ultrasound with a pre-test (how much practical skills they know before the training). Then, the principal investigator oriented the trainees to these basic concepts through a 15-min short lecture followed by demonstration of instrument handling and above ultrasound procedures for 45 min. After demonstration, all the participants were given hands-on practice on the

ultrasound simulator under direct observation of the trainer. Their learning of practical skills was assessed later by a post-test (how much of practical skills the trainees achieved at the end of training session). The time taken to complete the task before and after the training was also noted. The perceptions of the trainees to ultrasound simulation program were taken. A total of 2 h (1-h theory and 1 h of practical orientation) training was given to each participant, and 2.5 h were spent on their assessment.

All the items in the knowledge domain were marked as yes = 1 and no = 0, and items in the practical skill domain were marked as optimally skilled = 2; partially skilled = 1 and missed = 0 in pre-test and optimally attained = 2, partially attained = 1 and missed = 0 in the post-test. The perceptions of trainees were rated on a 3-point Likert scale agree = 2; neither agree nor disagree = 1 and disagree = 0.

Statistical analysis: The data collected were coded and entered on a Microsoft Excel sheet and analyzed. Descriptive analysis was made using percentages and mean standard deviations. Paired t test was used for comparisons.

Results

A total of 80 health care professionals attended the workshop. The gender-wise distribution of the trainees is depicted in Fig. 1

The mean age of the participants was 30.5 years. The age distribution of the trainees is illustrated in Fig. 2.

Among 80 trainees, 33 (41.25%) belonged to the medical and allied departments, 3(3.75%) to the surgical and allied departments, 14(17.5%) to the emergency medicine and COVID ward and 30 (37.5%) to Obstetrics and Gynecology department.

Among 80 participants, 62(77.5%) were residents, 5(6.25%) were specialists and 13(16.25%) faculty. None of the participants were exposed to prior ultrasound simulation training.

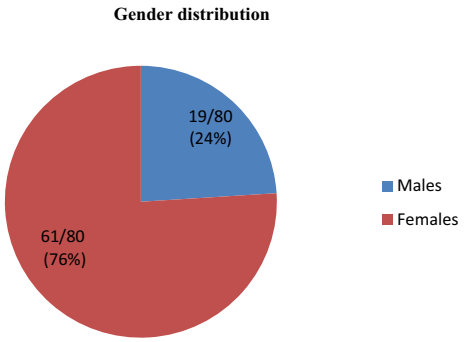

Fig. 1 Gender-wise distribution of trainees

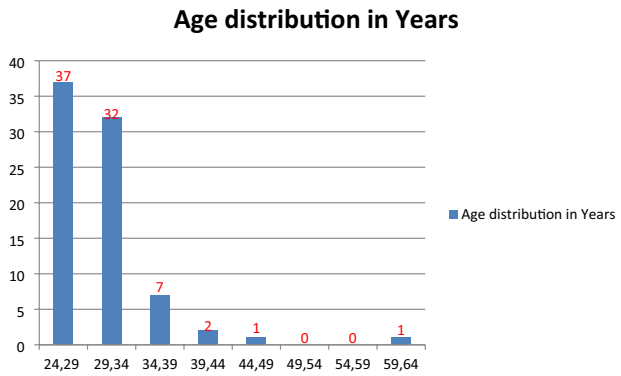

Fig. 2 Age distribution of the health care professionals

The mean pre- and post-test scores were calculated and compared. It was found that the mean post-test score of the knowledge domain was significantly higher than the mean pre-test score (P value = $P < 0.0001$). The details of paired sample t test pre- and post-knowledge domain are depicted in Table 1

Similarly, the mean post-test scores of instrument handling, basic gynecological skills and first-trimester antenatal ultrasound skills in the practical domain were significantly higher than their pre-test scores with P values of 0.0001 in all domains.

The details of pre- and post-test basic gynecological skill scores are depicted in Table 2.

The details of pre- and post-test first-trimester antenatal scan scores are depicted in Table 3.

The average time required to complete the pre-test was 4.59 min, to complete the post-test (3.11 min), and the difference in pre- and post-test time was 1.48 min.

The perceptions of the trainees to ultrasound simulation training were taken. Out of 80 participants, 45 (56.3%) agreed that ultrasound simulation is an ideal method of teaching and training basic OG skills to the novice. Sixty-six out of 80 (82.5%) felt that the principles of handling a human mannequin are the same as those of real patients. In addition, 48 participants out of 80 (60.0%) felt that ultrasound simulation can be used as an ideal tool for self-assessment of health care professionals. Further 74 out of 80 (92.5%) trainees felt that the workshop was interesting and 45 out of 80 (56.3%)

Table 1 Paired Sample *t*-test: pre and post test of knowledge domain

	Sample 1 (Pretest)	Sample 2 (Post-test)
Sample size	80	80
Arithmetic mean	0.3250	1.0000
95% CI for the mean	0.2372 to 0.4128	1.0000 to 1.0000
Standard deviation	0.3946	0.0000
Two-tailed probability	$P < 0.0001$ (Statistically significant)	

Table 2 Paired Sample *t*-test: pre and post test. Basic gynecology skills

	Sample 1 (Pretest)	Sample 2 (Post-test)
Sample size	80	80
Arithmetic mean	0.1250	1.8875
95% CI for the mean	0.05094 to 0.1991	1.8167 to 1.9583
Standard deviation	0.3328	0.3180
Two-tailed probability	$P < 0.0001$ (Statistically significant)	

Table 3 Paired Sample *t*-test: pre and post first trimester antenatal scan

	Sample 1 (Pretest)	Sample 2 (Post-test)
Sample size	80	80
Arithmetic mean	0.4000	1.9125
95% CI for the mean	0.2317 to 0.5683	1.8400 to 1.9850
Standard deviation	0.7564	0.3258
Two-tailed probability	$P < 0.0001$ (Statistically significant)	

felt that the simulation training must be a part of the faculty development program at the institute (Table 4).

Discussion

Our study aimed to assess the reaction, satisfaction and learning of the participants in Obstetrics and Gynecology ultrasound simulation-based training.

Sixty-two out of 80 (77.5%) trainees in our study were residents, 13(16.25%) were faculty, and 5(6.25%) were specialists indicating trainees in various stages of medical professionals participating in the study. These findings are similar to the participant profiles in the study conducted by Sagar Shah et al. [12] in 2019.

All our study participants were never exposed to prior ultrasound training. This is in contrast to the study conducted by Selim Hani et al. [13] in 2019, where the participants had an average experience of 2.27 years and 30 scans at the time of training.

The current study showed significantly higher post-test mean scores in all domains (knowledge, instrument handling, basic gynecology skills and first-trimester antenatal scan skills) when compared to the pre-test mean scores ($P < 0.0001$), demonstrating skill transfer following simulation-based ultrasound training. These findings are concurrent with the study of Tolsgaard MG [14] in 2015. However, previous studies have shown that though simulation-based training helps the novice in attaining expert performance levels, the extent to which these performances can be transferred into clinical practice with real-time patients is not known [15].

The majority of participants in our study had positive perceptions of ultrasound simulation training in OG. Forty-five out of 80 participants in our study agreed that ultrasound simulation is an ideal method of teaching and training basic OG skills to the learner. The significance of simulation technology in acquiring and practicing clinical skills was illustrated in the study conducted by Issenberg et al [16] in 1999. Our findings are also concurrent with the results of Rosen H et al. [17] which stated that simulation-based training enables the novice to get more familiarized with the equipment and learn the basic ultrasound skills without getting exposed to real-time patients.

Table 4 Perceptions of Trainees to ultrasound simulation training

Perceptions to ultrasound simulation training	Agree, *n* (%)	Neither, *n* (%)	Disagree, *n* (%)
P1 = Ultrasound simulation is an ideal method for teaching and training basic OG skills to the novices	45(56.25)	20 (25.0)	15 (18.75)
P2 = US simulation gives a realistic experience of images and manipulation of the probe	52 (65.0)	22 (27.5)	6 (7.5)
P3 = During the training, I understood that the principles of handling a human mannequin are same as those of real patients	66 (82.5)	11 (13.8)	3 (3.8)
P4 = The trainer was confident and allotted sufficient time to teach the basic OG ultrasound skills	17 (21.3)	60 (75.0)	3 (3.8)
P5 = The session was very interesting, and I am satisfied with the basic skills I have learnt today	74 (92.5)	6 (7.5)	0 (0)
P6 = I am likely to recommend this course to my friends and colleagues outside the institution	79 (98.8)	1 (1.3)	0 (0)
P7 = Ultrasound simulation can be used as an ideal tool for self-assessment of health care professionals	48 (60.0)	30 (37.5)	2 (2.5)
P8 = Ultrasound simulation should be a part of faculty development program in the institute	45 (56.3)	32 (40.0)	3 (3.8)
P9 = I am likely to practice the skills I acquired during the workshop in managing emergency situations in future pandemic	65 (81.3)	13 (16.3)	2 (2.5)
P10 = I am very much interested to participate in future simulation initiatives	43 (53.8)	31 (38.8)	6 (7.5)

A study by Madsen et al. [15] in 2014 showed that a few hours of hands-on practice in a simulated setting can train the novice to attain expert levels of performance at selected tasks.

Sixty-five out of 80 participants in our study were confident in practicing the skills they acquired in simulation training to be used for emergencies during the COVID pandemic. A study conducted by Tolsgaard MG et al. [18] in 2018 concluded that simulation-based ultrasound training increased the confidence of the operator and led to performance improvement in a clinical setting. Another study by Le Lous M et al. [19] in 2017 found that the work performance of the residents who underwent simulation-based ultrasound training was superior to those who received clinical training alone.

Forty-eight participants out of 80 felt that ultrasound simulation can be used as an ideal tool for self-assessment of health care professionals. A study by Madsen et al. [15] in 2014 demonstrated that performance could be reliably and validly assessed using a virtual reality ultrasound simulator. In addition, the majority of our participants recommend ultrasound simulation in Obstetrics and Gynecology to be included in the faculty development program. A study conducted by Ziv et al. [20] in 2003 found that simulation-based training is essential for all health professionals as it improves patient care.

Conclusion

The study showed that simulation-based ultrasound training can provide a realistic setting for teaching and assessing basic skills for novices. Such simulation-based training must be incorporated into the faculty development programs to train all the health care professionals so that they can handle emergencies. However, repeated training is required to retain the knowledge gained during the workshop.

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Declarations

Conflict of interest The authors declare that there is no conflicts of interest.

Human or Animal Rights This article does not involve any human or animal participants.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Ethical Statement The study was approved by the Institutional Ethical Committee vide no: ESICMC/SNR/IEC-F0389/09/2021, Version no. V01. It was in accordance with ethical standards of institutional ethical committee and Helsinki Declaration. After assuring confidentiality, informed consent was taken from the study participants. This study is in line with the principles of Helsinki Declaration.

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