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RESEARCH ARTICLE

The Importance of Multimodality Pelvic Ultrasound Simulation in Teaching of Obstetrics and Gynecology Residents

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ABSTRACT

Objective: The use of transabdominal and transvaginal ultrasound is the test of choice in many Obstetrics and Gynecology practices. The objective of our study is to demonstrate how simulated ultrasound teaching could improve residents' knowledge between PGY1 and PGY2 years in the area of (1) the ability to perform an accurate transabdominal and transvaginal ultrasound in a sensitive manner, (2) to identify and describe normal and abnormal female pelvic sonographic findings for interpretation and (3) to demonstrate clinical sonographic correlation of the most common clinical presentations on pelvic ultrasound.

Materials and methods: A total of 24 residents participated in this course during their usual scheduled training period from July 2011 to July 2013. Twelve of the 24 residents had previously taken the course 1 year prior and were used to compare changes in their level of understanding of the subject matter. An introductory lecture with a precourse knowledge assessment was initially provided to the residents prior to simulation training. The residents were then randomized into four groups of 2 to 3 residents and provided 45 minutes of training at each simulation station.

Results: Overall, the mean score for all three stations was noted to be 81.1 and 88.9%, respectively, between PGY1 and PGY2 residents during the 3 years.

Conclusion: The results of both high fidelity and low fidelity simulations have improved when comparing the increase in scores between the PGY1 and the same learners as PGY2s in the following year. We have shown that of the 12 residents who were able to repeat the course during concurrent years, there was an increase in the post evaluation scores each year.

Keywords: Transabdominal ultrasound, Transvaginal ultrasound, Pelvic ultrasound, Pelvic ultrasound simulation, Pelvic examination simulation, Clinical sonographic correlation, Residency training.

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INTRODUCTION

The use of transabdominal and transvaginal ultrasound is the test of choice in many Obstetrics and Gynecology practices. The ability to both perform and interpret ultrasounds has always been an important part of the core curriculum in all obstetrics and gynecology residency-training programs in the United States as per the American Congress of Obstetrics and Gynecology (ACOG).[1] Medical simulation has become an essential part of training because it has the benefit to provide a safe learning environment for novices. Simulation also provides training physicians the ability to practice procedures without significant adverse complications on patients within a short period of time.[2] An additional benefit for training physicians is knowledge gained in a low stress environment *vs* the traditional method of training on live patients and impacting patient safety.[2,3] As residents continue to train in the clinical environment, their skill of practice is determined strongly by the case mix that they are exposed to through ultrasound rotations and gynecological exposure. Simulation provides a good baseline for incoming residents and can continually be measured for programs to determine where improvements in knowledge and technique need to be made.[4-6]

In 2009, the American College of Graduate Medical Education (ACGME) established new work hour regulations limiting residents to an 80 hours work week and mandated 1 day off per every 7 days of the week over an average of a month.[7,8] Due to these decreased work hour regulations, there has been a great impact in the surgical residency programs to continue to teach the same amount of information and skills in a shorter period of time, while still graduating successful future physicians. With these new time restraints, training incorporating simulation has become an essential tool to amplify real world experiences in the training environment.[3]

The objective of our study is to demonstrate how simulated ultrasound teaching could improve residents' knowledge between PGY1 and PGY2 years in the area

of (1) the ability to perform an accurate transabdominal and transvaginal ultrasound in a sensitive manner, (2) to identify and describe normal and abnormal female pelvic sonographic findings for interpretation, and (3) to demonstrate clinical sonographic correlation of the most common clinical presentations on pelvic ultrasound.

MATERIALS AND METHODS

Study Design

This was a prospective, randomized, cohort trial evaluating Obstetrics and Gynecology residents in their PGY1 and PGY2 years at Paul L Foster School of Medicine (PLFSOM), Texas Tech University Health Science Center (TTUHSC) at El Paso, TX. The protocol was approved by expedited review of Institutional Review Board at this institution.

Study Protocol

Our study was performed in a residency setting at PLFSOM, TTUHSC at El Paso, TX. A total of 24 residents participated in this course during their usual scheduled training period from July 2011 to July 2013. Twelve of the 24 residents had previously taken the course 1 year prior and were used to compare changes in their level of understanding of the subject matter.

An introductory lecture with a precourse knowledge assessment was initially provided to the residents prior to simulation training. The residents were then randomized into four groups of 2 to 3 residents and provided 45 minutes of training at each simulation station. The stations consisted of: clinical sonographic correlation (station 1), transabdominal ultrasound (station 2), and transvaginal ultrasound (station 3). Scenarios comprised within the stations were developed and reviewed by three board-certified obstetrics and gynecology and two radiology specialists subspecialized in ultrasound imaging. The physicians remained the same during each year of testing to decrease outsider variability. The simulators employed were a low fidelity pelvic simulator (Pelvic Examination Simulator set) manufactured by Limbs and Things, Savannah, GA, USA. A high fidelity pelvic simulator with sensors was manufactured by CAE Healthcare, Sarasota, FL, USA. An ultrasound training simulator ('UltraSim') was manufactured by MedSim Inc, Ft Lauderdale, FL, USA. The ultrasound machine employed was the Voluson E8, GE HealthCare Clinical Systems, Milwaukee, WI, USA.

In station 1 (clinical sonographic correlation), three case scenarios were presented individually to the residents. Each case comprised of a description of the patient, pertinent history and vitals in addition to pertinent ultrasound images. Residents were expected to complete a differential diagnosis

Fig. 1: Low fidelity mannequin for pelvic examination

Fig. 2: High fidelity mannequin (UltraSim) used for transvaginal ultrasound simulation

and appropriate diagnostic workup from the information provided. Case encounters included secondary amenorrhea, menorrhagia and a period pelvic exam. Each resident was provided the same information and both the low fidelity and high fidelity models were set up in the same manner (Fig. 1). Residents were given 15 minutes per scenario, followed by individual feedback by faculty and a computer-generated report demonstrating technical details on resident's manual dexterity during the high fidelity pelvic model. Residents were then graded by faculty using a standardized checklist.

Station two (transabdominal ultrasound) consisted of three standardized live patient pelvic exams. The faculty proctor demonstrated the technique to perform a transabdominal ultrasound on a standardized patient. The resident was then evaluated using a standardized skills checklist consisting of preparation for the ultrasound, producing images of the uterus, adnexa, *cul-de-sac* and the ability to interpret and discuss relevant sonographic findings. Residents were rated on a scale of 0-2 with 0 indicating inability to perform the particular task and 2 identifying competence in the performed task. A total score of 10 was the maximum possible for the station. The assigned faculty

proctor provided feedback on the particular residents' performance. The same standardized patients were used each year to keep continuity for the exercise.

Station three (transvaginal ultrasound) consisted of three case scenarios in which pelvic exam was performed on a high fidelity mannequin (UltraSim) (Fig. 2). This model had the capability to change the in-built portion of the pelvic anatomy based on the clinical scenario. Prior to performing the exercise, the proper technique to perform a pelvic exam was demonstrated by the proctor. The residents were then evaluated using a standardized skills checklist; the same as described for station two. Skills reports were generated and specific feedback was discussed with each resident. At the end of the completion of all the stations, a post-test knowledge assessment was taken by the residents to identify if the simulation exercises were helpful in learning.

Data Analysis

Data collected was entered in to a Microsoft excel worksheet with all results per resident level, scenario checklist and pre and post evaluations. The mean value of each of these factors was then expressed. The total percentage of correct answers per group was expressed.

Results

A total of 24 residents were evaluated between July 2011 and July 2013 during their PGY1 and PGY2 years. Comparisons were performed between the 2 years as residents were able to complete the same course in concurrent years. Results were divided into three subgroups based on the completed stations of clinical sonographic correlation (station 1), transabdominal ultrasound (station 2) and transvaginal ultrasound (station 3).

A total of 8 residents participated in July 2011 (Table 1). Results from station one revealed a mean score of 85% for PYG 1 and 88.3% for PGY 2, respectively. Table 1 further describes the quantitative results of residents' electronic bimanual exam recorded by the METI Pelvic Exam simulator. Results from station two and three showed that 73.8% of PGY1 and 83.3% of PGY2, respectively, were able to successfully identify and discuss the images of the urinary bladder, uterus, cervix, vagina, adnexa and cul-de-sac on ultrasound. Overall, the mean score for all three stations were 79.2 and 86.3%, respectively, between PGY1 and PGY2 residents.

A total of 8 residents participated in July 2012. Table 2 demonstrates a mean score at station one of 58.3% for PGY1 and 93.8% for PGY2. When comparing the current PGY2 residents to their former scores as PGY1 in 2011, there is a notable improvement. Station two and three revealed a combined score of 100% for both the PGY1 and PGY2 residents. This again is a vast improvement from the year prior. Overall, the mean score for all three activities was 76.6 and 87.9%, respectively, between PGY1 and PGY2 residents.

A total of 8 residents participated in July 2013. Table 3 demonstrates the mean score at station one of 73.9% for PGY1 and 88.9% for PGY2. When comparing to the current PGY2 residents to their former scores as PGY1 in 2012, there is again a notable improvement. Station two and three revealed a combined score of 100% for both the PGY1 and PGY2 residents. This, however, showed no improvement from the year prior in 2012. Overall, the mean score for all three activities was noted to be 87.3 and 91.2%, respectively, between PGY1 and PGY2 residents. There was an increase of 10% in the overall score for the PGY2 residents compared to their original PGY1 score in 2012.

Table 1: Ultrasound simulation results for first cohort of residents in July 2011

PGY	*Number of residents*	*Precourse assessment*	*TA and TV ultrasound stations*	*Clinical sonographic correlation*	*Postcourse assessment*	*Mean score*
PGY 1	4	74.8%	73.8%	85%	83%	79.2%
PGY 2	4	83.8%	83.3%	88.3%	89.6%	86.3%

PGY: postgraduate year; TA: transabdominal; TV: transvaginal

Table 2: Ultrasound simulation results for first cohort of residents in July 2012

PGY	*Number of residents*	*Precourse assessment*	*TA and TV ultrasound stations*	*Clinical sonographic correlation*	*Postcourse assessment*	*Mean score*
PGY 1	4	71.3%	100%	58.3%	76.9%	76.6%
PGY 2	4	80%	100%	93.8%	78.1%	87.9%

PGY: postgraduate year; TA: transabdominal; TV: transvaginal

Table 3: Ultrasound simulation results for first cohort of residents in July 2013

PGY	*Number of residents*	*Precourse assessment*	*TA and TV ultrasound stations*	*Clinical sonographic correlation*	*Postcourse assessment*	*Mean score*
PGY 1	4	88.2%	100%	73.9%	87.3%	87.3%
PGY 2	4	89.5%	100%	88.9%	85.7%	91.2%

PGY: postgraduate year; TA: transabdominal; TV: transvaginal

Table 4: Overall analysis of ultrasound simulation results (2011-2013)

PGY	*Number of residents*	*Precourse assessment*	*TA and TV ultrasound stations*	*Clinical sonographic correlation*	*Postcourse assessment*	*Mean score*
PGY 1	12	78.1%	91.3%	72.4%	82.4%	81.1%
PGY 2	12	84.4%	96.1%	90.8%	84.6%	88.9%

PGY: postgraduate year; TA: transabdominal; TV: transvaginal

Overall Analysis

A total of 24 residents participated during the period from July 2011 to July 2013 with 12 overlapping residents, making a correlation between PGY1 and PGY2 possible. Table 4 demonstrates station one mean scores of 72.4% for PGY1s and 90.8% for PGY2s, respectively. As shown in the correlation of 2011-2012, the PGY2 mean score improved significantly within the year of residency. Station two and three showed a combined mean score of 91.3 and 96.1% for PGY1 and PGY2 respectively. Overall, the mean score for all three stations was noted to be 81.1 and 88.9%, respectively, between PGY1 and PGY2 residents during the 3 years.

DISCUSSION

The use of simulation has been a core part of the curriculum in many other career fields to both train and enhance learning. The military has used simulation to train soldiers prior to deployment for the past decade. Flight simulators are also an essential part of training for pilots prior to their first flight and have long shown to be an effective and safe method of training.[9] These devices have been relatively new to the medical field, however use of simulation in the residency environment has been shown to improve the quality of resident education as well as teach residents real world scenarios in a low stress environment.[2,3] It also gives each resident an equal opportunity to learn basic and advanced skills in a safe environment without placing patients at harm. The use of simulation early in resident education has shown to enhance individual confident levels, stress hardiness and encourage residents to take more leadership roles in emergency situations.[10,11]

Many studies demonstrated that both the use of high fidelity and low fidelity trainers can improve training to both residents and board certified physicians in all areas of the medical field.[12,13] The use of multiple simulation devices to gain a better understanding for residents have been used in Emergency Medicine, General Surgery, Anesthesia and Internal Medicine to teach residents to place basic IV lines to more advanced skills such as running an emergency code or performing a surgery.[14-16]

The unique aspect of our course is that it includes a combination of high fidelity models, low fidelity models and standardized patients to give residents a complete experience when performing ultrasound. The protocol teaches residents not on the skill and technique necessary to effectively perform the task but also reinforces the importance of bedside manner when performing such a sensitive test. Our course shows that the combination of multiple modalities can assist residents in not only interpreting ultrasounds but also to be able to be comfortable in performing transabdominal and transvaginal ultrasounds both in the simulated and real world situation. Residents gain the knowledge and confidence to be able to interpret findings in a complete clinical scenario. The advantage of the course was that board certified physicians instructed residents so errors could be easily corrected and proper technique could be taught during each training session. The combination of simulation, standardized patient encounters and one-on-one teaching synergizes the approach of simulation training.

One of the limitations in this study was that we were unable to evaluate or account for the clinical experience each resident gained between years PGY1 and PGY2 during their clinical residency time. Another limitation was the small study population due to the limited number of residency spots available at our particular institution per year.

CONCLUSION

The importance of both high fidelity and low fidelity simulations were shown in this course when comparing the increase in scores between the PGY1 and the same residents as PGY2s in the following year. We have shown that of the 12 residents who were able to repeat the course during concurrent years, there was an increase in the post evaluation scores each year. When comparing skill levels on the standardized forms from each year, there was also noted improvement as each resident progressed through their residency levels. Our course shows the importance of incorporating multiple modalities when teaching ultrasound simulation as a standard portion of residency didactic education to increase knowledge and standardize the ultrasound techniques taught to each resident.

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