



Introduction of a student tutor-based basic obstetrical ultrasound screening in undergraduate medical education

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Abstract

Background While there is an increasing interest in incorporating ultrasound in undergraduate medical education and the use of student tutors in conveying this medical skill to assist faculty members, little is known about undergraduate ultrasound teaching in obstetrics and gynecology.

Methods After a 3 week training of the student tutors, the student tutors joined an undergraduate ultrasound educational program to teach practical round students. After being certified, the student tutors organized a pre-test, gave a presentation about ultrasound, and then supervised the hands on ultrasound course under faculty staff supervision for round students. Finally, the practical round students had to answer a post-test with image recognition. The practical round students had to evaluate the course using a Likert scale.

Results 111 students joined this ultrasound course. The objective theoretical and practical multiple-choice questions' (MCQ) test showed a statistically significant improvement (50 vs. 90%, $p < 0.05$). The practical round students expressed a high acceptance (Likert 1.7) and subjective medical skill learning (Likert 1.8). The students also positively graded the student tutors (Likert 1.3).

Conclusion Student tutor-based undergraduate obstetrical and gynecological ultrasound course is a useful method to teach a medical skill and is well accepted by students.

Keywords Ultrasound · Undergraduate education · Tutor · Medical education

Introduction

Ultrasound is a cornerstone in the diagnostics and management of obstetrics and gynecology. Several guidelines have been developed to standardize the clinical practice, organize, and support research in this field [1]. Sonographers have been internationally classified after standardized training programs and exams according to their competence [2].

Different training programs have also been developed for residents [3].

Despite of this development, little attention has been paid for the undergraduate education of ultrasound in obstetrics and gynecology. To our knowledge, even in undergraduate educational programs, where ultrasound was horizontally incorporated, obstetrical ultrasound has not been included [4]. Yet, the conventional undergraduate medical curricula incorporated classical examination methods, e.g., inspection, palpation, the use of stethoscope, and blood pressure measurement [5, 6]. Therefore, we are convinced that modern curricula should integrate obstetrical and gynecological ultrasound to prepare sufficient young physicians for their future careers [4, 7, 8].

The development of ultrasound training programs in undergraduate education has been increasingly receiving attention in the past decade. Introducing ultrasound in medical undergraduate education has extended to include basic sciences, e.g., anatomy, and physiology and clinical

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disciplines, e.g., echocardiography, neurosonography [4, 9–15]. To our best knowledge, we were the first to present in a previous publication that basic obstetrical and gynecological ultrasound can be taught in a standardized ultrasound program [9].

To compensate for the limited availability of hospital staff, peer-student instructors have been incorporated to teach clinical skills. Following proper skill and didactical development, students offer a good potential to tutor undergraduate ultrasound teaching programs [9]. Different methods to train undergraduate medical students, as ultrasound instructors, were described. Ahn et al. were able to show that senior medical students may serve as instructors for an integrated ultrasound and physical exam curriculum. However, they recommended further research to assess their effectiveness [16].

In our current teaching approach, we present a peer-student-instructed-based undergraduate ultrasound program to teach basic obstetrical and gynecological ultrasound.

Methods

We trained student tutors that worked under supervision of the teaching staff to train undergraduate students according to a previously developed curriculum for basic obstetric and gynecological ultrasound [9]. The Saarland Medical Council's ethical committee was informed about the teaching project (91/18). All subjects in the project, students and patients, were asked orally for consent prior to taking part in this teaching project. Given the benefit of the project, all students agreed to participate. All patients were asked prior to undergoing sonography, whether a student may perform the ultrasound under a qualified guidance. Patients not agreeing to participate were excluded from this project.

Selection of the student tutors

We selected our student tutors among a preselected tutor group that worked in another undergraduate ultrasound student teaching project at the University of Saarland, SonoBYstudents. Being student tutors for abdominal ultrasonography, their incorporation offered the advantage of having student tutors that are already trained in handling ultrasound devices with good teaching experiences and didactic skills [17]. To be a student tutor in the SonoBYstudent program, each student should have finished her/his preclinical studying, finished the basic course during their first clinical semester, or have studied at least four semesters in the University of Saarland.

Training of the student tutors

The student tutors received an extensive 3 week training program. This program included online and onsite theoretical and practical sections about ultrasound in obstetrics and gynecology based on national and international protocols [1, 2]. The training took place in the outpatient clinics of the department of obstetrics and gynecology. For gynecological ultrasound, we used the protocols of the American institute for ultrasound in medicine for the sonography of the female pelvis [1]. For obstetrical ultrasound, we used the protocol of the German society of ultrasound in medicine (DEGUM) [2].

Before starting the course, the students had to answer a pre-test, where theoretical and practical knowledge about ultrasound in obstetrics and gynecology was assessed. After answering this multiple-choice question test, they started the first theoretical course.

The theoretical courses were presented using online power point presentations about the general aims of the program and basics of ultrasound in obstetrics. The whole theoretical part comprised four lectures, followed by practical course on the following day using the knowledge acquired in presentation of the night before. After the fourth presentation, the students had acquired knowledge about:

- a. assessment of the fetal presentation and lie;
- b. assessment of the location of the placenta;
- c. assessment of the amniotic fluid index;
- d. assessment of the basic fetal biometry and estimating the fetal weight;
- e. assessment of Doppler Indices of the uterine, umbilical, middle cerebral arteries and ductus venosus;
- f. assessment and measurement of the puerperal and non-pregnant uterus, ovaries and urinary bladder using transabdominal sonography.

In the remaining days, the student tutors performed ultrasound using the standardized methods presented until day 21. During the course, we introduced the student tutors to our department and familiarized them with the different rooms, ultrasound devices, post-labor, and labor wards. We also taught them how to recruit inpatients for undergraduate teaching purposes later.

At the end of the training program, the candidates performed an objective structured clinical examination (OSCE) assessing the acquired skills using ultrasound in obstetrics and gynecology on patients. We also evaluated their theoretical knowledge via multiple-choice questions (MCQ). After attending the course and successfully passing the practical and theoretical exams, we certified the

student as a tutor for undergraduate students for obstetrics and gynecology. The curriculum of the course is summarized in Table 1.

Integration of the student tutors in the undergraduate teaching program:

As previously reported [9], 9–12 students rotate weekly into the practical course from Monday to Thursday. The students rotate in different specialized units within the department, including ultrasound department. The prenatal ultrasound department includes three specialized consultants (one DEGUM level III and two DEGUM level II sonographers) and one resident in training. The department also includes the above-mentioned trained tutor.

The students received a logbook prior to attending the practical sessions in the department. They also received a curriculum evaluation, as shown in Table 3, where they were asked to grade their training program using a Likert scale and four questions that evaluate their student tutors.

Pre-course evaluation

Prior to our practical sessions, the students had to solve a multiple-choice questionnaire (MCQ), which is composed of four theoretical- and six clinical-oriented questions. The standardized exam was supervised by the tutor. After having finished the exam, the tutor handed them out to the physicians of the department for correction. We used Klaus® (Blubbsoft GmbH) Version 1.0 for the correction and grading of the MCQs in the pre- and post-course evaluation.

Using the MCQs, we intended to show to the students their inability to identify basic sonographic fetal planes and their lack of basic clinical skills, thus consciously incompetent, according to the Peyton approach for skills teaching [5].

Theoretical orientation

As reported [9], we included a theoretical orientation for the students. The trained tutor outlined under surveillance the scientific and practical content of the ultrasound program

Table 1 Summary of the content of the course from day 0 to day 21

	Content of the presentation
Presentation 1	Introduction of the course, aim of the course, detailed structure of the training program
Day 1	Introduction of the department and different rooms, attendance of ultrasound sessions
Presentation 2	Different ultrasound modalities in obstetrics, knobology, ultrasound probes, assessment of fetal vitality, assessment of fetal lie and presentation, assessment of the placenta. Only B-mode sonography is used
Day 2	Attendance in the ultrasound department. Performing ultrasound on patients with assessment of only the contents in presentation 2
Presentation 3	Fetal biometry, different formulas, growth charts, assessment of the planes and measurement of the biparietal diameter, head circumference, abdominal circumference, femur length, quick glimpse on fetal sonomorphology, and assessment of amniotic fluid index
Day 3	Attendance in the ultrasound department. Performing ultrasound on patients with assessment of only the contents in presentation 3
Presentation 4	Basics of uterine perfusion during pregnancy, fetal haemodynamics, measurement of the Doppler Indices of uterine artery, umbilical artery, middle cerebral artery and ductus venosus, basics of first trimester ultrasound, invasive diagnostics (Amniocentesis, Chorionic Villous Sampling), non-invasive prenatal diagnostics
Day 4	Attendance in the ultrasound department. Performing ultrasound on patients with assessment of only the contents in presentation 4
Presentation 5	Female pelvic anatomy, basics of gynaecological ultrasound using the transabdominal probe, presenting and measurement of different planes of the uterus, ovary and urinary bladder, the role of 3D sonography
Day 5	Attendance in the post-labour department. Performing ultrasound on patients with assessment of only the contents in presentation 5 on an enlarged puerperal uterus. Attendance in the ultrasound department. Performing ultrasound on patients with assessment of only the contents in presentation 4
Day 6	Attendance in the gynecology outpatient clinic. Performing transvaginal and transabdominal ultrasound on patients with assessment of only the contents in presentation 5 on an enlarged puerperal uterus
Day 7–19	Performing ultrasound under direct supervision with presentation of the standardized examination aspects presented in presentations 1–5
Day 20	Quick round to present all the ultrasound devices in the department, presenting the labour ward and how to acquire patients for students, quick round in the operation room if wished
Day 21	Certification exam Objective structured clinical examination (OSCE) assessing the acquired skills using ultrasound in obstetrics and gynaecology Assessment of theoretical knowledge via multiple-choice questions (MCQ) This was followed by the correction of the exam and discussing the results

in a pre-designed, standardized presentation after the pre-course evaluation. The course also included the basics of ultrasound technique and its application in obstetrics and gynecology, with a special focus on prenatal medicine.

Practical training

Each student rotated for 1 day in the department of ultrasound, where they were expected by the student tutors. The student tutors prepared patients that were already scanned by an advanced sonographer to exclude any fetal pathologies. The students were given a guided course on how to perform a basic obstetrical examination. The student tutors taught them how to estimate the fetal lie, amniotic fluid index and how to locate the placenta. They only showed them how to perform a fetal biometry and umbilical artery Doppler. Following that, the students were assisted while scanning puerperal patients and were shown to measure a uterus.

The students then rotated to the specialized advanced sonographers, where the fetal anatomy was presented to them in detail. Again, students could perform guided basic obstetrical ultrasound, with a focus on evaluating the following fetal structures: (1) biparietal diameter and head circumference in the transthalamic plane; (2) abdominal circumference, presenting the proximal abdominal area in cross section; (3) the femur length in the sagittal plane; (4) the four-chamber view of the fetal heart; (5) the position of the fetal spine and fetal lie; and the placental position. Before performing an ultrasound, the patients were asked for consent to take part in the course.

Post-course evaluation

As previously reported, we ended the course with a reassessment of the students' knowledge using the same MCQs of the beginning of the week [9]. The students then evaluated the course anonymously and returned their logbooks.

Statistical analysis

MCQ scores

The MCQ scores, four theoretical and six practical (image recognition) questions, were categorized into theoretical, practical, and overall marks. We did a statistical analysis using SPSS Version 20 (IBM Inc, Armonk, NY) for Mac. We calculated the mean, median, and range for each test category (Table 3). The scores were treated as continuous variables.

The Shapiro–Wilk test rejected a normal data distribution. Therefore, we used Wilcoxon signed-rank test to compare the medians of the pre- and post-evaluation test

scores. A two-sided p value of less than 0.05 was considered statistical significant.

Student curriculum evaluation

We treated the Likert score given in the student curriculum evaluation assessment as continuous variables. We statistically analyzed the descriptive data and calculated the mean, median, and range via SPSS version 20.

Using the Likert scale, the lower the mean or the median, the more positive the result (and vice versa). We also listed the cumulative percentages of the “agree” and “strongly agree” inputs to elaborate the percentage of positive answers among the whole population. The cumulative percentage and the student curriculum evaluation Likert scale were marked as subjective parameters for the impact of the tutor-based basic obstetrical and gynecological ultrasound course in medical education. Our analysis is based on complete cases, not imputing for missing values.

The Likert is an ordered scale used to evaluate attitudes by offering a range of answers, for which the respondents choose levels to which they “agree” or “disagree.” Questionnaire respondents select one choice best suitable with their judgement. An average scale could be “strongly disagree, agree, neutral, disagree, or strongly disagree.” Considering our scale, the more the mean or median goes to 1, the more positive is the assessment [18].

Results

A total of 111 students took part in the course from April to July 2017.

MCQ scores

The MCQ score data were available for 99 students. The median overall MCQ scores were 50 (50%) of 100 before and 90 (90%) of 100 after the course, with a range of 0–100 and 30–100, respectively. The median of the theoretical MCQ score was 20 (50%) of 40 before and 40 (100%) of 40 after the course, with a range of 0–40 and 10–40, respectively. The median of practical MCQ scores was 40 (66.7%) of 60 before and 50 (83.3%) of 60 after the course, ranging from 0 to 60 before and after the course.

The MCQ scores before and after the course showed a statistically significant improvement in all subparameters (overall, theoretical, and practical parameters) ($p < 0.001$). These data are presented in Table 2.

Table 2 Descriptive statistics and statistical analysis of the pre- and the post-course multiple-choice questionnaire

Variable	Pre-course	Post-course	<i>p</i> value*
Theoretical knowledge, median score (range)	20/40 (0–40)	40/40 (10–40)	< 0.0001
Practical ability, median score (range)	40/60 (0–60)	50/60 (0–60)	< 0.0001
Overall median score (range)	50/100 (0–100)	90/100 (30–100)	< 0.0001

**p* values were calculated using Wilcoxon signed-rank test

Table 3 Mean percentage (%) responding agree or strongly agree, mean, and median Likert scores of the student evaluation

Questions	Mean Likert Score ^a	Median Likert Score ^a	Mean % responding agree or strongly agree (%)
Part A			
Using ultrasound improved recognizing the fetal physiology	1.63	1	86
Using ultrasound improved my skills to detect fetal anomalies	1.96	2	75
I did have problems with patient contact	1.48	1	90
I learned a lot from dealing with patients	1.67	1.5	86
The ultrasound course improved the overall quality of medical studies	1.48	1	91
I would like to do more ultrasound during my training	1.17	1	97
I would like to do more ultrasound in other branches and subjects	1.15	1	98
Utilizing ultrasound improved my understanding of gynecology and obstetrics	1.63	1	85
Ultrasound improved my understanding and competence in the medical examination	1.56	1	89
I received sufficient technical knowledge of ultrasound examination	2.22	2	60
I acquired enough confidence in using ultrasound	2.24	2	63
I was motivated during the semester to do ultrasound examination	1.33	1	95
The introduction of the ultrasound course motivated me to choose ob/gyn as a career	2.96	3	37
I enjoyed the ultrasound practices	1.32	1	95
Part B			
Using student tutors was a good idea	1.24	1	95
Using student tutors improved the quality of undergraduate education	1.35	1	92
The practical training by the student tutors made the course enjoyable	1.29	1	94
The student tutors were able to answer my questions	1.26	1	94

Part A: Questions evaluating the course. Part B: Questions evaluating the student tutors. The mean, median, and percentage responding agree or strongly agree

^aScale: 1, strongly agree; 2, agree; 3, neutral; 4, disagree; and 5, strongly disagree

Part A: student curriculum evaluation

Curriculum evaluation data were available in 96 cases and were included in the following evaluation. The data are presented in Table 3.

86% of the students reported an improvement of their ultrasound for detection of fetal physiology (Likert scale 1.63), while 75% reported an improvement of the detection of fetal pathologies (Likert scale 1.96). Despite the primary concern dealing with patients, 90% of the round students reported having no problems when encountering patients (Likert scale 1.48). 86% even reported having benefited from their contact with real patients (Likert scale 1.67). Regarding the quality of the medical studies after incorporating this course, 91% reported an overall quality improvement (Likert scale 1.48) with 97% of them wishing to do more ultrasound

in their undergraduate training program (Likert scale 1.17) and 98% longing for incorporating more ultrasound courses in other disciplines during their undergraduate studies (Likert scale 1.15).

Adding this student-based practical ultrasound course improved the understanding of obstetrics and gynecology in the eyes of 85% of the round students (Likert scale 1.63). 89% of the round student reported an improvement of their medical examination skills after having done with course (Likert scale 1.56).

Only 60% received sufficient technical knowledge about ultrasound examination (Likert scale 2.22) and only 63% acquired ample confidence in using ultrasound (Likert scale 2.24).

Despite the fact that 95% of the round students were motivated during the semester to perform ultrasound (Likert scale

1.33), only 37% were further motivated to choose obstetrics and gynecology as their future career (Likert scale 2.96).

Part B: evaluation of the student tutors

Regarding the student tutors, 95% of all students agreed that integrating student tutors in our course being a good idea. 94% of all students expressed their satisfaction of the course. 92% of the students thought that employing student tutors caused an overall improvement of the undergraduate educational system. Around 92% of the undergraduate students thought that this course may have improved the undergraduate educational system. 94% of the students stated that all other questioned could be also solved by students and trainee.

Discussion

We were able to show a positive educational effect of integrating peer-student instructors in our undergraduate ultrasound program to teach obstetrical and gynecological ultrasound. This is particularly important for teaching ultrasound skills, since efficient teaching requires a high teacher/student ratio in this area. The course was generally well accepted by the students. Our main parameters were the MCQ results of the pre- and post-tests, which is an objective evaluation method with the questionnaire being a subjective evaluation method.

The students showed a statistically significant improvement of their theoretical and practical knowledge following the course. In a 2- or 4-week bedside ultrasound elective course, Ahn et al. trained twenty 4th-year medical students. Their peer instructors tutored ultrasound course for first and second year medical students in the physical exam course of ocular, abdominal, musculoskeletal, cardiac, vascular, and pulmonary disciplines. In their prospective randomized trial, peer students were shown to have a positive impact on the ultrasound skill education [16]. In another comparable teaching project by Celebi et al., peer students were also effectively able to teach sonographic anatomy as effectively as faculty staff sonographers [19]. Similar to our teaching approach, students received a pre-test, followed by post-test after the ultrasound course, in which they showed a statistically significant improvement. Hoppmann et al. reported about their extensive ultrasound course, which accompanied the students throughout their whole undergraduate medical studies. In their concept, undergraduate ultrasound education accompanied most of the medical disciplines. Yet, no obstetrical course was reported in their course. With regard to the effectiveness of peer students as ultrasound student tutors, their results were comparable to ours [4, 20].

As mentioned above, student tutors have been increasingly involved in assisting undergraduate education of medical skills. Yet, we did not find studies that highlighted their role in undergraduate skill education of gynecological and especially obstetrical ultrasonography. To our knowledge, we are the first to report about an undergraduate obstetrical ultrasound course given by peer-student instructors.

The practical round students reported a subjective sense of learning a new skill (Likert 1.56–2.24), better understanding of fetal physiology (Likert 1.63), and pathology (Likert 1.96) throughout the course. Most of the students reported an improvement of the quality of their education (Likert 1.48). There was also a positive feedback about the idea (Likert 1.24) and competence (Likert 1.26–1.35) of peer-student tutors in the course. Most of the students showed a great overall satisfaction regarding the course (Likert 1.32). As shown in the questionnaire, students welcomed the idea of enriching the course with student tutors (Likert 1.24–1.35).

A similar workgroup examined a cross-year peer-tutor system in the skills lab of internal medicine at the University of Tübingen, Germany [21]. In that approach, one student tutor instructed an intense training session with small learning groups. The acceptance was very high and self-confidence ratings increased significantly as reported in the student evaluation. The students gave very positive individual feedback with high global ratings about the competence of student tutors. In 82% of cases, the students thought that peer-teaching model is adequate, which is comparable to our workgroup. Our student evaluation results are also comparable to another work group at the University of South Carolina [4]. Since the students attended only 1 day to learn the basics of obstetrical and gynecological ultrasound, we had the same problem as in our previous teaching approach regarding acquisition of technical knowledge and confidence [9]. In the project of Hoppmann et al., ultrasound was widely applied in different basic and clinical sciences throughout several years. It is to be considered to integrate our course in a more comprehensive undergraduate teaching program, which accompanies the students throughout their whole-study years.

In our teaching project, we followed a very strict criteria of choosing our student tutors. The student tutors were members of the sonoBYstudents project of the Saarland University [17]. These students received an extensive course of ultrasound education based on a self-initiative as followed: After 6 weeks of an extensive ultrasound course, certain students are selected to become student tutors. The training includes teaching technical and didactical skills. Out of these pre-selected students, we then chose a group of students to become future student tutors for our course. Many teaching projects offered training to their student tutors to be [4, 19–22]. Yet, we are not aware of other studies that followed similar selective criteria to recruit

their student tutors. It remains unknown whether such a complex selection process is beneficial. It can be assumed that the participating candidates profit significantly from undergoing the training process even if they are finally not selected to become student tutors.

We are aware that this course needs modifications to further improve its effectiveness. Since ultrasound is a central tool of the diagnosis and management in obstetrics and gynecology, transvaginal and breast sonography should also be included in future teaching projects to cover the whole diagnostic spectrum in our discipline. Due to the intimacy of the female genital organs, the patient's agreement is required for such an educational program.

To test the acquired skills, we performed an image recognition test as stated above. In a future project, we intend to add an objective structured clinical examination (OSCE) to assess the actual ultrasound skill of the students, as reported by Hoppmann et al. [4].

In conclusion, incorporating student tutors in ultrasonography courses in obstetrics and gynecology offers a great scientific value for students, improves to the quality of undergraduate education, and should be generally recommended and extended. Yet, it should be further evaluated in its effectiveness in comparison to faculty staff-based undergraduate courses in the field of obstetrics and gynecology. Given the high acceptance and endless benefit of this program, we are planning to continue this course and extend it in the future.

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Compliance with ethical standards

Conflict of interest The author declares that they have no conflict of interest.

Ethical approval Ethical committee is informed.

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