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MAIN RESEARCH ARTICLE

Quality assured ultrasound simulator training for the detection of fetal malformations

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Abstract

Objective. Sonographic training in obstetrics differs broadly in Germany, although there are clearly defined quality-oriented requirements. In order to improve professional education, a training concept was devised utilizing an ultrasound simulator system. *Design.* Between October 2004 and May 2006, 100 obstetric ultrasound training courses were held in 12 federal states of Germany. In these daily courses, doctors were trained in the detection of the most common malformations. *Sample.* One hundred training courses with a total of 1,266 participants. *Methods.* As a measure of quality assurance, a standardized questionnaire focusing on testing sonographic proficiency before and after the courses was issued in order to analyze the effect of these simulator-based ultrasound courses. *Main outcome measures.* Effectiveness of the method with reference to its potential role in structured sonographic training. *Results.* The concept found prevailing approval (90%) at the level of principle, practical implementation, and clinical usefulness. Of the participants, 91% estimated their subjective training effect as good. The questionnaire analysis showed significant improvement. On average, 75.3% of the questions relating to sonographic proficiency were answered correctly at the end of the course as opposed to 48.6% at the beginning. *Conclusion.* Structured ultrasound training courses based on an ultrasound simulator system seem to be useful for defining a basic standardized quality of training and significantly improving examiners' skills. This is a suitable additional instrument to improve the education in obstetric ultrasound.

Key words: *Ultrasound training, prenatal medicine, quality control*

Introduction

In Germany, significant individual as well as institutional differences exist concerning the inherent quality of sonographic training in obstetrics. The German Board of Obstetricians and Gynecologists' training regulations stipulate that to become a medical specialist in gynecology there is a basic requirement of 300 gynecological and 300 obstetrical ultrasound examinations. Due to the decentralized structure of the German Healthcare System, there is a lack of training scenarios in terms of practical training, especially in the field of fetal pathology. Fetal abnormalities are relatively rare and occur randomly, and women cannot be repeatedly examined for training purposes.

With regard to filling this gap between the apparent defects of sonographic training and the social demand for sonographic proficiency, conventional teaching methods are of limited use. Books can display two-dimensional (2D) reference slice planes only as static pictures, but they cannot mediate how to find them. Audiovisual aids, such as video or CD/DVDs, also have limitations because of the lack of interaction as regards the movement of the ultrasound probe. However, interactive ultrasound training programs for prenatal medicine have been available since the

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mid-1990s. They achieve, as was proven in previous studies (1,2), the objective of mediating knowledge, but without permitting the possibility of an individual screen adjustment (3). So far, conventional computer-based training programs are available for sonography of the abdomen and for gynecological and obstetrical examinations (4,5), and models that simulate invasive procedures such as amniocentesis exist (6).

Over the past years, an ultrasound simulator (Sonofit®, Sonofit GmbH, Darmstadt, Germany; www.sonofit.de) has been introduced in various publications (7–11). With this simulator, practical sonographic examinations on physiological and pathological cases can be done under real-time conditions, that is, without any noticeable lag between the movement of the ultrasound probe and its corresponding slice sections. Depending on the arbitrary position of an ultrasound scanning probe in a three-dimensional (3D) space, spatially corresponding 2D slice sections are calculated from scanned fetal 3D volumes by way of a magnetic 3D sensor allowing for random positioning of an ultrasound transducer in real time. This is displayed on a screen in order to simulate the whole procedure of a sonographic examination on a dummy. With the introduction of the ultrasound simulator into obstetrical sonography, the principles of 3D computer-assisted and interactive learning have been combined for the first time in the field of obstetrics and gynecology (7).

To fill the gap between training and demand, the German Academy of Gynecology (FBA) decided to adopt the obstetrical sonographic training concept using the ultrasound simulator in one-day courses. In order to allow effective learning, the training concept was divided into several modules, which are again subdivided into a theoretical (accompanying lectures) and a practical part (independent training on the simulator with the help of accompanying texts and sonographically experienced tutors). The first module (A-module) 'basic course in obstetrics' aimed at mediating how to structure sonographic exclusion of fetal malformations as a fundament for the diagnosis of fetal anomalies. Additionally, the A-module familiarizes the trainees with the sonotrainer technique and introduces them to the basic procedures. Thus, the focus of this module rests with the communication of sonographic standards and, therefore, provides a basis for differentiating pathological sonographic patterns from physiological diagnostic findings.

The aim of this study was to review the usefulness of this method in the setting of the advanced training (B-module) and measure ultrasound knowledge before and after participating in this training in order to objectively assess the extent of a possible learning success resulting from simulator training.

Material and methods

In the fall of 2004, the FBA started the advanced training courses in obstetrics (the so-called B-module covering only fetal pathologic anatomy), which forms a part of the continuing training on the ultrasound sonotrainer (Figure 1). According to the concept of the sonotrainer, ultrasound knowledge is mediated in the form of modules where 3D volumes covering different fetal anatomical conditions are combined. Each volume correlates to one special case, which has been captured in the simulator. The simulator system used was the Sonofit® together with a GE Voluson 730 Expert ultrasound machine (GE Healthcare, Munich, Germany; www.gehealthcare.com).

Board certification as a specialist in obstetrics and gynecology and prior attendance of the A-module (basic course in obstetric ultrasound) course was mandatory for participation in the 'advanced training course in obstetrics' (B-module). In this second module (B-module), training was given for the detection of the most common malformations. Besides recapitulating sonographic knowledge as regards the performance of a structural obstetric exclusion of fetal malformations, the main focus was to mediate the ability to detect common malformations and, therefore, improve the reliability of malformation diagnostics.

A standardized questionnaire, which aimed to estimate the benefit and possible learning success of these simulator-assisted ultrasound courses, was distributed before and after the B-module courses. The participants' standard of knowledge was tested with a view to assess whether the learning success correlated with the training. The participants had to answer 10 multiple-choice questions on fetal malformations (in 20 minutes) before and after the course (crossed matched pair technique). The questions were developed by a Stage 3 sonographer and were formulated with caution so that they were equally difficult. In both questionnaires, the follow-up of the respective questions was correlated with the same malformation (question 1 in Questionnaires 1 and 2 relates to malformation a, question 2 in Questionnaires 1 and 2 relates to malformation b, and so on) and, therefore, allowed a comparison of the answers. This method aimed at supplying evidence for the objective effectiveness of the courses. To maintain a high objectivity as regards data ascertainment and data analysis, the corresponding questionnaires were tagged with an anonymized code providing a solid classification of the correlating questionnaires (before and after). In another questionnaire, the participants were offered the possibility to reflect on issues such as organization, contents of learning, learning success, and

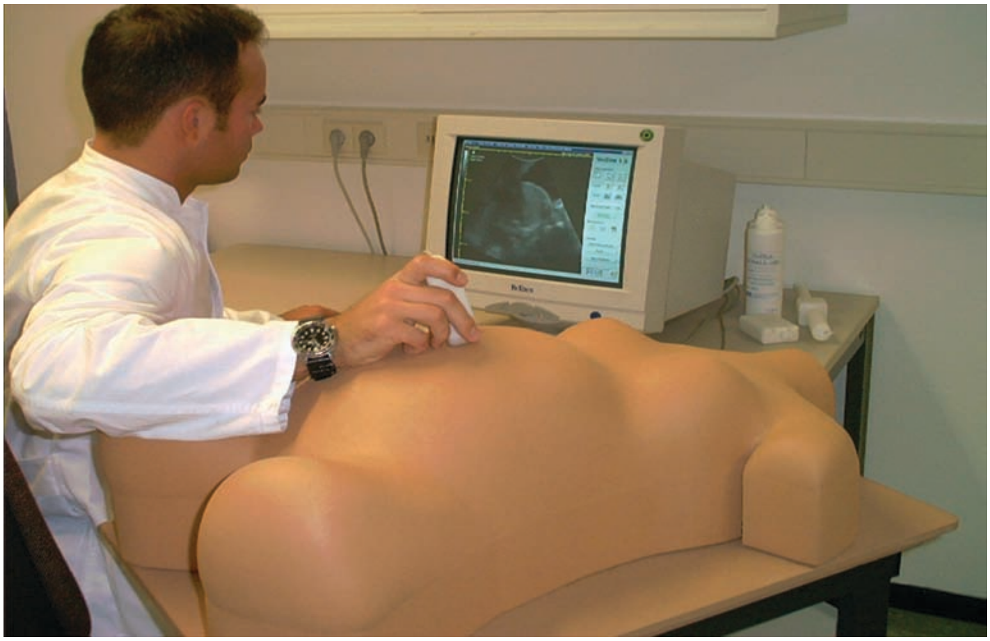


Figure 1. The ultrasound simulator.

future enhancements. Each course contained a maximum of 16 participants. They worked on four simulators so that a maximum of four physicians were assigned to one simulator. Two tutors were responsible for the implementation of the course and participant supervision.

Statistical analysis was done with SPSS 12.0 for Windows at the Institute of Biometry of the Medical School of Hannover. The surveyed data were evaluated with ANOVA tests and a p value < 0.05 suggested significance.

Results

Between October 2004 and May 2006, 100 B-module ultrasound training courses following the ultrasound simulator concept of the Medical School of Hannover were held in 12 federal states by the FBA (Saarland, Schleswig-Holstein, Hamburg, Brandenburg, Mecklenburg-Western Pomerania, North Rhine-Westphalia, Berlin, Rhineland-Palatinate, Saxony, Hessen, Lower Saxony, and Bavaria).

Altogether, 1,266 gynecologists attended the courses, of whom 1,239 (97.8%) filled in the first questionnaire and 1,234 (97.4%) filled in the second questionnaire (containing 10 questions each).

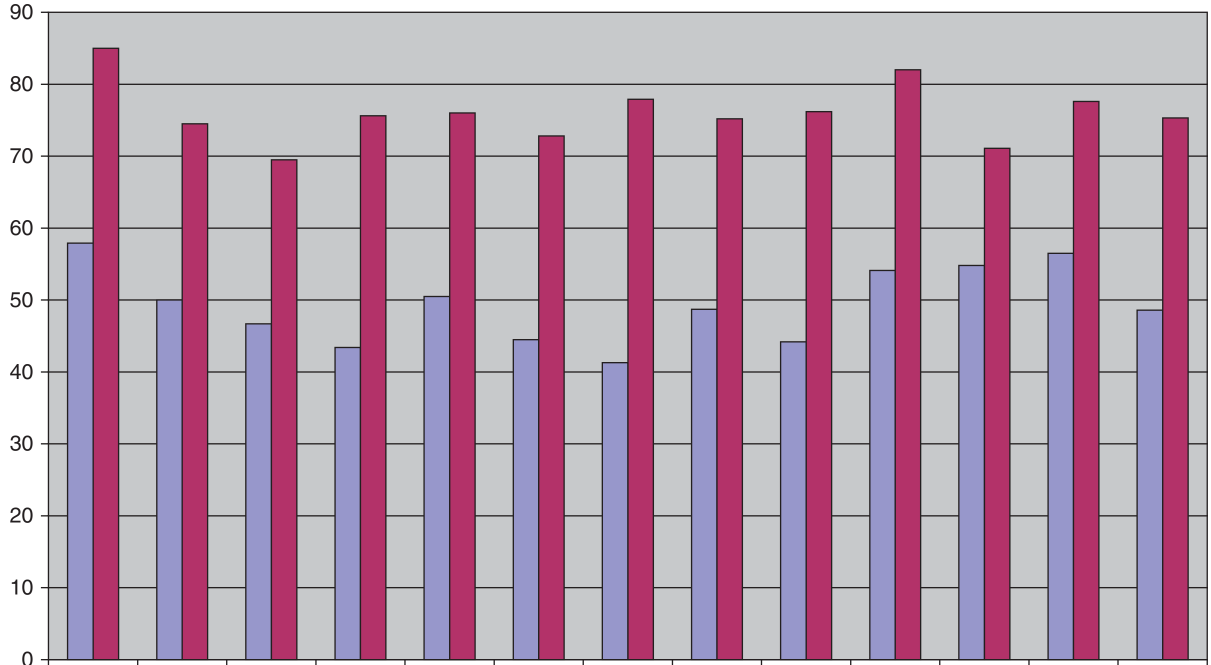
In Questionnaire 1, answered at the beginning of the course, an overall number of 6,022 answers (48.6%) from all participants were correct and 6,368 answers (51.4%) were incorrect. In Questionnaire 2, at the end of the course, an overall number of 9,292 answers (75.3%) from all participants were correct and 3,048 answers (objective: 24.7%) were incorrect. Figure 2 shows a comparison between the correct answers in the first and second questionnaires, broken down by federal states. The difference in the results of Questionnaires 1 and 2 (i.e. the difference between correct and incorrect answers) was significant ($p < 0.0001$).

With regard to questions on organization, content of learning, and learning success, the majority (90%) approved of the concept. Of the participants, 99% considered the theoretical and practical parts well balanced and adequate. The time selection for the practical exercises was widely approved (99%). The interaction between contributors and tutors was described as positive and uncomplicated. Picture quality was rated with a weaker value and was approved of by 49% of the participants.

There were 89% affirmatives to the question on the module as a useful and advisable part of ultrasound advanced training in obstetrics, and 91% of the participants considered it a learning success. Close to 81% wished for an integration of the courses into structured ultrasound training during the board-certified specialization program.

Discussion

The response to the courses was altogether positive, not least the practical part which appeared to have met the participants' desire for active involvement.



	Saarland	Schleswig-Holstein	North Rhine-Westphalia	Brandenburg	Hamburg	Mecklenburg-Western Pomerania	Berlin	Rhineland-Palatinate	Saxony	Hessen	Lower Saxony	Bavaria	Overall view of all 12 federal states
Questionnaire 1	57,9	50	46,7	43,4	50,5	44,5	41,3	48,7	44,2	54,1	54,8	56,5	48,6
Questionnaire 2	85	74,5	69,5	75,6	76	72,8	77,9	75,2	76,2	82	71,1	77,6	75,3

Figure 2. Comparison between the correct answers (%) in the first and second questionnaires, broken down by federal states.

In terms of learning success, the majority of the participants expressed a subjective individual benefit. This is supported by the questionnaire replies, with a significant increase of correctly answered questions after participation. This suggests that combining theoretical teaching with reproducible practical training in small groups provides knowledge and experience. The results of this study confirm a preliminary analysis of effectiveness, which showed a high expedience and individual acceptance of these simulator ultrasound courses (11,12).

The advantages of decentralized care, as practiced in Germany by accredited gynecologists, are well known (individual and effective medical care is close and prompt). However, in the field of prenatal ultrasound diagnostics, these advantages may be missing due to low quality standards of the advanced training regulations. The average rate for detecting fetal malformations on routine screening has only been 48%, whereas it approaches 90% (2,3) in a tertiary ultrasound center. An increase of close to 40%, achieved for the prenatal knowledge–experience complex, indicates that a noticeable increase in the detection of fetal malformations among physicians could be achieved by the use of well-constructed ultrasound simulator modules.

Even for medical specialists with some ultrasound experience, the ultrasound simulator training may serve as an effective instrument for acquiring new skills.

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