Research Article

# Usefulness of an Intrapartum Ultrasound Simulator (IUSim™) for Midwives Training: Results from a RCT

## Simulation in Obstetrics



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## Abstract

### Introduction

We conducted a randomized study to determine whether a training session on a dedicated simulator (IUSim™) would facilitate the midwives in learning the technique of transperineal intrapartum ultrasound.

### Methods

Following a 30-min multimedia presentation including images and videos on how to obtain and measure the angle of progression (AoP) and the head-perineum distance (HPD), 6 midwives with no prior experience in intrapartum ultrasound were randomly split into 2 groups: 3 of them were assigned to the "training group" and 3 to the "control group." The midwives belonging to the former group were taught to measure the 2 sonographic parameters during a 3-h practical session conducted on IUSim™ under the supervision of an expert obstetrician. In the following 3 months, all the 6 midwives were asked to independently perform transperineal ultrasound during their clinical practice and to measure on the acquired images either the AoP or the HPD. The sonographic images were examined in blind by the teaching obstetrician who assigned a 0–3 score to the image quality (IQS) and to the measurement quality (MQS).

### Results

A total of 48 ultrasound images (24 patients) from 5 midwives were acquired and included in the study analysis. A midwife of the "training group" declined participation after the practical session. Independently from the randomization group, the image quality score (IQS + MQS) was significantly higher for the HPD compared with the AoP (2.5 ± 0.66 vs. 1.79 ± 1.14; $p = 0.01$). In the training group, the MQS of either AoP (2.66 ± 0.5 vs.1.46 ± 1.45. $p = 0.038$) and the HPD (2.9 ± 0.33 vs. 1.87 ± 0.83 $p = 0.002$) was significantly higher in comparison with the control group, while the IQS of both measurements was comparable between the 2 groups (1.91 ± 1.24 vs. 2.25 ± 0.865; $p = 0.28$).

### Conclusion

The use of a dedicated simulator may facilitate the midwives in learning how to measure the AoP and the HPD on transperineal ultrasound images.

**Keywords:** Intrapartum ultrasound; Simulator; Training; Angle of progression; Head-perineum distance

# Introduction

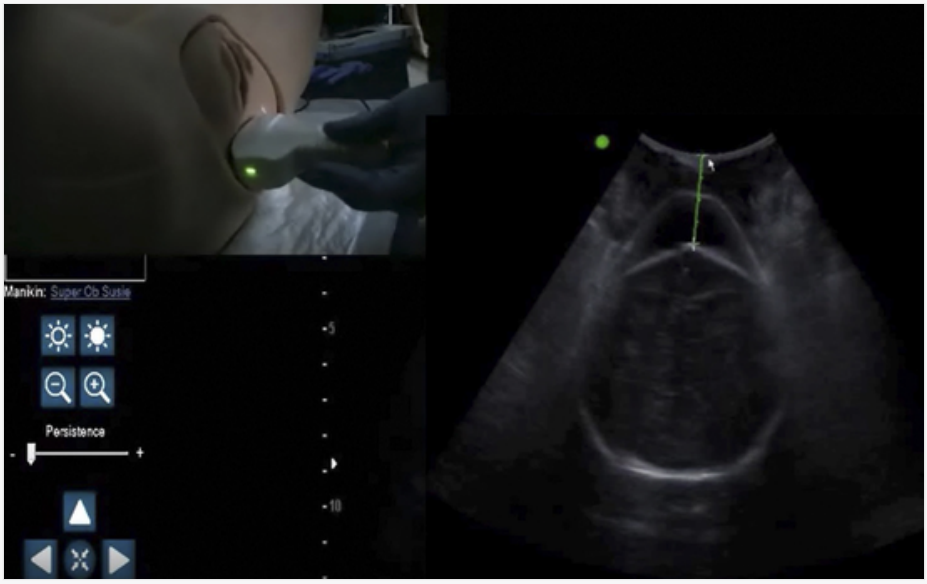
In recent years, the use of ultrasound has been suggested as an additional tool for the obstetrician in the management of labor [1–3]. In particular, intrapartum ultrasound has been consistently demonstrated to be more accurate and reproducible than clinical examination in the diagnosis of fetal head station [4–10]. Moreover, transperineal ultrasound has been described by the laboring women as more acceptable and less intrusive than digital exploration [11, 12]. Among the different ultrasound parameters proposed, both the AoP and the HPD have gained much popularity and have been increasingly used by the clinician in the management of abnormal labor course [13–16]. The ISUOG Guidelines have recommended their routine measurement in the prolonged second stage of labor or before considering or performing an operative delivery [1].

Although the midwives play a crucial role in the intrapartum care, to date, ultrasound facilities have been mostly employed by the doctors who are claimed to take over when the labor course becomes abnormal and a clinical decision must be taken [17–19]. However, due to its objectivity and to the high tolerability, the use of intrapartum ultrasound has been recently proposed also in the management of physiological labor, and it is likely to extend also to low-risk cases that are routinely managed by the midwives. There is scarcity of data on the use of intrapartum ultrasound by the midwives, and it would seem appropriate to encourage a specific training in order to improve their technical skills in transperineal scanning. A dedicated mannequin for intrapartum ultrasound simulation has been recently made available for such aim [20]. Simulation-based training provides the opportunity to acquire confidence and knowledge and to have an immediate feedback without leading discomfort to patients [21]. The aim of this study was to assess whether a training session on a dedicated simulator for intrapartum ultrasound would facilitate the midwives in learning the technique of transperineal intrapartum ultrasound.

# Material and Methods

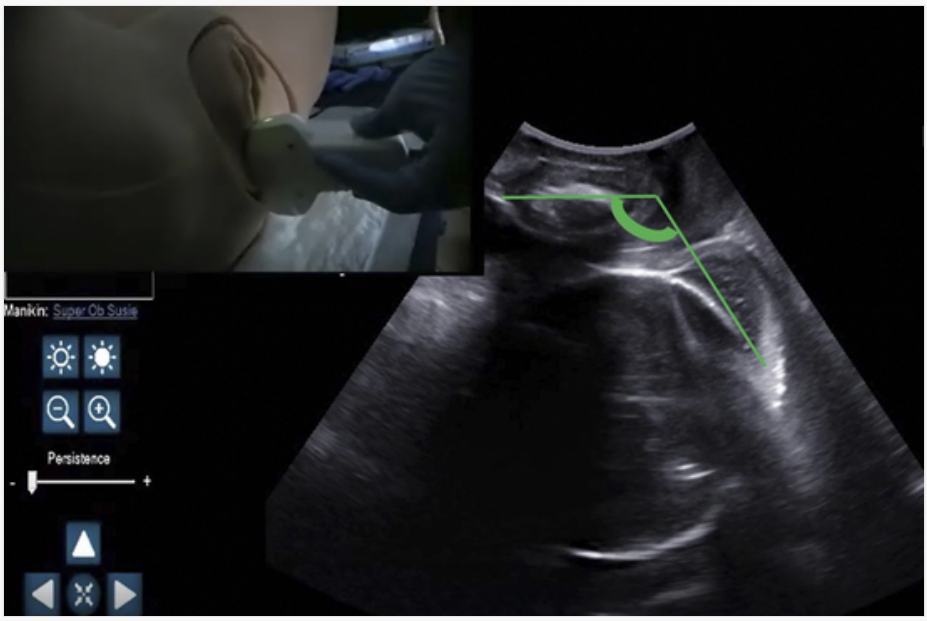
This was a randomized study conducted in between June and October 2019 at the University Hospital of Parma, Italy. The study subjects were 6 midwifes with no prior experience or exposure in intrapartum ultrasound who attended a 60-min multimedia presentation based on images and videos on how to measure transperineally the angle of progression (AoP) and the head-perineum distance (HPD) on longitudinal and axial planes, respectively. The participants were then randomly split into 2 groups, 3 of them were assigned to the “training group” and the other 3 to the “control group.” The midwives belonging to the former group were taught how to measure the 2 sonographic parameters during a 3-h practical session conducted on IUSim™ (Intrapartum Ultrasound Simulator; Accurate – Health and Learning, Cesena, Italy), a dedicated device developed for transperineal ultrasound simulation, under the supervision of an expert obstetrician. This simulator is composed by a PC-based system displaying realistic ultrasound images and clips from a library of different clinical cases from which the fetal head position, station, and attitude can be assessed by placing a convex probe on radiofrequency sensors that are located in specific anatomic landmarks of the mannequin as shown in Figures 1 and 2.

**Fig. 1.**




The use of IUSim™ for the transperineal sonographic assessment of the fetal head station: the measurement of the HPD on the axial plane. HPD, head-perineum distance.

**Fig. 2.**




The use of IUSim™ for the transperineal sonographic assessment of the fetal head station: the measurement of the AoP on the sagittal plane. AoP, angle of progression.

In the following 3 months, all the 6 midwives were asked to independently perform transperineal ultrasound during their clinical practice and to measure on the acquired images either the AoP or the HPD. Each ultrasound examination was conducted by the midwife in the absence of the referring physician during the second stage on a nonconsecutive series of low-risk women with normal labor course and ruptured membranes who agreed to be submitted to transperineal ultrasound without a clinical indication.

The sonographic examination was performed as previously described using a portable machine equipped with multifrequency probe and for each patient both the measurement of the AoP and the HPD were obtained, stored in the hard disk as anonymized images and exported on a USB device. All the sonographic images were collected by a study collaborator (EDP) and provided to the teaching obstetrician who examined them in blind assigning a 0–3 score to the IQS and to the MQS. The IQS and the MQS were based on the following parameters.

## AoP-IQS

- View of the internal nucleus of the symphysis joint (1 point)

- Symphysis joint in horizontal position (1 point)
- Full skull with both anterior and posterior tabula visible (1 point)

### AoP-MQS

- Correct position of the caliper on symphysis (2 point)
- Correct position on the external contour of the fetal skull (1 point)

### HPD IQS

- Visualization of the entire fetal skull (1 point)
- Symmetric position of the fetal brain midline (1 point)
- Visualization of the choroid plexus (1 point)

### HPD-MQS

- Correct position of the caliper on the fetal skull (2 points)
- Correct position of the caliper on the perineum (1 point)

Maternal and labor characteristics and mean IQS and MQS were compared between the 2 groups. The primary outcome of this study was to compare the AoP and HPD IQS and MQS between the midwives exposed to the practical training and the controls. This study was approved by the Ethics Committee of the University Hospital of Parma (registration number 0037091).

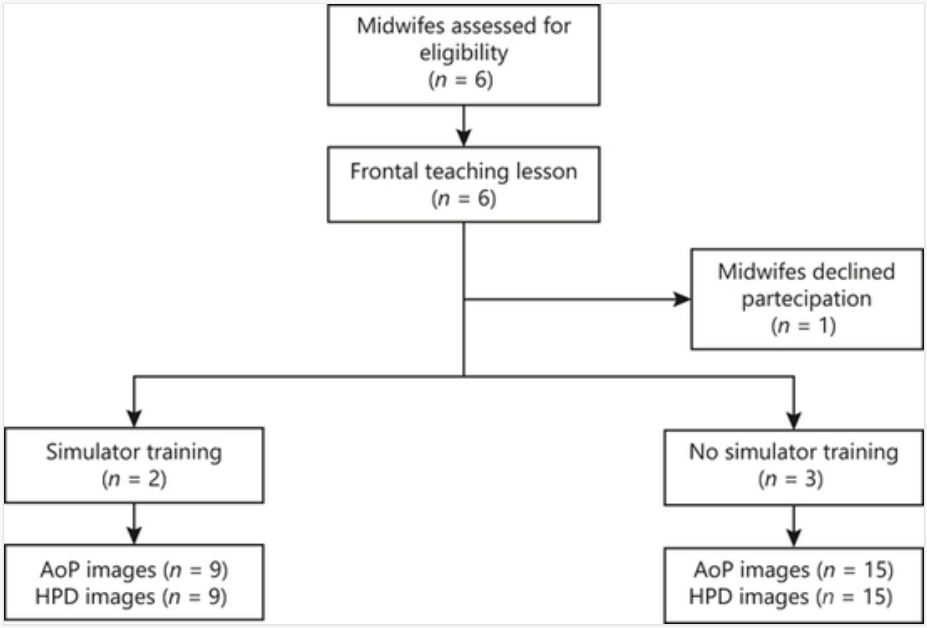
### Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) v. 22 (IBM Inc., Armonk, NY, USA). The Kolmogorov-Smirnov test was used to assess the normality of the distribution of the data. Data were displayed as mean ± SD or as number (percentage). Categorical variables were compared using the $\chi^2$ or Fisher's exact test. Between-group comparison of continuous variables was performed using the *T*-test and the Mann-Whitney nonparametric equivalent test. Two-sided *p* values were calculated, and *p* values <0.05 were considered as statistically significant.

## Results

Over a period of 3 months, a total of 48 ultrasound images (24 patients) from 5 midwives were acquired and included in the study analysis (Fig. 3). One of the midwives belonging to the training group withdrew from the study before starting the acquisition of the ultrasound images due to health issues.

**Fig. 3.**




Flowchart of the included cases. AoP, angle of progression; HPD, head-perineum distance.

The baseline maternal and labor characteristics of the women who have been submitted to transperineal intrapartum ultrasound by the midwives assigned to the "training group" and by those assigned to the "control group" were comparable and are shown in Table 1. The primary outcome was evaluated for 100% of the ultrasound images and is illustrated in Table 2.

**Table 1.**

ⓘ The table layout displayed in this section is not how it will appear in the final version. The representation below is solely purposed for providing corrections to the table. To preview the actual presentation of the table, please view the Proof.

Demographic and labor characteristics of the women submitted to transperineal intrapartum ultrasound by the midwives assigned to the "control group" and those assigned to the "training group"

| | **Women ($n$ = 15) examined by the control group** | **Women ($n$ = 9) examined by the training group** | ***p* value** |
|---|---|---|---|
| Maternal age, years | 28.8±6.6 | 30.3±5.8 | 0.57 |
| Pre-pregnant BMI, kg/m$^2$ | 22.3±3.4 | 24.2±2.8 | 0.20 |
| Weight gain, kg | 13.3±3.8 | 12.8±2.8 | 0.77 |
| Nulliparous | 8 (53.3) | 7 (77.8) | 0.23 |
| Gestational age at delivery, weeks | 39.2±1.3 | 40.0±0.9 | 0.13 |
| Length of first stage, min | 214.2±162.0 | 186.7±156.0 | 0.70 |
| Length of second stage, min | 32.1±43.5 | 20.0±33.5 | 0.50 |
| Neonatal weight, g | 3,377.9±413.5 | 3,387.0±493.6 | 0.96 |

Data are expressed as (mean ± SD) or $n$ (%).

**Table 2.**

ⓘ The table layout displayed in this section is not how it will appear in the final version. The representation below is solely

purposed for providing corrections to the table. To preview the actual presentation of the table, please view the Proof.

Primary outcome

| | Control group ($n = 15$) | Training group ($n = 9$) | Mean difference | $p$ value |
|---|---|---|---|---|
| AoP-IQS | 1.60±1.30 | 2.11±0.78 | $-2.47 \times 10^{-5}$ | 0.44 |
| AoP-MQS | 1.46±1.45 | 2.66±0.5 | −1.00 | 0.038 |
| HPD-IQS | 2.33±0.72 | 2.77±0.44 | $-1.71 \times 10^{-5}$ | 0.12 |
| HPD-MQS | 1.87±0.83 | 2.9±0.33 | −1.00 | 0.002 |

Data are expressed as (mean ± SD).

AoP, angle of progression; HPD, head-perineum distance; IQS, image quality score; MQS, measurement quality score.

Independently from the randomization group, the overall quality score (IQS + MQS) was significantly higher for the HPD compared with the AoP (2.5 ± 0.66 vs. 1.79 ± 1.14; $p = 0.01$). In the training group, the MQS of either AoP (2.66 ± 0.5 vs.1.46 ± 1.45. $p = 0.038$) and the HPD (2.9 ± 0.33 vs. 1.87 ± 0.83 $p = 0.002$) was significantly higher in comparison with the control group, while the IQS of both measurements was comparable between the 2 groups (1.91 ± 1.24 vs. 2.25 ± 0.865; $p = 0.28$).

# Discussion

## Main Findings

Our data demonstrated that the use of a dedicated simulator may facilitate the midwives in learning how to measure the AoP and the HPD on transperineal ultrasound images. Conversely, the quality of the ultrasound images obtained at transperineal scanning does not seem to be positively influenced by the prior use of the IUSim™ device. Finally, we have shown that independently from the practical training, it is easier to learn how to obtain and how to calculate the HPD rather than the AoP.

## Interpretation

The present study provides an insight into the potential usefulness of a dedicated intrapartum ultrasound simulator in teaching the beginners on how to perform transperineal ultrasound. Our observations seem to suggest that a practical training session with these devices may help the caregivers with no prior experience in intrapartum ultrasound in becoming familiar with this novel imaging technique. We have decided to assess the efficacy of this training among our midwives who are generally not confident in intrapartum ultrasound since this investigation is commonly performed when labor course is abnormal by the attending physician. However, we may expect that a similar approach may be adopted with favorable results among the junior residents of obstetrics who are starting their training in the labor ward management.

Not surprisingly, our data showed that the accuracy and the precision in measuring both the AoP and the HPD was increased following the practical part of the course while the quality of the ultrasound images obtained at transperineal scanning was not better among the midwives who were exposed to the practical training on the simulator. This may be due to the fact that the IUSim™ simulator used for this study is composed by a PC system displaying previously acquired transperineal ultrasound video clips from a library of different clinical cases from which the fetal head station can be measured [20]. Therefore, while extremely useful for the visual interpretation of the ultrasound findings and for the practical calculation of the AoP and the HPD, this type of simulator does not teach how to acquire the sonographic images on the correct plane. Finally, our observation that overall MQS and IQS are higher for the HPD than for the AoP independently from the type of training seems to confirm that a higher expertise is required to acquire the AoP on the midsagittal plane compared with the HPD on the axial plane and to measure an angle rather than a straight distance [22].

## Previous Studies

Several studies have previously investigated the advantages of a simulation-based training in order to acquire competent ultrasound skills especially in performing transabdominal ultrasound [23–25]. A meta-analysis of 4 studies by Osborne et al. [26] showed positive results with high-fidelity simulators in obstetric ultrasound training considering as outcome the accurate acquisition of fetal biometry and the ability of the participants to detect fetal anomalies. In the studies included in this meta-analysis, the participants were medical students or medical doctors.

Gueneuc et al. [27] first tested the use of an ultrasound simulator on midwifery students by means of an objective and structured assessment score of ultrasound skills (OSAUS) to compare ultrasound skills between the groups that had been exposed to the training on the simulator, respectively, before or after the clinical training on real patients. They demonstrated that ultrasound simulation-based training, as an adjunct to ultrasound clinical training, significantly improves obstetrical ultrasound skills and that the best time to train on simulators seems to be prior to clinical training on real patients. Similarly, in a randomized study, Rosen et al. [28] demonstrated that the obstetric ultrasound simulator is an effective training tool and may hold extra benefits over real patient training particularly for those trainees with a minimal prior exposure to ultrasounds.

Fewer studies on simulation training have been conducted on intrapartum ultrasound. Youssef et al. [29] demonstrated that a theoretical and practical course seems to improve the participants' accuracy and precision in assessing the fetal head descendant by transperineal ultrasound. Ducklemann et al. [30] in a study involving midwives with no prior experience in intrapartum ultrasound demonstrated that after a 15-min theoretical course, the measurement of the AoP on transperineal ultrasound imaging is reliable regardless of the fetal head station or the level of ultrasound experience. However, differently from our study, they did not evaluate the effects of a practical training on the measurement's quality. Furthermore, our study is the first which has been conducted with the use of a dedicated simulator for transperineal ultrasound. The potential usefulness of this ultrasound-friendly mannequin in the simulated management of intrapartum complications has been recently highlighted [20]. The use of a simulator obviates the need of patient participation and avoids bedside live training which may either create discomfort to the woman in active labor or embarrass the practitioner with a low confidence in transperineal ultrasound examination [24, 25].

### Clinical Implications

All midwives should be expected to gain confidence and competence in intrapartum ultrasound in the labor ward as the use of this method has been shown to support clinical skills not only in the management of abnormal cases but also in confirming the normal labor progression, thanks to a more objective and accurate diagnosis of the fetal head station and position. Moreover, transperineal ultrasound has been reported by the laboring women as less uncomfortable than serial digital exploration [11, 12], and in some settings such as prolonged rupture of membranes, repeated transperineal scans seem to pose a smaller risk of infection compared with frequent vaginal examinations [31, 32]. Furthermore, recent studies have demonstrated that the use of transperineal ultrasound during the active second stage of labor may improve the effectiveness of maternal pushing efforts. In 2 independent studies, including a RCT, it has been actually shown that the visualization of the fetal head descent on the ultrasound screen may shorten the active phase of the second stage of labor and increase the pushing efficacy as witnessed by a greater change in the AoP [33, 34]. For this latter approach, the use of intrapartum ultrasound may be conveniently left to the hands of the midwife who is expected to coach maternal pushing during the active second stage.

### Strengths and Limitations

Among the main strengths of this study are its randomized design and the original use of a dedicated simulator for transperineal ultrasound for midwives with no prior knowledge of ultrasound in labor. Furthermore, the blind assessment of the ultrasound images by the expert and the objective scoring system implemented for such evaluation may be considered as additional strengths of our work. The small size of the study group and more importantly the reduced number of ultrasound images produced by the participants are to be acknowledged as major weaknesses of our study.

## Conclusion

Despite these limitations, our study has demonstrated that the use of a dedicated simulator for intrapartum ultrasound may facilitate the midwives in learning how to measure the AoP and the HPD on transperineal ultrasound images.

## Statement of Ethics

This study complies with the guidelines for human studies and has been conducted ethically in accordance with the World Medical Association Declaration of Helsinki. Subjects gave their written informed consent, and the study protocol has been approved by the Ethics Committee of the University Hospital of Parma (registration number 0037091).

## Conflict of Interest Statement

The authors have no conflicts of interest to disclose.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The authors did not receive any funding.


## Author Contribution

Di Pasquo E., Ghi T., Kiener A.J.O., and Gobbi L.: substantial contributions to the conception or design of the work, the acquisition, analysis, or interpretation of data for the work. Di Pasquo E., Ghi T., Ramirez Zegarra R., and Dall'Asta A.: drafting the work or revising it critically for important intellectual content. Fieschi L., Cugini L., Copelli M., and Frusca T.: final approval of the version to be published. Frusca T. and Ghi T.: agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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