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The "breech progression angle": a new feasible and reliable transperineal ultrasound parameter for the fetal breech descent in the birth canal

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Contribution

What are the novel findings of this work?

- Transperineal ultrasound has not been used for the evaluation of fetuses in breech presentation. Breech progression angle represents a new sonographic parameter for the evaluation of fetal breech descent in the birth canal.
- We showed that breech progression angle is a feasible parameter with excellent intra- and interobserver reproducibility regardless potential confounders

What are the clinical implications of this work?

- The clinical value should be tested in the context of the prediction of the labor outcome of fetuses in breech presentation undergoing trial of vaginal delivery and of the success of external cephalic version.
- This can be extremely useful in counseling women with fetuses in breech presentation at or near term.

Abstract

Objectives

The aim of the present study was to assess the feasibility and reliability of transperineal ultrasound in the assessment of breech descent in the birth canal, by measuring the “breech progression angle”.

Methods

We recruited pregnant women with singleton pregnancies and fetuses in breech presentation between 34 and 41 weeks’ gestation. We acquired transperineal ultrasound images in the midsagittal view for each woman twice by an operator and once by another. Each operator measured the breech progression angle after anonymization of the transperineal ultrasound images. Breech progression angle was defined as the angle between a line running along the long axis of the pubic symphysis and another line extending from the most inferior portion of the symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis. Each operator was blinded from any other measurement performed for the same woman. The intra- and interobserver reproducibility were evaluated with intraclass correlation coefficient (ICC). To investigate the presence of any bias, intra- and interobserver agreement was also analyzed using the Bland–Altman plot. Student’s *t*-test and Levene’s W_0 test were used to investigate whether a number of clinical factors had an effect on systematic differences (*t*-test) and homogeneity (W_0 test) between breech progression angle measurements.

Results

Overall, 44 women were included in the analysis. Breech progression angle was successfully measured by both operators on all images. Both intra- and interobserver agreement analyses showed excellent reproducibility, with an ICC of 0.88 (95% CI, 0.80 to 0.93) and 0.83 (95% CI, 0.71 to 0.90), respectively. Mean differences for intraobserver repeatability was 0.4 (95%CI, -1.4 to 2.2) and for interobserver repeatability was -0.4 (95%CI, -2.6 to 1.8). The upper limits of agreement were 12.0 (95% CI, 8.9 to 15.1) and 13.6 (95% CI, 9.9 to 17.3) for intraobserver and interobserver repeatability, respectively. The lower limits of agreement were -11.2 (95% CI, -14.3 to -8.1) and -14.4 (95% CI, -18.2 to -10.7) for intraobserver and interobserver repeatability, respectively. No systematic difference was found both in the intra- and interobserver agreement analyses. None of the clinical factors examined (maternal body mass index, maternal age, gestational age at the ultrasound scan and parity) showed a statistically significant effect on intra- and interobserver reliability.

Conclusions

Breech progression angle represents a new feasible and highly reproducible tool for the evaluation of fetal breech descent in the birth canal. Future studies assessing its usefulness in the prediction of successful external cephalic version and the success of breech vaginal delivery are needed.

Introduction

Breech presentation occurs in about 4% of pregnancies at term and is more frequent in nulliparous women and in preterm deliveries.[1-3] The Term Breech Trial (TBT) evaluated the labor outcome in fetuses in breech presentation and demonstrated a lower incidence in perinatal morbidity and mortality among women who delivered by Cesarean section compared to whom who delivered vaginally.[4] On the other hand, several studies have reported that planned vaginal delivery of singleton fetuses in breech presentation at term was a safe option when practiced in settings with experience in this type of procedure.[5-7] Furthermore, Cesarean delivery was associated with higher rates of maternal morbidity and mortality compared with vaginal delivery.[3, 8] Despite controversial evidence in this field, worldwide the rate of cesarean deliveries for breech presentation has progressively increased, while obstetricians' experience and interest in the performance of breech deliveries has decreased.[9-11] In order to reduce the rates of non-cephalic fetal presentation and thus the number of Cesarean deliveries, external cephalic version (ECV) remains a universally recommended intervention, and the major international guidelines endorse offering ECV to all women with fetuses in breech presentation at 37 weeks' gestation.[2, 12, 13] Accurate prediction of the success of both breech vaginal delivery and ECV may be extremely helpful in the counselling of women with fetuses in breech presentation near term. Such prediction however remains a clinical challenge.[14-17]

In the recent years, transperineal ultrasound (TPU) has developed considerably. In obstetrics settings, many TPU parameters have been suggested.[18-27] Among these, the angle of progression (AoP) is one of the most studied. [18, 27-30] Many studies demonstrated that AoP is a reliable and reproducible tool in the assessment of the degree of fetal head engagement in the birth canal.[18-23, 27, 31-34] To the best of our knowledge, TPU has never been used for the evaluation of fetuses in breech presentation.

The aim of the present study was to assess the feasibility and reliability of a new transperineal sonographic parameter, namely the “Breech Progression Angle” (BPA) during the third trimester of pregnancy.

Methods

We recruited a non-consecutive series of women with singleton pregnancies and fetuses in breech presentation between 34 and 41 weeks' gestation and before the onset of labor between September and December 2020. Women were invited to participate to the study when they presented to our outpatient clinic dedicated for the evaluation of women with a potential indication for Cesarean delivery or upon admission for elective Cesarean delivery. The recruitment took place when one of the two investigators (A.Y. and E.B.) with more than three years of experience in transperineal ultrasound (TPU) was present exclusively for the aim of the study. We performed transabdominal and transperineal scan to each woman. At transabdominal scan, the aim was to describe the breech type: complete (buttocks and feet down towards the birth canal with folded legs), frank (fetal buttocks down), or footling breech (Figure 1).[35]

<u>Transperineal ultrasound (TPU)</u>

Women were assessed in the lithotomy position with empty bladder. Ultrasound was performed using an ultrasound machine (Voluson SWIFT, GE Healthcare, Zipf, Austria, or Voluson P8, GE Healthcare, Zipf, Austria) with a convex transducer covered by a sterile glove and positioned in the midsagittal plane (Figure 2) visualizing the pubic symphysis, the urethra, the vagina and the fetal breech or foot. The breech progression angle (BPA) was defined as the angle between a line running along the long axis of the pubic symphysis and another line extending from the most inferior portion of the symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis (Figure 2).

In order to evaluate the intraobserver and interobserver reproducibility, three images were acquired for each patient: two by operator 1 (A.Y.) and one by operator 2 (E.B.). For the aim of interobserver reproducibility analysis, the first image of operator 1 was considered. To minimize any systematic bias, the images were acquired in a pre-defined alternating sequence. The two-alternating order of acquisition were thus: (operator 1, operator 2, operator 1) and (operator 2, operator 1, operator 1). Subsequently, BPA was measured on each image by the acquiring investigator on a second occasion. An interval of at least one week between any two measurements performed by operator 1 for the same woman was respected. Each operator was blinded for any other measurement performed for the same woman.

Statistics

Median, range and frequencies were used as descriptive statistics. Intra-rater reliability of measurements made by Operator 1 was assessed with intra-class correlation coefficient (ICC) estimate and 95% confidence interval (CI) based on a single-rating, absolute-agreement, two-way mixed-effects model. Inter-rater reliability of measurements made by the two operators was assessed with ICC estimate and 95% CI based on a single-rating, absolute-agreement, 2-way random-effects model.[36] As a rule of thumb, values between 0.01 and 0.20 indicate “slight” agreement, values between 0.21 and 0.40 indicate “fair” agreement, values between 0.41 and 0.60 indicate “moderate” agreement, values between 0.61 and 0.80 indicate “substantial” agreement, and values between 0.81 and 1.00 indicate “almost perfect” agreement.[37]

To investigate the presence of fixed bias and/or proportional bias, intra- and interobserver agreement was also analyzed using the Bland–Altman plot. Student’s *t*-test and Levene’s W_0 test were used to investigate whether a number of clinical factors had an effect on systematic differences (*t*-test) and homogeneity (W_0 test) between BPA measurements. For this purpose, continuous factors (i.e., BMI, maternal age and gestational age) were dichotomized using a median split. This was a pilot study, therefore no sample size calculation was performed.

The repeatability coefficients were also computed. All data were analyzed using SPSS software version 25.0 (SPSS Inc., Chicago, IL, USA) and Stata 15 (StataCorp. 2017. *Stata Statistical Software: Release 15.* College Station, TX: StataCorp LP). The significance level was set at 5%.

Ethical approval

The study protocol was approved by the Ethical committee of our Hospital. All participants included in the study signed a consent form. The study protocol coheres the Ethical guidelines of the "World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects".

Results

Overall, 44 women were included in the study. The characteristics of study population are shown in Table 1. Measurement of BPA was feasible in all cases on all acquired images. The breech type was complete in 10 (22.7%), frank in 33 (75.0%) and footling only in one case (2.3%). The median gestational age at the scan was 37 weeks (range 34 to 40 weeks). Among our population, nine (20.5%) had a previous delivery. The median BPA was 93.0° (range 69.0 to 118.0) for the first measurement of operator 1, 92.5° (range 64.0 to 119.0) for the second measurement of operator 1, and 92.0° (66.0 to 125.0) for the measurement of operator 2.

The results of the analysis of intra- and interobserver repeatability are shown in Table 2. Both intra- and interobserver agreement analyses showed excellent reproducibility, with an ICC of 0.88 (95% CI, 0.80 to 0.93) and 0.83 (95% CI, 0.71 to 0.90), respectively. Mean differences for intraobserver repeatability was 0.4 (95%CI, -1.4 to 2.2) and for interobserver repeatability was -0.4 (95%CI, -2.6 to 1.8). The upper limits of agreement were 12.0 (95% CI, 8.9 to 15.1) and 13.6 (95% CI, 9.9 to 17.3) for intraobserver and interobserver repeatability, respectively. The lower limits of agreement were -11.2 (95% CI, -14.3 to -8.1) and -14.4 (95% CI, -18.2 to -10.7) for intraobserver and interobserver repeatability, respectively. No systematic difference was found both in the intra- and interobserver agreement analyses.

Table 3 and 4 display various factors studied for a potential effect on intra- and interobserver agreement, which included maternal BMI, maternal age, gestational age at the time of acquisition and multiparity. None of the studied factors had a statistically significant effect on intra- or interobserver reliability. Bland–Altman plots for intra- and interobserver reproducibility are shown in Figure 3 and figure 4.

Discussion

This is the first study that evaluates the role of transperineal ultrasound in the assessment of breech descent in the maternal birth canal. We demonstrated that the breech progression angle (BPA) is a feasible and highly reproducible parameter of fetal breech descent in the maternal birth canal. In our unselected population of women with fetuses in breech presentation in the third trimester of pregnancy, the measurement of BPA was possible in all cases, with excellent intra- and interobserver agreement. Interestingly, this was true regardless of maternal age, gestational age, maternal BMI, and parity. All the studied factors did not have an influence on the reliability of BPA measurements.

External cephalic version (ECV) is a widely performed maneuver. Accurate prediction of its success may help clinicians in counseling women with fetuses in breech presentation at or near term. Many factors have been found to correlate with ECV success, which include maternal BMI, parity, amniotic fluid volume, placental position, neuraxial analgesia, palpation of the fetal head, and station of the breech in the birth canal.[38-42] Clinical assessment of the engagement of fetal breech is of questionable accuracy and reproducibility. In addition to the lack of studies on its reliability we advocate that evaluating the station of the fetal soft breech in relation to the ischial spines with a closed cervix can often be problematic, at best. Various studies previously demonstrated that, even with a well palpable fetal head, digital examination of head engagement is poorly reproducible.[43-46] Transperineal ultrasound provides a highly reproducible and accurate tool for fetal head descent assessment, in addition to its high acceptability by women thanks to its non-invasiveness. [22, 25, 26, 46-52] We believe that accurate measurement of the breech descent in the birth canal by means of the breech progression angle (BPA) can be of great help in providing more accurate and applicable predictive models of ECV success, although studies are needed to confirm this.

Another important potential application of BPA is in women willing for breech vaginal delivery. Worldwide, breech vaginal delivery has become much less common, with Cesarean section being the first choice for persistent breech presentation in many clinical realities. However, what is the best approach for breech delivery is largely debated. Whereas many studies found a higher risk of perinatal complications in case of vaginal delivery[4, 53], others demonstrated that planned vaginal delivery of singleton fetuses in breech presentation at term remains a safe option, in particular in places where this practice is common. [5-7] Prediction of successful breech vaginal delivery is challenging. Many transperineal ultrasound indices were found to strongly correlate with successful vaginal delivery.[23, 54-57] [58] We believe that BPA can be an extremely promising parameter to predict the risk of cesarean delivery in fetuses in breech presentation. It is worth mentioning that the retention of the after-coming head is one of the main risks of breech vaginal delivery. Further studies assessing BPA, together with other relevant parameters such as fetal head dimensions and fetal head flexion, are highly encouraged.[59, 60]

Our study paves the way for studies assessing the clinical application of this non-invasive, feasible and reproducible parameter. Accurate predictive models for external cephalic version and for successful vaginal delivery may be of great help in counseling women with fetuses in breech presentation at or near term. We highly encourage future studies assessing the role of breech progression angle in clinical practice for these two aims, possibly providing accurate cut-offs which would be key in helping both clinicians and women.

Despite our promising data, our study has some limitations. Firstly, our study provides useful data on the feasibility and reproducibility of BPA but does not test its clinical usefulness. This should be the subject of future studies. In addition, although BPA was highly reproducible with good intra- and interobserver agreement, the limits of agreement were relatively wide. We think that further larger studies involving various centers and different levels of expertise can be useful for the confirmation of the reliability of the use of this new parameter. Such studies may also have the ability to assess the effect of various breech variants on the reliability of BPA assessments.

To sum up BPA represents a new feasible and highly reproducible tool for the evaluation of fetal breech descent in the birth canal. Future studies are needed to assess its usefulness in the prediction of successful external cephalic version and breech vaginal delivery.

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Declaration of interests:

The authors report no declaration of interest.

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FIGURES

Figure 1

Different types of breech presentation.

Figure 2

Technique of measurement of the breech progression angle. The convex transducer is placed sagittal on the midline between the labia visualizing the pubic symphysis and the fetal breech (A). The breech progression angle (BPA) was defined as the angle between a line running along the long axis of the pubic symphysis and another line extending from the most inferior portion of the symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis (B). Graphic illustration of the technique of measurement of the breech progression angle (C).

Figure 3

Bland–Altman plot of *intraobserver* reliability of breech progression angle measurements (°). Short-dashed lines indicate the 95% confidence interval for the mean difference; dotted lines indicate the 95% confidence intervals of the limits of agreement.

Figure 4

Bland–Altman plot of *interobserver* reliability of breech progression angle measurements (°). Short-dashed lines indicate the 95% confidence interval for the mean difference; dotted lines indicate the 95% confidence intervals of the limits of agreement.

Table 1

Characteristics of the study population (n=44). Data are presented as median and range or *n* (%).

Characteristics	Value
Maternal age (years)	33 (19 to 40)
Gestational age (weeks)	37 (34 to 40)
Body mass index (Kg/m^2)	26.7 (19.3 to 38.3)
Multiparity	9 (20.5%)
Breech type	
Complete	10 (22.7%)
Frank	33 (75.0%)
Footling	1 (2.3%)
Breech progression angle (°)	
Operator 1 first measurement	93.0 (69.0 to 118.0)
Operator 1 second measurement	92.5 (64.0 to 119.0)
Operator 2	92.0 (66.0 to 125.0)

Table 2. Summary of the intraobserver and interobserver reliability for the measurement of the Breech Progression Angle (BPA)

Parameter	**Intraobserver**	**Interobserver**
Mean difference (95% CI), °	0.4 (–1.4 to 2.2)	–0.4 (–2.6 to 1.8)
Range of differences, °	–20.5 to 15.9	–37.0 to 10.2
Systematic difference P-value*	0.679	0.71
ICC (95% CI)	0.88 (0.80 to 0.93)	0.83 (0.71 to 0.90)
95% LOA (95% CI), °		
Upper	12.0 (8.9 to 15.1)	13.6 (9.9 to 17.3)
Lower	–11.2 (–14.3 to –8.1)	-14.4 (-18.2 to -10.7)
Repeatability coefficient, °	11.59	14.01

Abbreviations: CI, confidence interval, ICC, intraclass correlation coefficient; LOA, Limits of agreement.
*Student's *t*-test.

Table 3. Potential factors influencing the *intraobserver* reliability of Breech Progression Angle measurements (°).

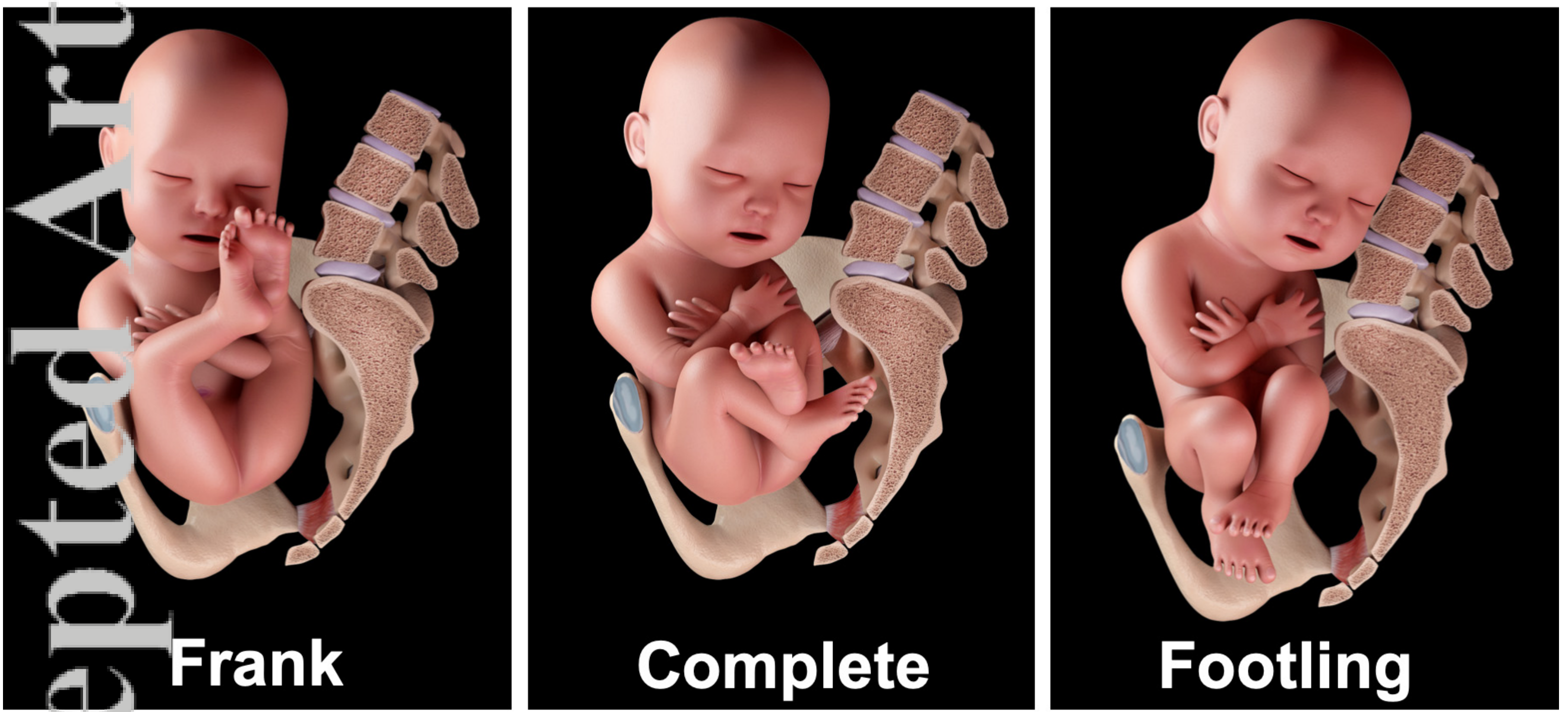
Factor	*n*	Breech Progression Angle (mean ± SD)		Difference in measurements (mean ± SD)	*P*-value for systematic difference*	*P*-value for Homoscedasticity†
		First measurement	Second measurement			
BMI at term						
<26 kg/m²	22	94.5 ± 10.9	95.0 ± 11.9	–0.5 ± 5.2	0.31	0.47
≥26 kg/m²	22	93.0 ± 12.7	91.7 ± 13.2	1.3 ± 6.5		
Maternal age						
<34 y	26	96.5 ± 11.6	96.5 ± 12.1	0.0 ± 6.1	0.59	0.81
≥34 y	18	89.7 ± 11.0	88.8 ± 12.1	1.0 ± 5.7		
Gestational age						
<38 w	27	95.2 ± 14.2	95.3 ± 14.2	–0.1 ± 4.3	0.52	0.13
≥38 w	17	91.3 ± 5.7	90.2 ± 8.9	1.1 ± 7.9		
Multiparity						
No	35	94.9 ± 11.3	94.8 ± 12.3	0.1 ± 5.7	0.58	0.49
Yes	9	89.0 ± 12.7	87.6 ± 12.3	1.4 ± 6.8		

*Student's *t*-test.
†Levene's test.

Table 4. Potential factors influencing the *interobserver* reliability of Breech Progression Angle measurements (°).

Factor	*n*	Breech Progression Angle (mean ± SD)		Difference in measurements (mean ± SD)	*P*-value for systematic difference*	*P*-value for Homoscedasticity†
		First measurement	Second measurement			
BMI at term						
<26 kg/m²	22	94.5 ± 10.9	94.1 ± 10.4	0.4 ± 5.2	0.47	0.89
≥26 kg/m²	22	93.0 ± 12.7	94.2 ± 14.7	–1.2 ± 8.7		
Maternal age						
<34 y	26	96.5 ± 11.6	98.1 ± 12.7	–1.6 ± 8.2	0.17	0.82
≥34 y	18	89.7 ± 11.0	88.3 ± 10.2	1.4 ± 5.0		
Gestational age						
<38 w	27	95.2 ± 14.2	95.6 ± 14.4	–0.4 ± 4.7	0.97	0.34
≥38 w	17	91.3 ± 5.7	91.8 ± 8.9	–0.4 ± 10.1		
Multipara						
No	35	94.9 ± 11.3	95.4 ± 12.5	–0.4 ± 7.8	0.97	0.50
Yes	9	89.0 ± 12.7	89.3 ± 12.4	–0.3 ± 4.4		

*Student's *t*-test.
†Levene's test.



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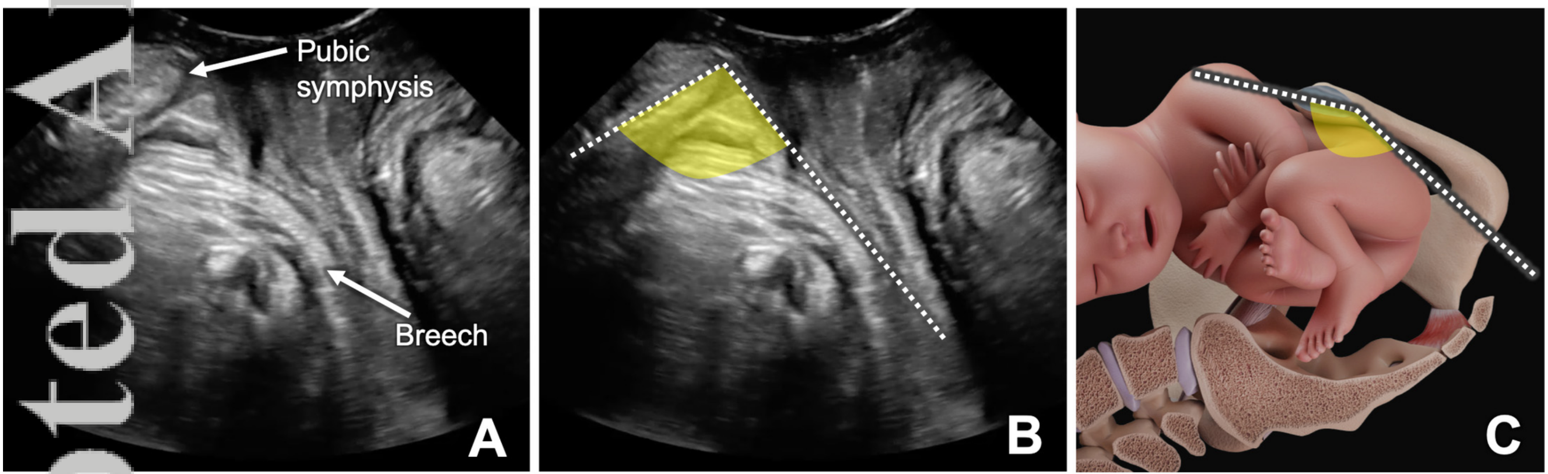

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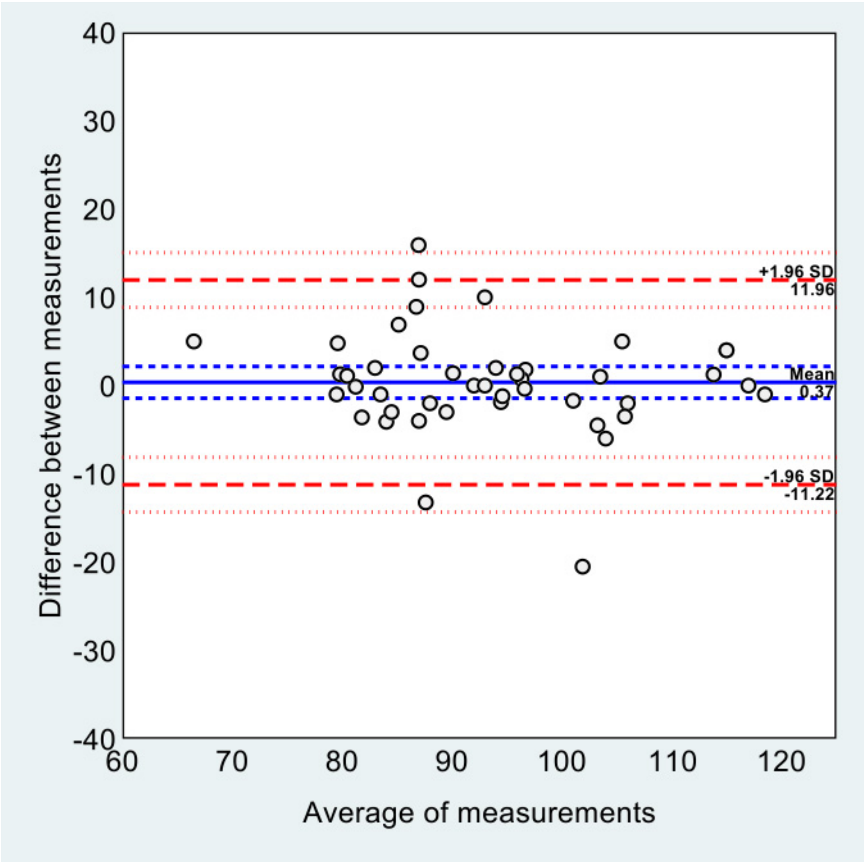

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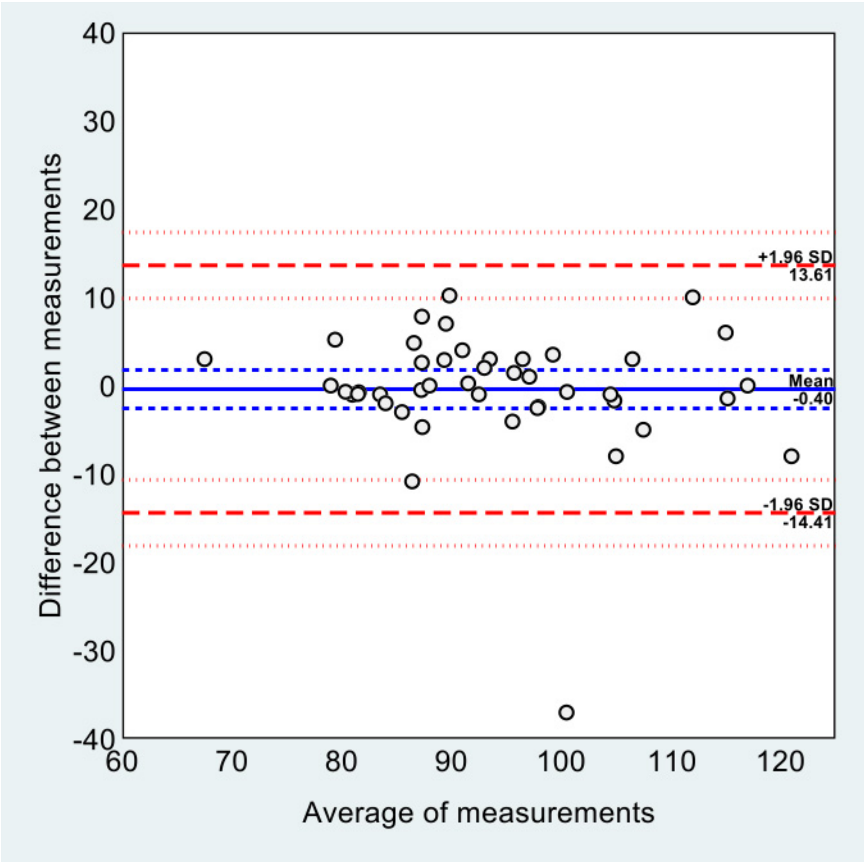

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