Ultrasound Obstet Gynecol 2021; **58**: 609–615
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.23649

Breech progression angle: new feasible and reliable transperineal ultrasound parameter for assessment of fetal breech descent in birth canal

A. YOUSSEF[1], E. BRUNELLI[1], M. FIORENTINI[1], J. LENZI[2], G. PILU[1] and A. EL-BALAT[3]

[1]*Obstetric Unit, Department of Medical and Surgical Sciences, IRCCS Sant'Orsola-Malpighi University Hospital, University of Bologna, Bologna, Italy;* [2]*Section of Hygiene, Public Health and Medical Statistics, Department of Biomedical and Neuromotor Sciences, University of Bologna, Bologna, Italy;* [3]*Department of Obstetrics and Gynecology, Goethe University Frankfurt, Frankfurt, Germany*

KEYWORDS: breech delivery; breech progression angle; Cesarean delivery; external cephalic version; translabial ultrasound; transperineal ultrasound

CONTRIBUTION

What are the novel findings of this work?
Transperineal ultrasound has not been used previously 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 measurement of breech progression angle is feasible, with excellent intra- and interobserver reproducibility regardless of potential confounders.

What are the clinical implications of this work?
The clinical value of breech progression angle should be tested in the context of the prediction of labor outcome of fetuses in breech presentation undergoing trial of vaginal delivery and of the success of external cephalic version. This could be very useful in counseling women with a fetus in breech presentation at or near term.

ABSTRACT

Objective *To assess the feasibility and reliability of transperineal ultrasound in the assessment of fetal breech descent in the birth canal, by measuring the breech progression angle (BPA).*

Methods *Women with a singleton pregnancy with the fetus in breech presentation between 34 and 41 weeks' gestation were recruited. Transperineal ultrasound images were acquired in the midsagittal view for each woman, twice by one operator and once by another. Each operator measured the BPA after anonymization of the transperineal ultrasound images. 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 pubic symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis. Each operator was blinded to all other measurements performed for each woman. Intra- and interobserver reproducibility of BPA measurement was evaluated using the intraclass correlation coefficient (ICC). To investigate the presence of any bias, intra- and interobserver agreement was also analyzed using Bland–Altman analysis. Student's* t*-test and Levene's* W_0 *test were used to investigate whether a number of different clinical factors had an effect on systematic differences and homogeneity, respectively, between BPA measurements.*

Results *Overall, 44 women were included in the analysis. BPA was measured successfully by both operators on all images. Both intra- and interobserver agreement analyses showed excellent reproducibility in BPA measurement, with ICCs of 0.88 (95% CI, 0.80–0.93) and 0.83 (95% CI, 0.71–0.90), respectively. The mean difference between measurements was 0.4° (95% CI, −1.4 to 2.2°) for intraobserver repeatability and −0.4° (95% CI, −2.6 to 1.8°) for interobserver repeatability. The upper limits of agreement were 12.0° (95% CI, 8.9–15.1°) and 13.6° (95% CI, 9.9–17.3°) for intra- 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 intra- and interobserver repeatability, respectively. No systematic difference between BPA measurements was found on either intra- or interobserver agreement analysis. 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- or interobserver reliability.*

Correspondence to: Dr A. Youssef, Department of Obstetrics and Gynecology, Sant'Orsola-Malpighi University Hospital, University of Bologna, Via Massarenti 13, 40138 Bologna, Italy (e-mail: aly.youssef78@gmail.com)

Accepted: 26 March 2021

 ORIGINAL PAPER

Conclusions *BPA represents a new feasible and highly reproducible measurement 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 breech vaginal delivery are needed. © 2021 International Society of Ultrasound in Obstetrics and Gynecology.*

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 of fetuses in breech presentation and demonstrated a lower incidence of perinatal morbidity and mortality among women who delivered by Cesarean section compared with in those who delivered vaginally[4]. On the other hand, several studies have reported that planned vaginal delivery of singleton fetuses in breech presentation at term is 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, the rate of Cesarean delivery for breech presentation has increased progressively worldwide, while obstetricians' experience and interest in the performance of breech vaginal delivery 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 the fetus in breech presentation at 37 weeks' gestation[2,12,13]. Accurate prediction of the success of both breech vaginal delivery and ECV may be very helpful in counseling women with a fetus in breech presentation near term. Such prediction, however, remains a clinical challenge[14–17].

In recent years, transperineal ultrasound (TPU) has developed considerably. In obstetric 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 have demonstrated that the AoP is a reliable and reproducible tool in the assessment of the degree of fetal head engagement in the birth canal[18–27,31,32]. To the best of our knowledge, TPU has not been used previously 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 measurement, namely the breech progression angle (BPA), during the third trimester of pregnancy.

METHODS

We recruited a non-consecutive series of women with singleton pregnancy with the fetus in breech presentation between 34 and 41 weeks' gestation, before the onset of labor, between September and December 2020. Women were invited to participate in the study when they presented to our outpatient clinic dedicated to the evaluation of women with a potential indication for Cesarean delivery or upon admission for elective Cesarean delivery at the obstetric unit of IRCCS Sant'Orsola-Malpighi University Hospital, University of Bologna, Bologna, Italy. Recruitment took place when one of the two investigators (A.Y. or E.B.), with more than 3 years of experience in TPU, was present exclusively for the aim of the study. We performed transabdominal and TPU scans in each woman. The aim of the transabdominal scan was to describe the breech presentation type: complete (buttocks and feet down towards the birth canal with folded legs), frank (fetal buttocks down) or footling (Figure 1)[33].

The study protocol was approved by the hospital's ethics committee and all participants included in the study signed a consent form. The study protocol adhered to the ethical guidelines of the World Medical Association Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects.

Transperineal ultrasound

Women were assessed in the lithotomy position with an empty bladder. Ultrasound was performed using a Voluson SWIFT or Voluson P8 (GE Healthcare, Zipf, Austria) machine 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 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 pubic symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis (Figure 2).

In order to evaluate intra- 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 interobserver reproducibility analysis, the first image obtained by Operator 1 was considered. To minimize any systematic bias, the images were acquired in a predefined alternating sequence. The two alternating orders of acquisition were: Operator 1, Operator 2, Operator 1; and Operator 2, Operator 1, Operator 1. Subsequently, BPA was measured offline on each image by the acquiring investigator at a later date. An interval of at least 1 week between any two measurements performed in the same woman by Operator 1 was ensured. Each operator was blinded to all other measurements performed in the same woman.

Statistical analysis

Median (range) and *n* (%) were used as descriptive statistics. The intrarater reliability of measurements made by Operator 1 was assessed using the intraclass correlation coefficient (ICC) estimate and 95% CI based on a single-rating, absolute-agreement, two-way mixed-effects model. The inter-rater reliability of measurements made by the two operators was assessed using the ICC estimate and 95% CI based on a single-rating, absolute-agreement, two-way random-effects model[34]. As a rule of thumb, ICC 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[35].

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

All data were analyzed using SPSS software version 25.0 (SPSS Inc., Chicago, IL, USA) and Stata 15 (StataCorp., College Station, TX, USA). The significance level was set at 5%.

RESULTS

Overall, 44 women were included in the study. The characteristics of the study population are shown in Table 1. Measurement of BPA was feasible in all cases on all acquired images. The breech presentation type was complete in 10 (22.7%) cases, frank in 33 (75.0%) cases and footling in only one (2.3%) case. Median gestational age at the scan was 37 (range, 34–40) weeks. Nine (20.5%)

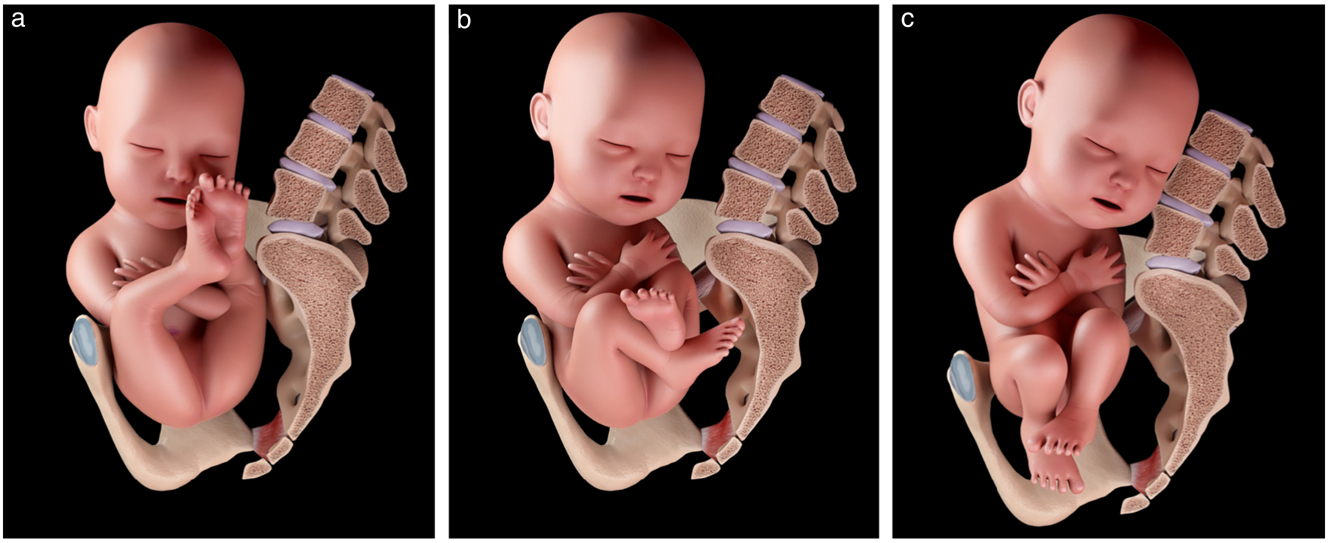

Figure 1 Graphical representations of different types of breech presentation: (a) frank; (b) complete; and (c) footling.

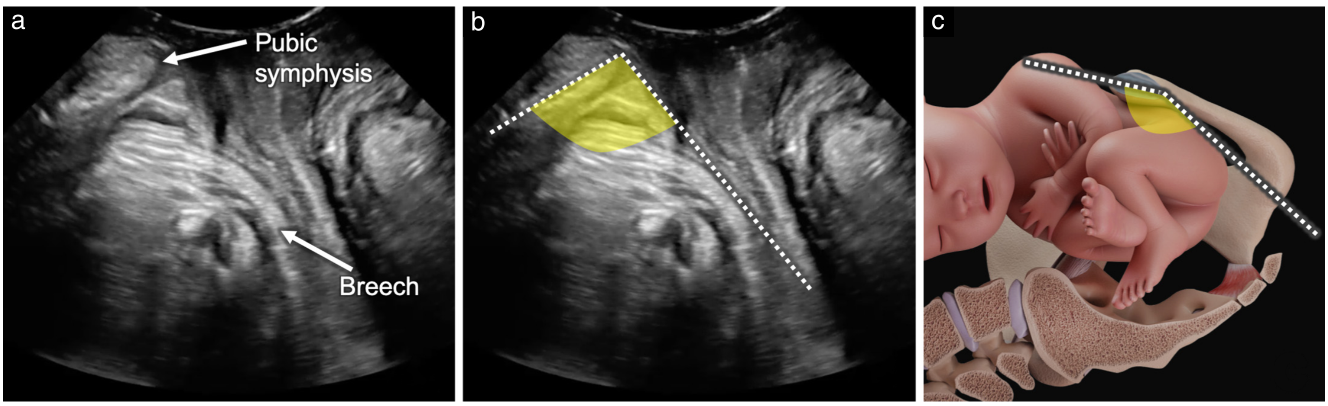

Figure 2 Transperineal ultrasound images (a,b) and graphical illustration (c) demonstrating technique for measurement of the breech progression angle. (a) The convex transducer is placed sagittally on the midline between the labia, and the pubic symphysis and the fetal breech are visualized. (b) The breech progression angle is 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 pubic symphysis tangentially to the lowest recognizable fetal part in the maternal pelvis.

women had a previous delivery. Median BPA was 93.0° (range, 69.0–118.0°) for the first measurements performed by Operator 1, 92.5° (range, 64.0–119.0°) for the second measurements performed by Operator 1 and 92.0° (range, 66.0–125.0°) for the measurements performed by Operator 2.

The results of the analysis of intra- and interobserver repeatability of BPA measurement are shown in Table 2. Both intra- and interobserver agreement analyses showed excellent reproducibility, with ICCs of 0.88 (95% CI, 0.80–0.93) and 0.83 (95% CI, 0.71–0.90), respectively. The mean difference between BPA measurements was 0.4° (95% CI, −1.4 to 2.2°) for intraobserver repeatability and −0.4° (95% CI, −2.6 to 1.8°) for interobserver repeatability. The upper limits of agreement were 12.0° (95% CI, 8.9–15.1°) and 13.6° (95% CI, 9.9–17.3°) for intra- 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 intra- and interobserver repeatability, respectively (Figure 3). No systematic difference in BPA measurements was found on either intra- or interobserver agreement analysis.

Table 1 Characteristics of the study population of 44 pregnancies with breech presentation at or near term

Characteristic	*Value*
Maternal age (years)	33 (19–40)
Gestational age (weeks)	37 (34–40)
Body mass index (kg/m^2)	26.7 (19.3–38.3)
Parous	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 (69.0–118.0)
Second measurement	92.5 (64.0–119.0)
Operator 2	92.0 (66.0–125.0)

Data are given as median (range) or *n* (%).

Table 2 Summary of intra- and interobserver reliability for measurement of breech progression angle in 44 pregnancies with breech presentation at or near term

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

Values in parentheses are 95% CI. *Student's *t*-test. ICC, intraclass correlation coefficient; LOA, limits of agreement.

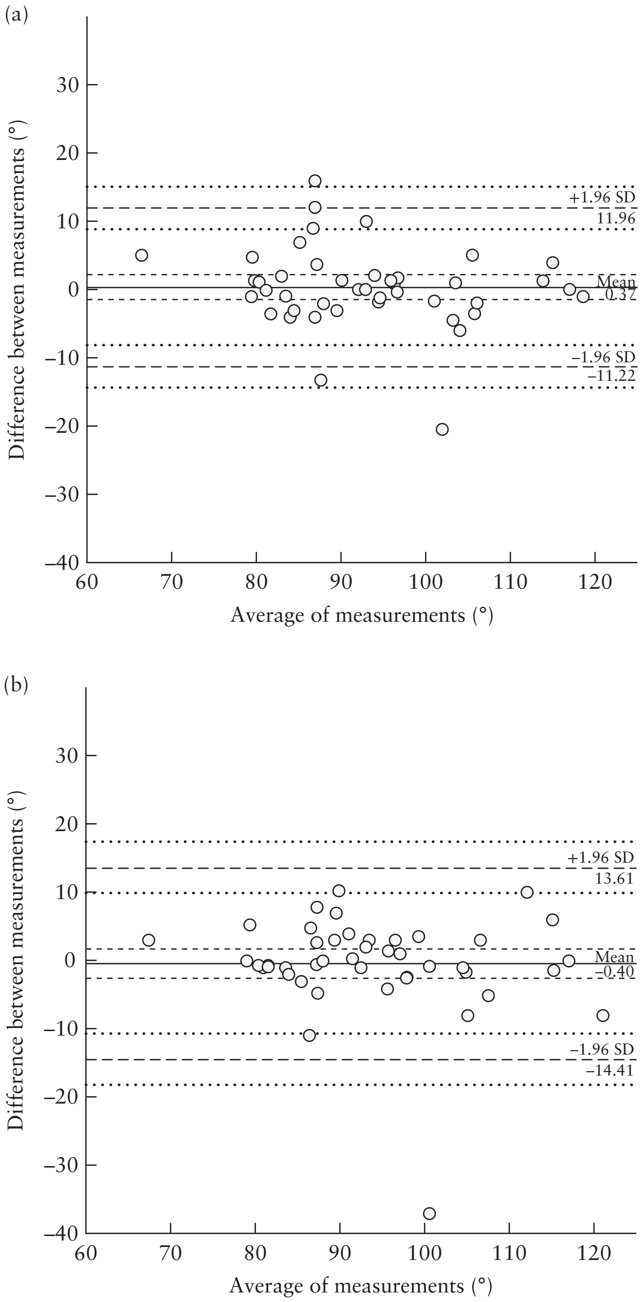

Figure 3 Bland–Altman plots of intraobserver (a) and interobserver (b) reliability of breech progression angle measurement. Mean difference (——) with 95% CI (- - - -) and limits of agreement (– – –) with 95% CI (······) are indicated.

Table 3 shows the effect of various factors on intra- and interobserver agreement in BPA measurement, which included maternal BMI, maternal age, gestational age at the time of acquisition and parity. None of the studied factors had a statistically significant effect on intra- or interobserver reliability.

DISCUSSION

This is the first study to evaluate the role of TPU in the assessment of fetal breech descent in the maternal birth canal. We demonstrated that BPA is a feasible and highly

Table 3 Effect of potential factors influencing intra- and interobserver reliability of measurement of breech progression angle (BPA) in 44 pregnancies with breech presentation at or near term

Factor	n	BPA (°) First measurement	BPA (°) Second measurement	Difference in measurements (°)	P for systematic difference*	P for homoscedasticity†
Intraobserver reliability						
BMI					0.31	0.47
< 27 kg/m^2	22	94.5 ± 10.9	95.0 ± 11.9	−0.5 ± 5.2		
≥ 27 kg/m^2	22	93.0 ± 12.7	91.7 ± 13.2	1.3 ± 6.5		
Maternal age					0.59	0.81
< 33 years	26	96.5 ± 11.6	96.5 ± 12.1	0.0 ± 6.1		
≥ 33 years	18	89.7 ± 11.0	88.8 ± 12.1	1.0 ± 5.7		
Gestational age					0.52	0.13
< 37 weeks	27	95.2 ± 14.2	95.3 ± 14.2	−0.1 ± 4.3		
≥ 37 weeks	17	91.3 ± 5.7	90.2 ± 8.9	1.1 ± 7.9		
Parous					0.58	0.49
No	35	94.9 ± 11.3	94.8 ± 12.3	0.1 ± 5.7		
Yes	9	89.0 ± 12.7	87.6 ± 12.3	1.4 ± 6.8		
Interobserver reliability						
BMI					0.47	0.89
< 27 kg/m^2	22	94.5 ± 10.9	94.1 ± 10.4	0.4 ± 5.2		
≥ 27 kg/m^2	22	93.0 ± 12.7	94.2 ± 14.7	−1.2 ± 8.7		
Maternal age					0.17	0.82
< 33 years	26	96.5 ± 11.6	98.1 ± 12.7	−1.6 ± 8.2		
≥ 33 years	18	89.7 ± 11.0	88.3 ± 10.2	1.4 ± 5.0		
Gestational age					0.97	0.34
< 37 weeks	27	95.2 ± 14.2	95.6 ± 14.4	−0.4 ± 4.7		
≥ 37 weeks	17	91.3 ± 5.7	91.8 ± 8.9	−0.4 ± 10.1		
Parous					0.97	0.50
No	35	94.9 ± 11.3	95.4 ± 12.5	−0.4 ± 7.8		
Yes	9	89.0 ± 12.7	89.3 ± 12.4	−0.3 ± 4.4		

Data are given as mean ± SD, unless stated otherwise. *Student's *t*-test. †Levene's W_0 test. BMI, body mass index.

reproducible measurement for assessment of fetal breech descent. In our unselected population of women with a fetus in breech presentation in the third trimester of pregnancy, 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. None of the studied factors had an influence on the reliability of BPA measurements.

ECV is a widely performed maneuver. Accurate prediction of its success may help clinicians in counseling women with a fetus in breech presentation at or near term. Many factors have been found to correlate with ECV success, including maternal BMI, parity, amniotic fluid volume, placental position, neuraxial analgesia, palpation of the fetal head and station of the fetal breech in the birth canal[36–40]. Clinical assessment of engagement of the 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. A number of studies have demonstrated previously that, even when the fetal head is easily palpable, the reproducibility of digital examination of fetal head engagement is poor[41–44]. TPU provides a highly reproducible and accurate tool for fetal head descent assessment, and it has high acceptability among women due to its non-invasiveness[22,25,26,44–50]. We believe that accurate assessment of fetal breech descent in the birth canal by means of BPA measurement could 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 undergoing 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, the best approach for breech delivery is largely debated. While many studies found a higher risk of perinatal complications in cases of vaginal delivery[4,51], others demonstrated that planned vaginal delivery of singleton fetuses in breech presentation at term remains a safe option, particularly in settings in which this practice is common[5–7]. Prediction of successful breech vaginal delivery is challenging. Many TPU indices have been found to have a strong association with successful vaginal delivery[23,52–56]. We believe that BPA could be a promising parameter for prediction of the risk of Cesarean delivery for fetuses in breech presentation. It is worth mentioning that 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[57,58].

This study paves the way for future studies assessing the clinical application of this non-invasive, feasible and reproducible measurement. Accurate predictive models for successful ECV and breech vaginal delivery may help in counseling women with a fetus in breech presentation at or near term. We encourage future studies assessing the role of BPA in clinical practice for these two aims, possibly providing accurate cut-offs, which would be key in informing both clinicians and women.

Despite our promising data, this study has some limitations. First, this study provides useful data on the feasibility and reproducibility of BPA measurement, but does not test the clinical usefulness of this parameter; this should be the subject of future studies. In addition, although BPA measurement was highly reproducible with good intra- and interobserver agreement, the limits of agreement were relatively wide. Further larger studies involving various centers and different levels of expertise would be useful for confirming the reliability of this new parameter. Such studies may also have the ability to assess the effect of different types of breech presentation on the reliability of BPA assessment.

In conclusion, BPA represents a new feasible and highly reproducible measurement for the evaluation of fetal breech descent in the birth canal. Future studies are needed to assess its usefulness in the prediction of successful ECV and breech vaginal delivery.

REFERENCES

1. Hickok DE, Gordon DC, Milberg JA, Williams MA, Daling JR. The frequency of breech presentation by gestational age at birth: a large population-based study. *Am J Obstet Gynecol* 1992; **166**: 851–852.
2. Impey LWM MD, Griffiths M, Penna LK on behalf of the Royal College of Obstetricians and Gynaecologists. External Cephalic Version and Reducing the Incidence of Term Breech Presentation. *BJOG* 2017; **124**: e178–192.
3. Hofmeyr GJ, Kulier R, West HM. External cephalic version for breech presentation at term. *Cochrane Database Syst Rev* 2015; **2015**: CD000083.
4. Hannah ME, Hannah WJ, Hewson SA, Hodnett ED, Saigal S, Willan AR. Planned caesarean section versus planned vaginal birth for breech presentation at term: a randomised multicentre trial. Term Breech Trial Collaborative Group. *Lancet* 2000; **356**: 1375–1383.
5. Goffinet F, Carayol M, Foidart JM, Alexander S, Uzan S, Subtil D, Breart G, Group PS. Is planned vaginal delivery for breech presentation at term still an option? Results of an observational prospective survey in France and Belgium. *Am J Obstet Gynecol* 2006; **194**: 1002–1011.
6. Kotaska A. Inappropriate use of randomised trials to evaluate complex phenomena: case study of vaginal breech delivery. *BMJ* 2004; **329**: 1039–1042.
7. Whyte H, Hannah ME, Saigal S, Hannah WJ, Hewson S, Amankwah K, Cheng M, Gafni A, Guselle P, Helewa M, Hodnett ED, Hutton E, Kung R, McKay D, Ross S, Willan A, Term Breech Trial Collaborative G. Outcomes of children at 2 years after planned cesarean birth versus planned vaginal birth for breech presentation at term: the International Randomized Term Breech Trial. *Am J Obstet Gynecol* 2004; **191**: 864–871.
8. Minkoff H, Chervenak FA. Elective primary cesarean delivery. *N Engl J Med* 2003; **348**: 946–950.
9. Rietberg CC, Elferink-Stinkens PM, Visser GH. The effect of the Term Breech Trial on medical intervention behaviour and neonatal outcome in The Netherlands: an analysis of 35,453 term breech infants. *BJOG* 2005; **112**: 205–209.
10. Lee HC, El-Sayed YY, Gould JB. Population trends in cesarean delivery for breech presentation in the United States, 1997–2003. *Am J Obstet Gynecol* 2008; **199**: 59e1–8.
11. Vlemmix F, Bergenhenegouwen L, Schaaf JM, Ensing S, Rosman AN, Ravelli AC, Van Der Post JA, Verhoeven A, Visser GH, Mol BW, Kok M. Term breech deliveries in the Netherlands: did the increased cesarean rate affect neonatal outcome? A population-based cohort study. *Acta Obstet Gynecol Scand* 2014; **93**: 888–896.
12. External Cephalic Version: ACOG Practice Bulletin, Number 221. *Obstet Gynecol* 2020; **135**: e203–212.
13. Betran AP, Temmerman M, Kingdon C, Mohiddin A, Opiyo N, Torloni MR, Zhang J, Musana O, Wanyonyi SZ, Gulmezoglu AM, Downe S. Interventions to reduce unnecessary caesarean sections in healthy women and babies. *Lancet* 2018; **392**: 1358–1368.
14. Chan LY, Leung TY, Fok WY, Chan LW, Lau TK. Prediction of successful vaginal delivery in women undergoing external cephalic version at term for breech presentation. *Eur J Obstet Gynecol Reprod Biol* 2004; **116**: 39–42.
15. Hoffmann J, Thomassen K, Stumpp P, Grothoff M, Engel C, Kahn T, Stepan H. New MRI Criteria for Successful Vaginal Breech Delivery in Primiparae. *PLoS One* 2016; **11**: e0161028.
16. Salzer L, Nagar R, Melamed N, Wiznitzer A, Peled Y, Yogev Y. Predictors of successful external cephalic version and assessment of success for vaginal delivery. *J Matern Fetal Neonatal Med* 2015; **28**: 49–54.
17. Leung TY, Fok WY, Chan LW, Law LW, Lau TK. Prediction of intrapartum Cesarean delivery for non-reassuring fetal status after a successful external cephalic version by a low pre-version pulsatility index of the fetal middle cerebral artery. *Ultrasound Obstet Gynecol* 2006; **27**: 416–419.
18. Barbera AF, Pombar X, Perugino G, Lezotte DC, Hobbins JC. A new method to assess fetal head descent in labor with transperineal ultrasound. *Ultrasound Obstet Gynecol* 2009; **33**: 313–319.
19. Dietz HP, Lanzarone V, Simpson JM. Predicting operative delivery. *Ultrasound Obstet Gynecol* 2006; **27**: 409–415.
20. Eggebo TM, Gjessing LK, Heien C, Smedvig E, Okland I, Romundstad P, Salvesen KA. Prediction of labor and delivery by transperineal ultrasound in pregnancies with prelabor rupture of membranes at term. *Ultrasound Obstet Gynecol* 2006; **27**: 387–391.
21. Henrich W, Dudenhausen J, Fuchs I, Kamena A, Tutschek B. Intrapartum translabial ultrasound (ITU): sonographic landmarks and correlation with successful vacuum extraction. *Ultrasound Obstet Gynecol* 2006; **28**: 753–760.
22. Ghi T, Farina A, Pedrazzi A, Rizzo N, Pelusi G, Pilu G. Diagnosis of station and rotation of the fetal head in the second stage of labor with intrapartum translabial ultrasound. *Ultrasound Obstet Gynecol* 2009; **33**: 331–336.
23. Youssef A, Maroni E, Cariello L, Bellussi F, Montaguti E, Salsi G, Morselli-Labate AM, Paccapelo A, Rizzo N, Pilu G, Ghi T. Fetal head–symphysis distance and mode of delivery in the second stage of labor. *Acta Obstet Gynecol Scand* 2014; **93**: 1011–1017.
24. Youssef A, Bellussi F, Montaguti E, Maroni E, Salsi G, Morselli-Labate AM, Paccapelo A, Rizzo N, Pilu G, Ghi T. Agreement between two- and three-dimensional transperineal ultrasound methods for assessment of fetal head-symphysis distance in active labor. *Ultrasound Obstet Gynecol* 2014; **43**: 183–188.
25. Youssef A, Bellussi F, Maroni E, Pilu G, Rizzo N, Ghi T. Ultrasound in labor: is it time for a more simplified approach? *Ultrasound Obstet Gynecol* 2013; **41**: 710-711.
26. Duckelmann AM, Bamberg C, Michaelis SA, Lange J, Nonnenmacher A, Dudenhausen JW, Kalache KD. Measurement of fetal head descent using the 'angle of progression' on transperineal ultrasound imaging is reliable regardless of fetal head station or ultrasound expertise. *Ultrasound Obstet Gynecol* 2010; **35**: 216–222.
27. Tutschek B, Braun T, Chantraine F, Henrich W. A study of progress of labour using intrapartum translabial ultrasound, assessing head station, direction, and angle of descent. *BJOG* 2011; **118**: 62–69.
28. Kalache KD, Duckelmann AM, Michaelis SA, Lange J, Cichon G, Dudenhausen JW. Transperineal ultrasound imaging in prolonged second stage of labor with occipitoanterior presenting fetuses: how well does the 'angle of progression' predict the mode of delivery? *Ultrasound Obstet Gynecol* 2009; **33**: 326–330.
29. Molina FS, Terra R, Carrillo MP, Puertas A, Nicolaides KH. What is the most reliable ultrasound parameter for assessment of fetal head descent? *Ultrasound Obstet Gynecol* 2010; **36**: 493–499.
30. Youssef A, Kamel R. Ultrasound in labor: impact of a theoretical and practical course on caregiver's perspective and accuracy. *J Matern Fetal Neonatal Med* 2020; **33**: 3163–3169.
31. *Gray's Anatomy. The Anatomical Basis of Clinical Practice* (40th edn). Standring S (ed). Churchill Livingstone: London, 2008.
32. Frick A, Kostiv V, Vojtassakova D, Akolekar R, Nicolaides KH. Comparison of different methods of measuring angle of progression in prediction of labor outcome. *Ultrasound Obstet Gynecol* 2020; **55**: 391–400.
33. Kok M, Cnossen J, Gravendeel L, Van Der Post JA, Mol BW. Ultrasound factors to predict the outcome of external cephalic version: a meta-analysis. *Ultrasound Obstet Gynecol* 2009; **33**: 76–84.
34. Shrout PE, Fleiss JL. Intraclass correlations: uses in assessing rater reliability. *Psychol Bull* 1979; **86**: 420–428.
35. Landis JR, Koch GG. The measurement of observer agreement for categorical data. *Biometrics* 1977; **33**: 159–174.
36. Melo P, Georgiou EX, Hedditch A, Ellaway P, Impey L. External cephalic version at term: a cohort study of 18 years' experience. *BJOG* 2019; **126**: 493–499.
37. Isakov O, Reicher L, Lavie A, Yogev Y, Maslovitz S. Prediction of Success in External Cephalic Version for Breech Presentation at Term. *Obstet Gynecol* 2019; **133**: 857–866.
38. Magro-Malosso ER, Saccone G, Di Tommaso M, Mele M, Berghella V. Neuraxial analgesia to increase the success rate of external cephalic version: a systematic review and meta-analysis of randomized controlled trials. *Am J Obstet Gynecol* 2016; **215**: 276–286.
39. Hutton EK, Simioni JC, Thabane L. Predictors of success of external cephalic version and cephalic presentation at birth among 1253 women with non-cephalic presentation using logistic regression and classification tree analyses. *Acta Obstet Gynecol Scand* 2017; **96**: 1012–1020.
40. Velzel J, de Hundt M, Mulder FM, Molkenboer JF, Van der Post JA, Mol BW, Kok M. Prediction models for successful external cephalic version: a systematic review. *Eur J Obstet Gynecol Reprod Biol* 2015; **195**: 160–167.
41. Buchmann E, Libhaber E. Interobserver agreement in intrapartum estimation of fetal head station. *Int J Gynaecol Obstet* 2008; **101**: 285–289.
42. Dupuis O, Silveira R, Zentner A, Dittmar A, Gaucherand P, Cucherat M, Redarce T, Rudigoz RC. Birth simulator: reliability of transvaginal assessment of fetal head station as defined by the American College of Obstetricians and Gynecologists classification. *Am J Obstet Gynecol* 2005; **192**: 868–874.
43. Zahalka N, Sadan O, Malinger G, Liberati M, Boaz M, Glezerman M, Rotmensch S. Comparison of transvaginal sonography with digital examination

and transabdominal sonography for the determination of fetal head position in the second stage of labor. *Am J Obstet Gynecol* 2005; **193**: 381–386.
44. Tutschek B, Torkildsen EA, Eggebo TM. Comparison between ultrasound parameters and clinical examination to assess fetal head station in labor. *Ultrasound Obstet Gynecol* 2013; **41**: 425–429.
45. Youssef A, Brunelli E, Azzarone C, Di Donna G, Casadio P, Pilu G. Fetal head progression and regression on maternal pushing at term and labor outcome. *Ultrasound Obstet Gynecol* 2021; **58**: 105–110.
46. Youssef A, Maroni E, Ragusa A, De Musso F, Salsi G, Iammarino MT, Paccapelo A, Rizzo N, Pilu G, Ghi T. Fetal head–symphysis distance: a simple and reliable ultrasound index of fetal head station in labor. *Ultrasound Obstet Gynecol* 2013; **41**: 419–424.
47. Yuce T, Kalafat E, Koc A. Transperineal ultrasonography for labor management: accuracy and reliability. *Acta Obstet Gynecol Scand* 2015; **94**: 760–765.
48. Dietz HP, Lanzarone V. Measuring engagement of the fetal head: validity and reproducibility of a new ultrasound technique. *Ultrasound Obstet Gynecol* 2005; **25**: 165–168.
49. Kamel R, Negm S, Montaguti E, Dodaro MG, Brunelli E, Di Donna G, Soliman E, Sharaf MF, ElHarty AS, Youssef A. Reliability of transperineal ultrasound for the assessment of the angle of progression in labor using parasagittal approach versus midsagittal approach. *J Matern Fetal Neonatal Med* 2021; **34**: 3175–3180 .
50. Youssef A, Brunelli E, Montaguti E, Di Donna G, Dodaro MG, Bianchini L, Pilu G. Transperineal ultrasound assessment of maternal pelvic floor at term and fetal head engagement. *Ultrasound Obstet Gynecol* 2020; **56**: 921–927.
51. Hofmeyr GJ, Hannah M, Lawrie TA. Planned caesarean section for term breech delivery. *Cochrane Database Syst Rev* 2015; **2015**: CD000166.
52. Carvalho Neto RH, Viana Junior AB, Moron AF, Araujo Junior E, Carvalho FHC, Feitosa HN. Assessment of the angle of progression and distance perineum-head in the prediction of type of delivery and duration of labor using intrapartum ultrasonography. *J Matern Fetal Neonatal Med* 2021; **34**: 2340–2348.
53. Kahrs BH, Usman S, Ghi T, Youssef A, Torkildsen EA, Lindtjorn E, Ostborg TB, Benediktsdottir S, Brooks L, Harmsen L, Romundstad PR, Salvesen KA, Lees CC, Eggebo TM. Sonographic prediction of outcome of vacuum deliveries: a multicenter, prospective cohort study. *Am J Obstet Gynecol* 2017; **217**: 69e1–10.
54. Kahrs BH, Usman S, Ghi T, Youssef A, Torkildsen EA, Lindtjorn E, Ostborg TB, Benediktsdottir S, Brooks L, Harmsen L, Salvesen KA, Lees CC, Eggebo TM. Descent of fetal head during active pushing: secondary analysis of prospective cohort study investigating ultrasound examination before operative vaginal delivery. *Ultrasound Obstet Gynecol* 2019; **54**: 524–529.
55. Eggebo TM, Wilhelm-Benartzi C, Hassan WA, Usman S, Salvesen KA, Lees CC. A model to predict vaginal delivery in nulliparous women based on maternal characteristics and intrapartum ultrasound. *Am J Obstet Gynecol* 2015; **213**: 362e1–6.
56. Brunelli E, Del Prete B, Casadio P, Pilu G, Youssef A. The dynamic change of the anteroposterior diameter of the levator hiatus under Valsalva maneuver at term and labor outcome. *Neurourol Urodyn* 2020; **39**: 2353–2360.
57. Bellussi F, Ghi T, Youssef A, Cataneo I, Salsi G, Simonazzi G, Pilu G. Intrapartum Ultrasound to Differentiate Flexion and Deflexion in Occipitoposterior Rotation. *Fetal Diagn Ther* 2017; **42**: 249–256.
58. Ghi T, Bellussi F, Azzarone C, Krsmanovic J, Franchi L, Youssef A, Lenzi J, Fantini MP, Frusca T, Pilu G. The ''occiput-spine angle'': a new sonographic index of fetal head deflexion during the first stage of labor. *Am J Obstet Gynecol* 2016; **215**: 84e1–7.

