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Full length article



Correlation between clinical and sonographic station during the second stage of labor: Which role for the occiput position? secondary analysis of a prospective dataset

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ABSTRACT

Background: The assessment of the occiput position and station of the fetal head are required for managing the second stage of labor. Clinical assessment has shown limitations in terms of accuracy and reproducibility, and previous sonographic data have demonstrated a different pattern of head descent in the event of occiput posterior compared to non-occiput posterior position.

Objective: To evaluate the relation between the position of the fetal occiput and the clinical and sonographic assessment of fetal head station during the second stage of labor.

Methods: Single center prospective observational study including singleton pregnancies in the second stage of labor. Firstly, eligible cases underwent vaginal examination for the assessment of fetal head position and station. Secondly, transabdominal and transperineal "research scan" was performed by a second operator blinded to the findings of the vaginal examination to ascertain the occiput position and evaluate the sonographic station by measuring the angle-of-progression (AoP) and the head-perineum distance (HPD). The primary endpoint was the comparison between occiput posterior (OP) and non-OP fetuses in terms of agreement rate between digital examination and ultrasound assessment and diagnosis of head engagement vs non-engagement.

Results: 303 women were included, of whom 81 (26.7%) had sonographically confirmed OP position. The rate of agreement between clinical and ultrasound assessment showed no difference between the cases in non-OP and those in OP position. Non-OP fetuses showed a higher rate of clinical underestimation (127/222, 57% vs 31/81, 38%, $p < 0.01$); conversely, in fetuses in OP position a higher frequency of clinical overestimation was observed (22/81, 27%, vs 29/222, 13%, $p < 0.01$). Paired comparison of the clinical and sonographic station showed a narrower AoP for the clinical stations 0, +1 and +2 [120 (94–144) degrees vs 129 (106–161) degrees, $p < 0.01$; 133 (116–145) degrees vs 138 (109–169), $p = 0.02$; 140 (120–165) degrees vs 149 (130–181) , $p < 0.01$, respectively] and a longer HPD for the clinical stations 0 and +1 [38 (33–55) vs 36 (25–46) mm, $p = 0.01$ and 35 (30–44) vs 32 (20–46) mm, $p = 0.03$, respectively] in fetuses in OP position.

Conclusions: OP position is associated with a higher rate of clinical overestimation of the head station if compared to non-OP position and with less favorable sonographic indicators of head station for the clinical stations 0, +1 and +2.

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Introduction

The clinical assessment of the occiput position and fetal head station are among the mainstay to evaluate labor progression [1] and manage human labor in the event of supervening complications including dystocia and fetal distress. However, evidence from the literature has shown that such clinical assessment of the head position and station performs suboptimally [2,3]. With respect to the latter, a previous study by Dupuis et al. investigating the reliability of the clinical assessment of fetal head station by using a birth simulator demonstrated rates of misdiagnosis up to 80% irrespective of the degree of expertise of the clinician performing the vaginal examination [4].

Intrapartum ultrasound (US) allows a reliable and reproducible evaluation of the fetal head station [2,5] and position [6,7]. Previous studies have shown correlations among the different sonographic indicators of head station [8,9] as well as between the clinical and sonographic station [10], albeit in the context of the limited agreement between the two techniques in evaluating the actual level of the presenting part and diagnosing head engagement[11]. Evidence from the literature has demonstrated the correlation between the sonographic station as evaluated by means of the angle-of-progression (AoP) and the actual distance between the presenting part and the pelvic outlet as evaluated by means of computed tomography [12] and magnetic resonance imaging [13]. Furthermore, sonographic studies from our group have shown that the pattern of head descent differs between cases with occiput posterior (OP) versus those with non-OP position [14,15]. Such difference between cases with OP and those with non-OP position allows to hypothesize that a different degree of agreement between clinical and ultrasound assessment may exist in relation to the position of the fetal occiput. However, to our knowledge there is little or no data investigating the relation between the clinical and the sonographic assessment of the head station in relation to the position of the fetal occiput. The aim of this study is to evaluate the agreement between the clinical and the sonographic assessment of the head station during the second stage of labor in sonographically confirmed OP versus non-OP position.

Methods

This is a secondary analysis of a prospective, observational study conducted at one tertiary maternity unit in Italy over a 12-months period, between 1st February 2022 and 31st January 2023 [11]. A non-consecutive series of non-anomalous singleton pregnancies at a gestational age on or beyond 36^{+0} weeks were enrolled during the second stage of labor. Vaginal examination for estimation of fetal head station was performed upon clinical indication by a senior Obstetrician. The clinical evaluation was classified by the level of the presenting part in relation to the ischial spines [16]. Within five minutes from clinical assessment a second operator with dedicated training on US in labor and blinded to the findings of the clinical examination performed one transabdominal and transperineal sonography for research purposes to ascertain the occiput position and evaluate the sonographic station by measuring the AoP and head perineum distance (HPD). Patients declining study enrollment were excluded.

Portable ultrasound devices equipped with low frequency transabdominal probe were used. The US measurements were performed on women lying in semirecumbent position with an empty bladder. Transabdominal US was performed by placing the probe transversely over the maternal suprapubic region to assess the position of the fetal head. The position was defined from the landmarks depicting fetal occiput and described as a clock face with 12 hourly divisions. Positions $>$ 09:30 and $<$ 2:30o'clock were classified as occiput anterior, while occiput transverse and occiput posterior (OP) were defined in the case of occiput $\geq$02.30 and $\leq$03.30o'clock or $\geq$08.30 h and $\leq$09.30o'clock and $>$03.30 and $<$08.30o'clock, respectively [2,7]. Transperineal ultrasound was performed with the transducer placed in a transverse or longitudinal position between the labia majora or more caudally at the level of the fourchette and allowed the measurement of the sonographic indicators of fetal head station and descent. The AoP was measured on the midsagittal image by drawing one line between calipers placed at the two points identifying the long axis of the pubic symphysis; a second caliper line was then created on the frozen image that extended from the most inferior portion of the pubic symphysis tangentially to the fetal skull contour [9]. The HPD was assessed placing the probe transversely at the level of the vaginal fourchette and measuring the shortest distance between the fetal skull and the transducer [5].

All the measurements were obtained in the absence of uterine contractions and/or maternal pushing efforts.

This secondary analysis consisted in two different comparisons of the clinical and sonographic station in relation to the position at recruitment. First, the reference ranges of AoP width across clinical station published by Tutschek et al. [8] were used to evaluate the correlation and agreement between the clinical and the sonographic station and the agreement with respect to the diagnosis of head engagement and non-engagement, which was defined sonographically as an AoP $>$ 116 degrees. This was evaluated by assuming that the sonographic measurements represent the reference for the assessment of the head station. Second, quantitative comparison of the AoP width and the HPD length was performed between cases in OP and those in non-OP position across the different levels of clinical station.

Clinical data including maternal age, ethnicity, maternal height, body mass index at booking and at the end of the pregnancy, gestational age at delivery, parity, induced or spontaneous labor, epidural analgesia, head station as well as mode of delivery, estimated blood loss, birthweight and 5-minute APGAR were collected from patient case notes. The study population was divided into two groups: the non-OP group including all cases in which the fetuses were in anterior or transverse occiput position and the OP group.

The primary aims were 1) to evaluate and compare the agreement of the clinical and the sonographic station evaluated by means of the AoP and for diagnosing engaged and unengaged fetal head, the former being defined by sonographic station 0 or below, which corresponds to an AoP $\geq$ 116 degrees and 2) to quantitatively compare the sonographic station in terms of AoP and HPD across clinical station in relation to the occiput position at enrolment.

Ethics approval for this study was granted by the local Ethics Committee at the University Hospital of Parma (N 270/2018/OSS/UNIPR). Statistical analysis was performed using SPSS version 20 (IBM Inc., Armonk, NY, USA). Normal and abnormal distribution of continuous variables was evaluated by means of the Kolmogorov-Smirnov and the Shapiro-Wilk tests and data were shown as mean $\pm$ standard deviation or as median (range) accordingly. Comparison of normally and non-normally distributed continuous variables included the *T* test for independent sample and 2-tailed *t* test and the Mann-Whitney *U* test, respectively. Categorical variables were reported as number (percentage) and compared using the Chi-square or Fisher exact test. $p < 0.05$ was considered as significant. This study was conducted following the STROBE guidelines [17].

Results

Overall, 303 women were included, of whom 81 (26.7%) had OP position at sonographic assessment performed at recruitment. The baseline and obstetric features the study population in relation to the occiput position are shown in Table 1. At paired comparison a higher maternal age (32.6 $\pm$ 5.2 vs 30.5 $\pm$ 4.9 years, $p < 0.01$) and height (164 $\pm$ 6 vs 163 $\pm$ 6 cm, $p = 0.03$), a lower booking BMI (23.8 $\pm$ 4.9 vs 25.6 $\pm$ 6.3 kg/m^2, $p = 0.03$) and a wider AoP (133 $\pm$ 16 vs 127 $\pm$ 17 degrees, $p < 0.01$) were noted in the cases with the fetus in non-OP position compared to those with the fetus in OP position. However, none of such parameters proved to be independently associated with occiput position at logistic regression analysis. Table 2 reports the rate of agreement across different station levels between clinical and sonographic station

Table 1
Comparison of the demographic features and labour outcomes between the cases in occiput posterior (OP) position and cases in non-OP position.

Variable	*Non-occiput posterior N 222*	*Occiput posterior N 81*	*p*
Ethnicity N(%)	Caucasian 191 (86.0%) Other 31 (14%)	Caucasian 67 (82.7%) Other 14 (17.3%)	0.47
Maternal age, years Mean ± SD	32.6 ± 5.2	30.5 ± 4.9	0.01
Height, cm Mean ± SD	164 ± 6	163 ± 6	0.03
NulliparityN(%)	179 (80.6%)	63 (77.8%)	0.58
Gestational age, weeks$^{+\ days}$ Mean ± SD	$39^{+6} \pm 1^{+1}$	$39^{+5} \pm 1^{+3}$	0.34
Booking BMI, kg/m2 Mean ± SD	23.8 ± 4.9	25.6 ± 6.3	0.03
Obesity at booking N(%)	20 (9.0%)	10 (12.3%)	0.39
Induction of labor N(%)	97 (43.7%)	32 (39.5%)	0.51
Epidural N(%)	193 (86.9%)	64 (79.0%)	0.09
First stage length, minutes Mean ± SD	421 ± 219	401 ± 183	0.51
Second stage length, minutes Mean ± SD	89 ± 68	90 ± 88	0.89
Total labor length, minutes Mean ± SD	511 ± 242	491 ± 217	0.53
Mode of delivery N(%)	Spontaneous vaginal delivery 165 (74.3%) Vacuum delivery 51 (23.0%) Caesarean section 6 (2.7%)	Spontaneous vaginal delivery 64 (79.0%) Vacuum delivery 12 (14.8%) Caesarean section 5 (6.2%)	0.13
HPD, mm Mean ± SD	35 ± 8	37 ± 10	0.08
AoP, degrees Mean ± SD	133 ± 16	127 ± 17	<0.01
Digital station, cm Median (range)	0 (−3 – +4)	0 (−5 – +3)	0.42
Estimated blood loss, mls Median (range)	446 ± 378	382 ± 343	0.19
Estimated blood loss > 500 mls N(%)	75 (33.8%)	23 (28.4%)	0.38
Episiotomy N(%)	31 (14.0%)	10 (12.3%)	0.72
OASI N(%)	2 (0.9%)	1 (1.2%)	0.80
Birthweight, grams Mean ± SD	3444 ± 442	3344 ± 410	0.08
APGAR at 1 min Median (range)	9 (1–10)	9 (3–10)	0.92
APGAR at 5 min Median (range)	10 (7–10)	10 (5–10)	0.30
Arterial pH Median (range) n = 280	7.24 ± 0.09	7.23 ± 0.09	0.42
Arterial base excess Median (range) n = 280	−3.7 ± 3.7	−3.8 ± 4.5	0.78
Neonatal acidaemia N(%) n = 280	3 (1.5%)	2 (2.7%)	0.50
APGAR ≤ 7 at 5 mins N(%)	0 (0.0%)	1 (1.2%)	0.10

BMI: body mass index; AoP: angle of progression; HPD: head-perineum distance; OASI: obstetric anal sphincter injury.

in fetuses with non-OP (a) and OP (b) position, respectively. Overall, no difference in terms of consistency between clinical and sonographic station in relation to sonographic position at enrolment was observed (66/222, 29.7%, vs 28/81, 34.6%, respectively, p = 0.45). However, clinical underestimation of the sonographic station occurred more frequently in the non-OP compared to the OP cohort (127/222, 57.2% vs 31/81, 38.3%, respectively, p < 0.01), while clinical overestimation of the sonographic station was more common in the OP compared to the non-OP cohort (22/81, 27.2%, vs 29/222, 13.1%, respectively, p < 0.01). For the fetuses in OP position the odds ratios (ORs) for clinical underestimation and overestimation were OR = 0.46 (0.28 – 0.78) and OR = 2.48 (1.33 – 4.64), respectively. The data concerning the agreement between clinical and sonographic diagnosis of head engagement in relation to the occiput position are shown in Table 3. In cases with non-OP position at sonographic assessment head engagement was clinically diagnosed in 150/222 cases, of whom 142 had sonographic confirmation of head station at or below the level 0 (94.7%). Conversely, among the 72 cases clinically diagnosed with unengaged fetal head, 26 (36.1%) were sonographically confirmed as non-engaged. In OP cases, head engagement was clinically diagnosed in 58/81 cases, of whom 53 (91.4%) had sonographic confirmation of head engagement; however, 10/23 (43.5%) cases clinically diagnosed with unengaged fetal head had sonographic confirmation of non-engagement. No difference was noted between the OP and the non-OP cohort with respect to the agreement of the clinical evaluation in the diagnosis of head engagement vs non-engagement if compared to the sonographic reference.

The comparison of the width of the AoP in relation to the clinical station between the non-OP and the OP cohorts is shown in Table 4. A narrower AoP for the clinical stations 0, +1 and +2 [129 (106–161) vs 120 (94–144), p < 0.01; 138 (109–169) vs 133 (116–145), p = 0.02; 149 (130–181) vs 140 (120–165), p < 0.01, respectively] and a longer HPD for the clinical stations 0 and +1 [38 (33–55) vs 36 (25–46) mm, p = 0.01 and 35 (30–44) vs 32 (20–46), p = 0.03, respectively] were recorded in fetuses in OP position compared to those in non-OP position (Fig. 1).

Discussion

Principal findings

Findings from our study suggest that, within an unselected cohort of women submitted to paired vaginal examination and sonographic assessment during the second stage of labor, clinical diagnosis is consistent with the sonographic reference in less than one-in-three cases irrespective of the head position. OP position is associated with an increased frequency of overestimation of the head station, a lower rate of underestimation of the head station and a narrower width of the AoP for the levels 0, +1 and +2 and a longer HPD for the levels 0 and +1 if compared to non-OP position. Such differences may have little or no impact on the rate of diagnosis (and misdiagnosis) of head engagement versus non-engagement.

Results in the context of what is known

Head station and position play a crucial role for the management of human labor and on the decision as to how to expedite delivery in those circumstances where an obstetric intervention in the second stage of labor is indicated [18–22]. As such, according to the existing Guidelines [18,20,23,24] head engagement and knowledge of the actual occiput position are among the safety criteria for assisted vaginal birth [18]. However, clinical evaluation of the occiput position fails in up to one in four cases overall and one in two cases of head malposition [3] whilst the assessment of the station is highly inaccurate and poorly reproducible irrespective of the level of the experience of the examiner [4,25].

Since its introduction in the clinical practice intrapartum US has been endorsed as a supportive tool for monitoring and predicting labor

Table 2
Evaluation of the rate of agreement, clinical underestimation and overestimation in relation to the sonographic station evaluated by means of the angle-of-progression.

a) Fetuses in non-occiput posterior position

	Number of cases	Clinical underestimation of head station			Agreement	Clinical overestimation of head station		
		By 3 cm	By 2 cm	By 1 cm		By 1 cm	By 2 cm	By 3 cm
AoP < 106 (−2 or higher)	7	–	–	–	4 (57%)	3 (43%)		–
106 < AoP < 116 (−1)	27	–	1 (4%)	4 (15%)	14 (52%)	6 (22%)	2 (7%)	–
116 < AoP < 127 (0)	49	–	4 (8%)	21 (44%)	16 (32%)	8 (16%)	–	–
127 < AoP < 138 (+1)	51	2 (4%)	9 (18%)	18 (35%)	17 (33%)	2 (4%)	3 (6%)	–
138 < AoP < 148 (+2)	47	8 (17%)	8 (17%)	18 (38%)	8 (17%)	5 (11%)	–	–
AoP > 148 (+3 or lower)	41	4 (10%)	13 (32%)	17 (41%)	7 (17%)	–	–	–
Total	222	14 (6%) 127 (57%)	35 (16%)	78 (35%)	66 (30%) 66 (30%)	24 (11%) 29 (13%)	5 (2%)	0 (%)

b) Fetuses in occiput posterior position

	Number of cases	Clinical underestimation of head station			Agreement	Clinical overestimation of head station		
		By 3 cm	By 2 cm	By 1 cm		By 1 cm	By 2 cm	By 3 cm
AoP < 106 (−2 or higher)	8	–	–	–	4 (50%)	2 (50%)	1 (12%)	1 (12%)
106 < AoP < 116 (−1)	7	–	–	2 (29%)	2 (29%)	3 (42%)		–
116 < AoP < 127 (0)	24	1 (4%)	3 (13%)	4 (17%)	8 (33%)	6 (25%)	2 (8%)	–
127 < AoP < 138 (+1)	19	–	2(11%)	4(21%)	7 (37%)	6 (31%)	–	–
138 < AoP < 148 (+2)	14	1 (7%)	1(7%)	6 (43%)	5 (36%)	1 (7%)	–	–
AoP > 148 (+3 or lower)	9	2 (22%)	–	5 (56%)	2 (22%)	–	–	–
Total	81	4 (5%) 31 (38%)	6 (7%)	21 (26%)	28 (35%) 28 (35%)	18 (22%) 22 (27%)	3 (4%)	1 (1%)

Table 3
Contingency table on diagnosis of head engagement between sonographic and clinical evaluation. Non-occiput posterior.

Sonographic evaluation	Clinical evaluation	
	Unengaged fetal head	Engaged fetal head
Unengaged fetal head	26	8
Engaged fetal head	46	142

(a) Occiput posterior

Sonographic evaluation	Clinical evaluation	
	Unengaged fetal head	Engaged fetal head
Unengaged fetal head	10	5
Engaged fetal head	13	53

outcome given its high accuracy in classifying the occiput position [6,7,26]. More specifically, there is grade A evidence from RCTs that intrapartum sonography outperforms clinical assessment in evaluating the occiput position[6]. Furthermore, the technique currently represents an accurate [13] and reproducible [27] tool to assess fetal station, and can predict the chance of successful instrumental delivery [28–30] and spontaneous vaginal delivery when labor dystocia is diagnosed [14,31,32].

Clinical station correlates with sonographic station [33], however the agreement between the two techniques is reported in approximately one in three cases overall [11]. Of note, most of the existing evidence is derived from unselected populations where the head descent was not evaluated in relation to the actual head position, hence of the different pattern of head descent in OP versus non-OP fetuses [14]. In this secondary analysis we confirm the poor agreement between the clinical and sonographic assessment of the head station [11], which seems not to be dependent upon head position. Furthermore, we demonstrate that OP position is associated with an increased frequency of overestimation of the level of the presenting part and with differences in the width of the AoP and length of the HPD across different head levels – mostly corresponding to midcavity – supporting the association between OP position and overestimation of the clinical station and non-OP fetuses. Such differences in the categorization of the station of the presenting part between OP and non-OP fetuses seem not to impact on the overall rate of misdiagnosis of head engagement versus non-engagement nor in the high rate of clinical misdiagnosis of unengaged head when the sonographic assessment indicates head engagement.

Clinical and research implications

In this manuscript we originally report differences in the clinically determined station of the fetal head which are dependent upon the occiput position. More specifically, if we assume that the accuracy of intrapartum sonography is superior to the clinical assessment in defining head station, then clinical overestimation of the head station seems more common in the event of OP position. This may lead to inappropriate clinical decisions when considering an operative delivery in the second stage of labor. Based on our data, quantitative differences in the

Table 4
Comparison of the sonographic station across clinical station evaluated by means of (a) the angle-of-progression (AoP)* and (b) the head-perineum distance (HPD)* in fetuses in occiput posterior (OP) and in non-OP position.

(a)

Clinical station	*N cases non-OP*	*AoP non-OP*	*N cases OP*	*AoP OP*	*P*
−5	–	–	2	83 (73 – 93)	–
−4	–	–	1	93	–
−3	1	108	1	120	–
−2	15	114 (95 – 131)	7	119 (105 – 139)	0.40
−1	56	122 (100 – 160)	12	120 (96 – 170)	0.71
0	51	129 (106 – 161)	18	120 (94 – 144)	<0.01
+1	57	138 (109 – 169)	19	133 (116 – 145)	0.02
+2	27	149 (130 – 181)	18	140 (120 – 165)	<0.01
+3	15	146 (130 – 196)	3	151 (139 – 155)	0.99

b)

Clinical station	*N cases non-OP*	*HPD non-OP*	*N cases OP*	*HPD OP*	*P*
−5	0	–	2	62.9 ± 7.2	–
−4	0	–	1	47.6	–
−3	1	62.0	1	53.0	
−2	15	46 (24–60)	7	45 (37–64)	0.48
−1	56	40 (20–54)	12	39 (31–52)	0.70
0	51	36 (25–46)	18	38 (33–55)	0.01
+1	57	32 (20–46)	19	35 (30–44)	0.03
+2	27	27 (14–42)	18	28 (17–38)	0.50
+3	15	29(16–42)	3	23 (16–29)	0.19

*values presented as median (range).

sonographic indicators of head station between cases in OP and in non-OP position are significant for the clinical stations 0, +1 and +2. These correspond to the mid- (0 and +1) and low- (+2) cavity stations according to the classification for assisted vaginal birth [18], and are acknowledged to represent the most challenging stations for labor management and for instrumental vaginal delivery. Based on our data, at clinical assessment head descent may "feel different" in the event of OP position for certain clinical stations if compared to non-OP position. As such, it can be hypothesized that the increased rate of overestimation of the head station in fetuses in OP position – and not the OP position itself – may be accounted among the contributing factors for the increased frequency of failed instrumental delivery in fetuses in OP position [34–37]. However, this study was not designed to evaluate the relationship between the outcome of instrumental delivery and misclassification of fetal head position.

One previous work from our group suggested that the HPD, but not the AoP, may represent a reliable indicator of head station in OP position given that it represents the actual distance of the fetal occiput (i.e. the actual fetal head station) to the outlet of the birth canal [15]. In this secondary analysis we originally report differences in HPD length between OP and non-OP for certain clinical stations that may not be dependent upon the pattern of head descent but on the OP position itself, which may impact on the rate of overestimation of the clinically assessed head station.

No difference in terms of rate of agreement in diagnosing head engagement versus non-engagement in relation to the occiput position was observed. However, the comparison of the clinical and sonographic station was performed through reference ranges of AoP width across clinical station that are derived from a population mainly consisting in non-OP positions [8]. We previously demonstrated that the HPD, but not the AoP, is associated with the outcome of instrumental delivery in fetuses in OP position [15]. This was explained by the fact that the width of the AoP is not only influenced by the actual level of the head in the birth canal but also by the direction of the head during its descent [15]. In this work we show quantitative differences of the AoP width for the clinical stations 0, +1 and +2. On this basis, we hypothesize that the cut-off values proposed for the sonographic diagnosis of head engagement using the AoP may differ between OP and non-OP position.

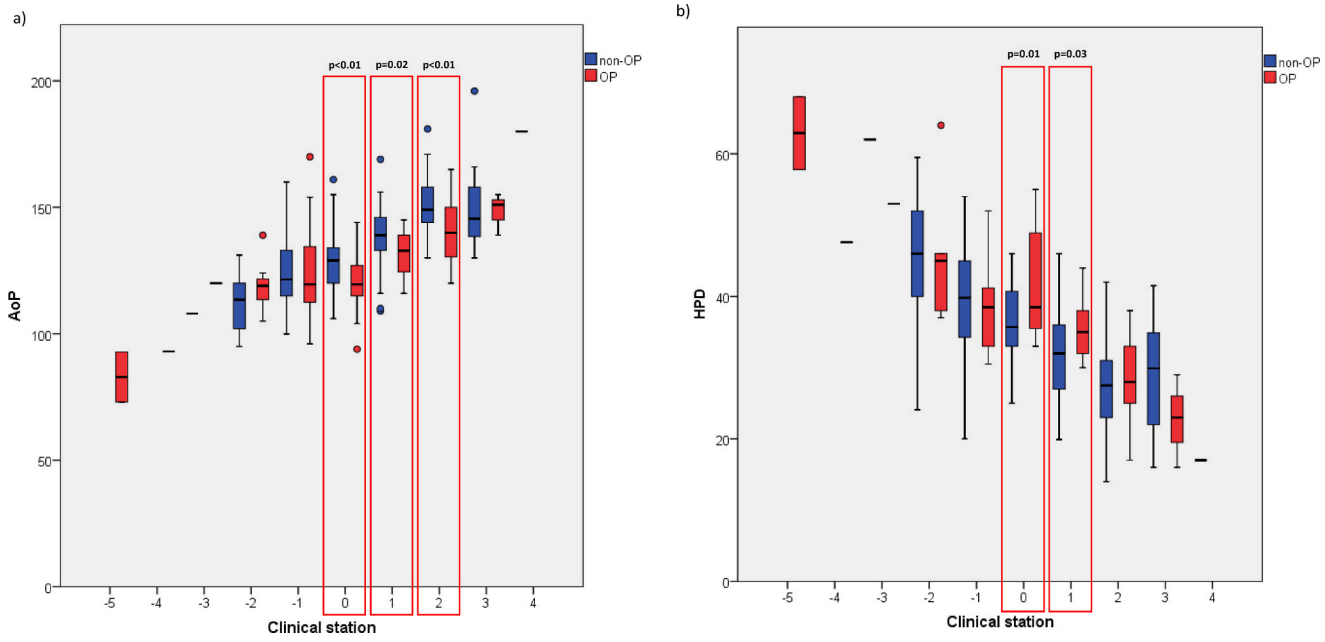


Fig. 1. Graphical representation of the sonographic station evaluated by means of a) the angle-of-progression (AoP) and (b) the head-perineum distance (HPD) (b) at different clinical stations in fetuses in occiput posterior (OP) (red bars) and in non-OP position (non-OP)(blue bars). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Strengths and limitations

To our knowledge, this is the first study evaluating the relationship between clinical and sonographic assessment of fetal head station in relation to the fetal head position. Furthermore, this prospective study has been devised and conducted by a team with dedicated expertise in the clinical and research field of intrapartum US.

With respect to the limitations, the "non-consecutive" enrolment may represent a potential source of bias. The fact that in every enrolled case vaginal examination was performed for clinical indication has led to a higher-than expected prevalence of OP position, even though the wide number of patients enrolled together with the strict inclusion criteria may overcome such potential limitation. Additionally, the reference ranges of AoP width adopted in this present analysis are derived from a population of mainly consisting in fetuses in non-OP position [8]. However, to date they represent the only reference ranges available in the clinical practice. Another limitation is that the single center design may reduce the generalizability of the study findings, and that our results do not apply to actively pushing women as clinical and sonographic evaluations were performed only in between uterine contractions and pushing efforts. Finally, the fetal attitude was not evaluated for the purposes of the study. It is to date uncertain whether the degree of head flexion impacts on the clinical "feeling" of head station as well as on the sonographic station. However, should this relation exist, it could be assumed that the degree of head flexion impacts on both clinical and sonographic stations.

Conclusions

In conclusion, this work has demonstrated a mismatch in the clinical and the sonographic assessment of the station in relation to the occiput position. OP position is associated with an increased trend of overestimation of the clinical station and narrower width of AoP as well as longer HPD at midcavity, which suggests that head malposition may impact on the digital findings. More studies are needed to evaluate whether different cut-off values of AoP for head engagement are to be considered between the fetuses in OP position and those in non-OP position.

CRediT authorship contribution statement

Andrea Dall'Asta: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Enrico Corno:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Chiara Melito:** Data curation. **Laura Angeli:** Data curation. **Giovanni Morganelli:** Data curation. **Elvira Di Pasquo:** Data curation. **Veronica Falcone:** Data curation. **Valentina Anna Degennaro:** Data curation. **Ariane Kiener:** Data curation. **Gabriella Maria Celora:** Data curation. **Michela Taverna:** Data curation. **Marinunzia Salluce:** Data curation. **Priscilla Bontempo:** Data curation. **Maurizio Di Serio:** Data curation, Conceptualization. **Stefania Fieni:** Methodology, Data curation, Conceptualization. **Tullio Ghi:** Writing – review & editing, Formal analysis, Data curation, Conceptualization.

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Condensation

This study suggests that the clinical station may be overestimated in fetuses in occiput posterior position if compared to non-occiput posterior position. Such data support the use of ultrasound to avoid misinterpretation of fetal head station in relation to the position of the fetal occiput.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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