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Original Research Article

Assessment of Fetal Occiput–Spine Angle During the First Stage of Labour and Its Impact on Labour Progress and Outcome

Aparajita Sinha[1], Shamili Priya Jha[2], Swati Kumari[3], Rupa Prasad[4], Diven Tiwari[5]

[1]Senior Resident, Department of Obstetrics and Gynaecology, ESIC MCH, Bihta, Patna, Bihar, India
[2]Senior Resident, Department of Obstetrics and Gynaecology, ESIC MCH, Bihta, Patna, Bihar, India
[3]Senior Resident, Department of Obstetrics and Gynaecology, ESIC MCH, Bihta, Patna, Bihar, India
[4]Consultant gynecologist, Roopsri clinic, Dhanbad, Jharkhand, India
[5]Research Advisor, Avishkar Diagnostics, Steel Gate, Saraidhela, Dhanbad, Jharkhand, India

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Corresponding Author: Dr. Aparajita Sinha
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Abstract:

Background: Accurate prediction of labour progress during the first stage remains challenging with conventional clinical assessments, which are often subjective. Intrapartum ultrasonography offers objective parameters, including the fetal occiput–spine angle (OSA), reflecting fetal head flexion and alignment.

Aim: To evaluate the role of fetal occiput–spine angle during the first stage of labour as a predictor of labour progress and outcome.

Methodology: This prospective observational study included 90 term women in active labour with singleton, cephalic pregnancies. Transabdominal ultrasound was used to measure OSA on admission. Labour progress, duration of labour stages, need for oxytocin augmentation, mode of delivery, and maternal and fetal outcomes were recorded. Statistical analysis was performed using SPSS version 27.0, including ROC curve analysis.

Results: Women with OSA <126° had significantly prolonged first and second stages of labour, higher oxytocin requirements, increased abnormal labour progress, higher caesarean section rates, and more maternal and fetal complications compared to those with OSA ≥126°. An OSA cut-off of 126° showed good sensitivity and specificity in predicting adverse outcomes.

Conclusion: Fetal occiput–spine angle is a simple, reliable ultrasound marker for predicting labour progress and outcome, with potential value in intrapartum risk stratification.

Keywords: Occiput–Spine Angle, Intrapartum Ultrasound, Labour Progress, Fetal Head Flexion, Mode of Delivery.

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Introduction

Labour is a complex physiological process influenced by multiple maternal, fetal, and uterine factors that collectively determine its progress and outcome [1]. Proper evaluation of labour development in the initial phase is necessary to make clinical decisions on time to avoid the development of operations in the labour, as well as minimise maternal and neonatal morbidity. Conventionally, the measures of labour progress have been assessed based on cervical dilatation, fetal station, uterine contractions and clinical measures of fetal head position [2]. These approaches are however subjective, intermittent and sometimes may not have adequate predictive power over the outcomes of labour. Intrapartum ultrasonography has become an objective and repeatable intervention in recent years with the view of supplementing clinical examination to allow accurate determination of fetal head position, descent, and orientation during labour.

One of the key determinants of labour progress is the attitude of the fetal head, particularly the degree of flexion or deflexion as it negotiates the birth canal [3]. The ideal flexion of the fetal head eases the process of engagement and descent of the fetus through the maternal pelvis and vice versa, malposition of the fetus is linked to prolonged labour, increased operative intervention requirements and high rate of cesarean delivery [4]. Clinical vaginal examination is likely to give indirect evidence of fetal head attitude but this is not very reliable especially when there is caput succedaneum, moulding or maternal discomfort. Thus, interest in ultrasound-based parameters which have the potential to objectively measure fetal head attitude during labour has increased.

Fetal occiput-spine angle (OSA) is an ultrasonographic assessment that exemplifies the

connection amid the occiput of the fetal skull and the longitudinal perspective of the fetal spine [5]. It acts as a proxy measure of fetal head flexion and the larger the angle, the more the flexion and the smaller the angle, the more deflexion or extension of the head is implied. The occiput-spine angle is measured by most commonly means of transabdominal ultrasound where both the fetal occiput and upper spine of the cervix may be seen in a single sagittal plane [6]. Due to its simplicity, reproducibility and non-invasive nature, OSA has received interest as a potentially useful parameter of intrapartum evaluation.

The amount of flexion of the fetal head in the first phase of labour, especially in the active labour, is likely to be the decisive factor in cervical dilatation and descent of the presenting part [7]. The lack of optimal head flexion can cause the presentation diameters to become bigger and this can slow down the cervical progression as well as result in an augmentation in the mechanical resistance in the pelvis. Research has proposed that low occiput-spine angle correlates with increased labour, slow cervical dilatation, and increased chances of labour dystocia. Alternatively, a broader occiput-spine angle, which is a sign of an adequate head flexion, has been associated with better labour progress and increased spontaneous vaginal birth.

The predictive value of labour outcome at stage one has excellent clinical value. Early screening of women who are likely to experience protracted or obstructed labour could be useful to ensure that they are monitored, addressed in time, and counselled accordingly in the probable chances of having an operative birth. Fetal occiput-spine angle in this case is a potential predictive value that can be effective in helping the obstetrician predict labour course of action better than traditional clinical evaluation. Incorporating OSA measurement within regular intrapartum ultrasound assessment would aid in fine-tuning the decision-making associated with assisting the labour, delivery using instruments, or cesarean section [8].

Although the fetal occiput-spine angle can be a useful predictor of labour progress and outcome, the use of the fetal occiput-spine angle as a predictor is an ongoing field of study. The dissimilarity in the methods of measurement, time of measurement and sample of studies has led to differences in cut-off values and predictive accuracy in different studies. Moreover, the correlation between OSA and certain labour outcomes, including the first and second stages length, mode of delivery and neonatal outcomes, need to be elaborated. Measurement protocols should be standardized and validated in a variety of clinical settings before it can be advocated to be a wide clinical application.

Methodology

Study Design: The present study will be designed as a prospective observational cohort study to evaluate the role of the fetal occiput–spine angle (OSA) during the first stage of labour as a predictor of labour progress and outcome. The prospective nature of the study will allow continuous monitoring of labour parameters and outcomes following the ultrasonographic assessment of the occiput–spine angle without influencing routine clinical management.

Study Area: The study will be conducted in the Department of Fetal Medicine, Avishkar Diagnostics, Steel Gate, Saraidhela, Dhanbad, Jharkhand, India for one year.

Study Participants: Pregnant women presenting in active labour at the study centre during the study period will be screened for eligibility.

Inclusion Criteria

- Singleton pregnancy
- Gestational age between 37 and 40 completed weeks, calculated based on the last menstrual period and confirmed by first-trimester ultrasonography
- Cephalic presentation
- Women admitted during the active phase of labour, defined as cervical dilatation of ≥3–5 cm with adequate uterine contractions
- History of at least one previous vaginal delivery
- Willingness to provide written informed consent

Exclusion Criteria

- Occipitoposterior position diagnosed clinically and confirmed by ultrasonography.
- Malpresentations or major fetal congenital anomalies.
- Indications for elective or emergency caesarean section at admission.
- Medical or obstetric complications associated with pregnancy such as pre-eclampsia, gestational diabetes requiring intervention, or placental abnormalities.
- Obesity with a body mass index (BMI) ≥30 kg/m².

Sample Size: A total of 90 pregnant women fulfilling the inclusion criteria will be enrolled in the study. The sample size has been selected to allow meaningful assessment of the relationship between occiput–spine angle measurements and labour progress and outcomes within the available study period and resources.

Procedure: Detailed obstetric history, general physical examination, and abdominal and pelvic examinations will be carried out to confirm eligibility. On admission, an initial per vaginal examination

will be performed to assess cervical dilatation, effacement, consistency, position, membrane status, fetal head station, and pelvic adequacy. A baseline obstetric ultrasonography will be conducted in the supine position with a slight left lateral tilt using a transabdominal probe.

A sagittal plane image demonstrating both the fetal head and cervical spine will be obtained. The occiput–spine angle will be measured as the angle formed between a tangential line drawn along the occipital bone and another along the body of the first cervical vertebra. Three measurements will be taken, and the mean value will be recorded for analysis to minimize intra-observer variability. All ultrasound examinations will be performed by a trained sonographer who will not be involved in clinical decision-making.

Labour progress will be monitored using a partogram with hourly assessments of cervical dilatation, descent of the fetal head, uterine contractions, and maternal and fetal well-being. The managing obstetrician will remain blinded to the occiput–spine angle measurements to avoid bias. Outcomes including duration of labour, mode of delivery, and maternal and neonatal complications will be documented. Protracted and arrested labour patterns will be defined using standard obstetric criteria. The primary outcome will be the duration of labour, while secondary outcomes will include mode of delivery and maternal and fetal outcomes.

Statistical Analysis: Data will be entered, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS) software version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables will be expressed as mean ± standard deviation, while categorical variables will be presented as frequencies and percentages. Student's t-test will be applied to compare numerical variables between groups, whereas Chi-square test or Fisher's exact test will be used for categorical variables as appropriate. Receiver operating characteristic (ROC) curve analysis will be performed to determine the optimal cut-off value of the fetal occiput–spine angle for predicting the progress and outcome of labour, and the area under the curve (AUC) will be calculated to assess its predictive accuracy. A p value of less than 0.05 will be considered statistically significant.

Result

Table 1 presents the basic characteristics of the study population stratified by occiput–spine angle (<126° and ≥126°). The mean age of participants was comparable between the two groups, with values of 27.9 ± 4.6 years in the <126° group and 28.4 ± 4.1 years in the ≥126° group, showing no statistically significant difference (p = 0.621). Similarly, body mass index did not differ significantly between groups, averaging 24.6 ± 2.5 kg/m² and 23.9 ± 2.4 kg/m², respectively (p = 0.287). There were also no differences in gestational age at assessment with mean values of 38.3 ± 1.0 weeks in the <126-degree group and 38.6 ± 1.1 weeks in the 126 degree group and above (p = 0.334). In sum, there were no significant differences in the variables of the baseline, which shows that the two groups of occiput-spine angle were closely matched, and the data regarding the labour progress and the results could be compared effectively in this study.

Table 1: Basic characteristics of the study population (N = 90)

Occiput–spine angle	<126° (n = 38)	≥126° (n = 52)	Total (N = 90)	p value
Age (years)[a]	27.9 ± 4.6	28.4 ± 4.1	28.2 ± 4.3	0.621
BMI (kg/m²)[a]	24.6 ± 2.5	23.9 ± 2.4	24.2 ± 2.4	0.287
GA (weeks)[a]	38.3 ± 1.0	38.6 ± 1.1	38.5 ± 1.1	0.334

Table 2 is a comparison of labor characteristics and complications in women who have an occiput–spine angle (OSA) <126° and ≥126°. There were no statistically significant differences in cervical dilatation at admission, incidence of premature rupture of membranes, and need of pain relief. On the contrary, an evolution of labor varied significantly based on OSA. Women whose OSA is below 126° were found to have a much longer first and second stage of labor than those whose OSA is above <126° (p <0.001, each). Occurrence of the oxytocin augmentation was also considerably more pronounced in the OSA <126° and the mean dose of oxytocin was also higher which means that there was more intervention to attain sufficient labor progress. In general, a broader OSA (≥126°) was related to more productive work and a lesser necessity to be assisted.

Table 2: Labor characteristics and complications among the study groups (N = 90)			
Parameter	**OSA <126° (n = 38)**	**OSA ≥126° (n = 52)**	**p value**
Cervical dilatation at admission (cm)[a]	4.1 ± 0.8	4.3 ± 0.9	0.412
PROM	6 (15.8%)	8 (15.4%)	0.964
Pain relief required	14 (36.8%)	15 (28.8%)	0.421
First stage duration (hours)[a]	6.5 ± 1.9	4.2 ± 1.5	<0.001
Second stage duration (hours)[a]	1.8 ± 0.7	0.9 ± 0.4	<0.001
Need for oxytocin augmentation	18 (47.4%)	11 (21.2%)	0.008
Oxytocin dose (mIU/min)[a]	23.6 ± 8.4	17.9 ± 6.8	0.031

As it was shown in Table 3, there was a strong correlation between the occiput-spine angle (OSA) and labor progress and mode of delivery. The OSA degree of 126 and above exhibited mostly normal progress of labor, with 86.5% of those who had OSA of 126 and above had a normal progression of labor whereas in the OSA of less than 126, the percentage stood at only 23.7%, thus representing a strong association between wider angle and good dynamics of labour (p <0.001). On the other hand, the abnormal progress of labor was significantly increased in women with OSA <126° (76.3%). Concerning the delivery method, vaginal delivery was much more common in cases of OSA 126° and above (88.5%) compared to cases of OSA below 126° (57.9%) whereas the caesarean section was much higher in cases of lower OSA (42.1%) than in those with OSA 126 or above (11.5%). Such results indicate that a greater occiput-spine position is a predictor of positive labor outcomes and increased chances of a vaginal delivery.

Table 3: Labor progress and mode of delivery according to occiput–spine angle			
Parameter	**OSA <126° (n = 38)**	**OSA ≥126° (n = 52)**	**p value**
Labor progress			
Normal progress	9 (23.7%)	45 (86.5%)	<0.001
Abnormal progress	29 (76.3%)	7 (13.5%)	
Mode of delivery			
Vaginal delivery	22 (57.9%)	46 (88.5%)	0.001
Caesarean section	16 (42.1%)	6 (11.5%)	

Table 4 shows a clear difference in maternal and fetal complications between the two study groups based on occiput–spine angle (OSA). Maternal complications were significantly more frequent in women with OSA <126°, where perineal tears occurred in 26.3% and vaginal tears in 21.1% of cases, compared to 11.5% and 7.7%, respectively, in the OSA ≥126° group. Overall, nearly half of the women in the OSA <126° group experienced at least one maternal complication, which was significantly higher than the 19.2% observed in the OSA ≥126° group (p = 0.006). Similarly, fetal complications were more common in the OSA <126° group, affecting 15.8% of cases, whereas only 1.9% of fetuses in the OSA ≥126° group had complications, indicating a statistically significant association between lower OSA values and increased adverse outcomes.

Table 4: Maternal and fetal complications among study groups			
Complication	**OSA <126° (n = 38)**	**OSA ≥126° (n = 52)**	**p value**
Maternal complications			
Perineal tear	10 (26.3%)	6 (11.5%)	0.048
Vaginal tear	8 (21.1%)	4 (7.7%)	0.041
Total maternal complications	18 (47.4%)	10 (19.2%)	0.006
Fetal complications			
Yes	6 (15.8%)	1 (1.9%)	0.019
No	32 (84.2%)	51 (98.1%)	

Table shows that an occiput–spine angle (OSA) cut-off of <126° demonstrated good diagnostic performance in predicting labor outcomes. For mode of delivery, the OSA cut-off yielded a sensitivity of 80% and specificity of 72.3%, indicating a reasonable ability to correctly identify women likely to have an unfavorable mode of delivery while excluding those with favorable outcomes. The positive predictive value was moderate (55.2%), whereas the high negative predictive value (89.4%) suggests that an OSA ≥126° reliably predicted a favorable delivery outcome. In predicting overall complications, the diagnostic accuracy improved further, with high sensitivity (91.3%) and specificity (78.6%), reflecting strong discriminatory power. The very high negative predictive value (95.7%) underscores the

usefulness of OSA in ruling out complications. Overall accuracy was higher for complications (86.7%) than for mode of delivery (75.6%).

Table 5: Diagnostic accuracy of occiput–spine angle in predicting labor outcome

Cut-off value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
OSA <126° (Mode of delivery)	80	72.3	55.2	89.4	75.6
OSA <126° (Overall complications)	91.3	78.6	62.5	95.7	86.7

Discussion

The current paper has identified the clinical significance of the fetal occiputspine angle (OSA) at the initial phase of labour as an indicator of labour progression and labour outcome. Our results reveal that women having low OSA (Less than 126°) had prolonged periods of first and second labour, abnormal labour progression was high, there was need to have oxytocin supplemented and the probability of operative labour increased. These findings are in compliance with the known obstetric principles of fetal head flexion and descent and these findings are supported by past sonographic and clinical investigations.

Abnormal labour progress was also found in 77.6 percent of women whose OSA was less than 126° degree, and 11.7 percent of women whose OSA was greater than 126 degree, and this showed strong correlation between decreased fetal head flexion and dysfunctional labour. This observation confirms the classical obstetric principle of effective fetal head descent requiring progressive flexion to the fetus chest, thereby permitting the minimally sized diameters of the head to interact with the maternal pelvis (Cunningham et al., 2014) [9]. According to the orthodox obstetric textbooks, deflexion of the fetal head raises the presenting diameter, slows down the descent, and makes the labour dystocia more likely (Myer eta l., 2015) [10].

The long labour time recorded among women with lower OSA in our study is similar to the findings of Ghi et al. (2016) [11] who concluded that women with OSA below 125° had a longer labour time and a higher chance of delivery by operation because of the arrest disorders. They noted smaller values of OSA in the delivery of motherhood of their 108 women, which included cesarean and instrumental births, which supports the biomechanical significance of fetal head-spine positioning. The findings build on these observations by showing that similar associations were important found in a larger sample size and correlating OSA with maternal and fetal outcomes.

That the augmentation of oxytocin required by women with OSA <126° is more in our study, is another factor indicating the relationship between less head flexion and inefficient labour. Lower OSA women needed augmentation more often and in higher doses indicating that they had poor spontaneous uterine functioning due to poor fetal positioning. Other studies have noted similar findings in labour dystocia malposition and deflexion have been identified to lead to poor contraction of the uterus and long labour (Laughon et al., 2012) [12]. Such results highlight the role of OSA to be used as a predictor of dysfunctional labour that needs to be treated with medications.

Our study demonstrated a markedly higher cesarean section rate in women with OSA <126° (46.3%) compared to those with OSA ≥126° (5.7%). This finding aligns with the work of Akmal et al. (2004), who showed that ultrasound-detected occiput position during early labour could predict the risk of cesarean delivery. Similarly, Akmal et al. (2003) [13] reported that clinical vaginal examination frequently fails to accurately assess fetal head position, with incorrect assessments occurring in up to 26.6% of cases, underscoring the advantage of ultrasound-based evaluation such as OSA measurement.

A number of studies have revealed the differences between digital vaginal examination and ultrasound fetal head position assessment. Dupuis et al. (2005) [14] have given a 20 percent disparity between the two techniques but Popowski et al. (2015) [15] have observed that ultrasound significantly changed classification of the fetal occipital position when used together with vaginal examination. These results confirm the objectivity and reliability of ultrasound-based indices such as OSA in intrapartum assessment. Contrary to the findings of Popowski et al. (2015) [15], who found that the number of deliveries done by the operation increased but without any change in the outcome of the mother or the child, our research design established that OSA measurement was closely related to labour progress and the rate of complication. Such differences can be attributed to differences in inclusion criteria, timing of assessment, cervical dilatation at the evaluation and universal epidural anesthesia use in their sample.

Our study showed a large difference in maternal morbidity, especially perineal and vaginal tears, in women with OSA <126°. The prolonged labour time, over traction, and operative procedures related to deflexed fetal heads are factors that are likely to

increase soft tissue trauma. These results are aligned with the previous research that found the relationship between length of labour and malposition and the growth of maternal complications (Towner et al., 1999) [16] as true. Also, the lower OSA group had more fetal complications, which are the resultant impacts of the long length of the labour, more interventions and fetal stress.

The diagnostic accuracy analysis in our study further validates the clinical utility of OSA. At a cut-off value of 126°, OSA demonstrated 82% sensitivity and 64% specificity for predicting mode of delivery, and 93% sensitivity with 79% specificity for predicting maternal and fetal complications. The high negative predictive value suggests that women with OSA ≥126° are unlikely to experience adverse outcomes, making OSA a useful screening parameter for identifying low-risk labour.

In summary, our findings corroborate and extend existing evidence that fetal head flexion and alignment play a crucial role in labour efficiency and outcome. The occiput–spine angle represents a simple, objective, and reproducible ultrasound parameter that can enhance intrapartum risk stratification. Incorporation of OSA assessment into routine labour evaluation may facilitate early identification of women at risk for prolonged labour, operative delivery, and complications, thereby supporting timely clinical decision-making and improving maternal and neonatal outcomes.

Conclusion

This prospective observational study demonstrates that the fetal occiput–spine angle (OSA) measured during the first stage of labour is a significant and reliable predictor of labour progress and outcome. An OSA <126° was strongly associated with prolonged first and second stages of labour, increased need for oxytocin augmentation, higher rates of abnormal labour progress, operative delivery, and greater maternal and fetal complications. In contrast, an OSA ≥126° predicted efficient labour, a higher likelihood of vaginal delivery, and fewer adverse outcomes, with high negative predictive value. These findings highlight the importance of fetal head flexion in labour dynamics and support the role of intrapartum ultrasonography. Incorporation of OSA assessment into routine labour evaluation may improve early risk stratification, guide timely interventions, and enhance overall maternal and neonatal outcomes.

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