ROLE OF TRANSPERINEAL ULTRASOUND MEASUREMENTS IN WOMEN WITH PROLONGED SECOND STAGE OF LABOR AS PREDICTORS OF THE MODE OF DELIVERY

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ABSTRACT

Aim of the work: To assess the clinical significance of transperineal ultrasound measurements, the angle of progression and the head progression distance in prediction of the mode of delivery in women with prolonged second stage of labor.

Subjects and methods: 60 women with a live singleton fetus at full term who presented with prolonged second stage of labor were enrolled in our study. Transperineal ultrasound was used for determination of both angle of progression and head progression distance. We statistically analyzed the relationship between the ultrasound measurements and the different modes of delivery.

Results: 32 women had spontaneous vaginal delivery, 13 women had assisted vaginal delivery using vacuum extraction and the remaining 15 women had a cesarean section. A statistically significant difference was found between the angle of progression and the mode of delivery, however there was no statistically significant difference between head progressive distance and different modes of delivery. The angle of head progression correlated with the mode of delivery using logistic regression analysis with a probability of 85.5% for an angle of 120°.

Conclusion: Angle of progression measured by transperineal ultrasound is an easy, simple, reliable, and noninvasive method for prediction of mode of delivery in women with prolonged second stage of labor rather than head progression distance.

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1. Introduction

The simple objective of any pregnancy is the delivery of a healthy baby to a healthy mother (1). Adverse maternal and perinatal outcomes have been related to prolonged second stage of labor. Avoiding such adverse outcomes depends on the safe and effective management of this stage (2).

The second stage of labor is defined as the duration from full cervical dilatation to delivery. It is considered prolonged if it exceeds 2–3 h in nulliparous and 1–2 h in multiparous women (2,3). Failure of head descent is a common indication of performing surgical delivery, hence proper evaluation of this process is a key to deciding what optimal mode of delivery should be chosen (4,5).

Digital transvaginal examination remains the mainstay for clinical evaluation of head descent. Head station is based on the relationship of the leading edge of the fetal head and maternal pelvic landmarks, namely the ischial spine (6). However, the latter method has proven to be inaccurate and poorly reproducible (7,8). Errors in assessment are further demonstrated with protracted labor, especially when fetal head molding and caput succedaneum occur, rendering position interpretation more difficult (9).

Intrapartum transperineal ultrasound has been described as an objective and reliable method of assessment of fetal head descent (10,11). Several sonographic parameters and their relationship to digital transvaginal examination and mode of delivery have been studied (5,10,12,13).

Kalache et al. (13) were the first report to study the relationship between a single objective transperineal ultrasound marker (i.e. angle of progression) and the mode of delivery in prolonged second stage of labor, and Gilboa et al. (5) studied the relationship of another single transperineal parameter, namely the head progression distance and the mode of delivery, however to the best of our knowledge each of these parameters was studied individually and their relations to each other is not fully described hence our aim was to assess the relation of the angle of head progression and head progression distance, to clinical assessment and to each other and their role in prediction of the mode of delivery in women with prolonged second stage of labor.

2. Patients and methods

From December 2013 to December 2014 we prospectively evaluated 60 women with the following inclusion criteria; full term (≥37 weeks) live singleton fetus in the occipito-anterior position and failure in progress of the second stage of labor, which was defined as full cervical dilatation for more than 2 h in nulliparous women or for more than 1 h in parous women, normal fetal heart rate and fetal head station at or below ischial spine.

Full history taking and complete clinical examination were undertaken for all participants; maternal, fetal and birth characteristics of the study group were collected for statistical analysis including the mode of delivery.

Intrapartum transperineal ultrasound (ITPU) examination and digital transvaginal examination were performed. The women in labor were placed in dorsal lithotomy position with their hips and knees flexed and the urinary bladder was emptied either by asking the patient to void before the procedure or by a catheter. Both examinations were performed between uterine contractions.

Intrapartum ultrasound examinations were performed in standard B-mode ultrasound using a Toshiba SSA-580 (Nemio XG, Toshiba Medical Systems, Japan), which has a 3–6 MHz convex probe installed. The transducer was prepped by covering it with a surgical latex glove filled with coupling gel, then the prepped transducer, after applying gel, was placed between labia below the pubic symphysis to obtain a sagittal plane, small adjustments in the form of lateral movements of the probe were made until the image obtained showed clear maternal pelvic (pubic symphysis) and fetal (fetal skull) landmarks that did not show any shadows from the pubic rami. Kalache et al. (13) described the angle of progression as the angle measured between a line placed through the midline of the pubic symphysis and a line running from the inferior apex of the pubic symphysis tangentially to the fetal skull. Dietz and Lanzarone (14) described the head progression distance as the minimal distance from a line through the inferior posterior symphyseal margin (parallel to the main transducer axis) and the leading edge of the fetal skull (Fig. 1).

Intrapartum ultrasound measurements, i.e. angle of progression and head progression distance, were measured and recorded 3 times during the same scan; the average of these measures was taken as a single estimate of these measurements. All patients tolerated the transperineal scan well without reporting any discomfort.

Digital per-vaginal examination was first performed by the managing obstetrician followed by transperineal ultrasound which was done by a radiologist who was not aware of the result of the digital per-vaginal examination.

After transperineal ultrasound scanning the decision as regards which mode of delivery; spontaneous vaginal delivery, vacuum extraction or cesarean section; is appropriate, was made exclusively on the basis of vaginal digital examination and the obstetrician experience and integration of patient’s preferences and characteristics. The examining radiologist was never involved in any clinical decisions regarding labor follow up or mode of delivery.

Statistical analysis was performed using the following tests; interclass correlation coefficient was used as a method of determination of intraobserver variability for the repeated trans-

![Fig. 1 Diagram showing the method of transperineal US, measurement of the head progression angle (A) and head progression distance (B).](image-url)
Role of transperineal ultrasound measurements

perineal ultrasound measurements, One way ANOVA for testing the effect of the different clinical variables with the mode of delivery, Kruskal–Wallis was used for non parametric data i.e. head station, binary logistic regression with binary fitted line plot for testing the correlation of ultrasound measurements with the mode of delivery and Pearson correlation for testing the relation of the transperineal US measurements to each other, 95% Confidence interval and p-value of < 0.05 were considered statistically significant. Software package used for analysis was Minitab V.17 (Minitab Inc., USA).

The protocol of the study was approved by the local ethics committee of our institution, informed consent was obtained from all patients and their data were stored on secured digital files anonymously.

3. Results

In the 60 women included in the study, the mean maternal age was 29.4 ± 3.8 years, the mean gestational age was 38.3 ± 0.98 weeks, and 48 women (80%) were nulliparous and 12 women (20%) were multiparous, all the subjects tolerated well the transperineal ultrasound examination, as the total scan time did not exceed 4 min. No discomfort was addressed by any of the patients.

Thirty two women (53.33%) had a spontaneous vaginal delivery, in 13 women (21.67%) vaginal delivery was facilitated by the use of vacuum extraction and the remaining 15 women (25%) had a cesarean section.

Interclass coefficient for the 3 head progression angle measurements was 0.9989 (95% CI = 0.9983 to 0.9993) and for the head progression distance was 0.9921 (95% CI = 0.9871 to 0.9952) denoting high reliability & low intraobserver variability of the measurements.

One way ANOVA test revealed no statistically significant relation (i.e. \( p > 0.05 \)) between the maternal age, maternal body mass index, gestational age, birth weight and fetal head circumference, and the mode of delivery. A statistically significant relation was found (\( p < 0.001 \)) between both the angle of head progression and the fetal head station and the mode of delivery. Patients who had spontaneous vaginal delivery showed larger angles of head progression than the other 2 methods. No statistically significant relation (\( p > 0.05 \)) between the head progression distance and the mode of delivery was found (Table 1 and Fig. 2).

Vacuum delivery was considered as assisted vaginal delivery and the patients where this technique was used were included with those having spontaneous vaginal delivery before performing logistic regression analysis, which showed a strong relationship between the angle of progression and the need for cesarean section (\( R^2 \) measure of fit = 73.22%, likelihood ratio chi-square \( p < 0.0001 \)). It was found that for an angle of progression of 100°, the fitted probability of spontaneous vaginal delivery or vacuum extraction was 10%, however this probability increased to 85.5% if progression angle was 120° (Fig. 3).

Logistic regression curve revealed failure of head progression distance in prediction of mode of delivery (\( R^2 \) measure of fit = 0.999%, likelihood ratio chi-square \( p < 0.415 \)).

Moderate correlation between the fetal head station and the head progression distance was found \( r = 0.408, p-value = 0.001 \) however weak correlation between the angle of progression and head progression distance was found \( r = 0.019, p-value = 0.884 \).

4. Discussion

With widespread availability of ultrasound systems in labor wards, intrapartum ultrasound examination had a large acceptance as a valuable tool in the hands of obstetricians (13). Intrapartum ultrasound enabled understanding of the complex physiology of childbirth and has been shown to give objective information on the dynamics of different stages of labor and has also been used to assess the prognosis for operative vaginal delivery (9,14).

In the current work transperineal ultrasound was done successfully, easily and with very short time for all women included in the study, and all women tolerated the procedure well without any discomfort, these results agreed with that reported by Khalil et al. (1) and Barbera et al. (10) Kalache et al. (13)mentioned that the measurement of the angle of progression is a simple ultrasound technique as it depends on two easily depicted ultrasound markers, one maternal pelvic (pubic symphysis) and one fetal (leading body edge of fetal skull) structure. This approach definitely overcomes some of limitations associated with transperineal ultrasound imaging such as difficulty to visualize the ischial spines which are the reference point where fetal head descent is determined subjectively by digital vaginal examination, also Barbera et al. (10)

### Table 1

Comparison of different modes of delivery and different clinical variables and the transperineal ultrasound measurements (angle of progression and head progression distance).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Spontaneous vaginal delivery (( n = 32 ))</th>
<th>Vacuum extraction (( n = 13 ))</th>
<th>Cesarean section (( n = 15 ))</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal age (year)</td>
<td>29.28 ± 3.59</td>
<td>30.23 ± 3.75</td>
<td>29.2 ± 4.66</td>
<td>0.729 (NS)*</td>
</tr>
<tr>
<td>Maternal BMI (kg/m(^2))</td>
<td>28.12 ± 3.8</td>
<td>28.38 ± 2.6</td>
<td>27.4 ± 3.81</td>
<td>0.744 (NS)*</td>
</tr>
<tr>
<td>Gestational age (weeks)</td>
<td>38.29 ± 0.91</td>
<td>38.7 ± 0.71</td>
<td>37.9 ± 1.23</td>
<td>0.094 (NS)*</td>
</tr>
<tr>
<td>Birth weight (g)</td>
<td>3434.4 ± 207</td>
<td>3384.6 ± 247</td>
<td>3433.3 ± 212</td>
<td>0.770 (NS)*</td>
</tr>
<tr>
<td>Head circumference (mm)</td>
<td>345.3 ± 5</td>
<td>346.9 ± 4.8</td>
<td>347.3 ± 4.5</td>
<td>0.351(NS)</td>
</tr>
<tr>
<td>Fetal head station</td>
<td>2 (0–3)</td>
<td>1 (0–3)</td>
<td>1 (0–2)</td>
<td>&lt;0.001+</td>
</tr>
<tr>
<td>Angle of progression</td>
<td>180.16 ± 26</td>
<td>124.62 ± 13.15</td>
<td>100.73 ± 8.63</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>Head progression distance (cm)</td>
<td>6.7 ± 1.6</td>
<td>6.8 ± 1.5</td>
<td>6.4 ± 1.1</td>
<td>0.721 (NS)*</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD for normally distributed parameters and median (range) for those not normally distributed. + Kruskal–Wallis test, NS: not significant, BMI: body mass index.

* One-way ANOVA.
reported that head edema and caput formation will not affect the angle measured by ultrasound. Ultrasound seems a proper solution to plan and monitor the labor and as well to guide instrumental delivery because it is available, safe, non-invasive and offers immediate and objective results, also it offers the possibility to record the data and is quick to learn and simple to use (15).

In the current study statistical analysis showed low level of intra-observer variability for both angle of progression and head progression distance, these results matched with that mentioned by Barbera et al. (10) which reported similar findings for the measurement of the angle of progression.

In the current work, statistical analysis of the maternal age, maternal body mass index, gestational age, birth weight, fetal head circumference and the head progression distance showed no significant relation to the mode of delivery, these results are in agreement to those reported by Gilboa et al. (5) and Kalache et al. (13).

In the current study, a statistically significant relation was found between the fetal head station and the angle of the progression measured by TPU. Further analysis of the previous findings showed a significant correlation between the angle of head progression and the mode of delivery and poor correlation between head progression distance and the mode of delivery (Figs. 4 and 5).

Gilboa et al. (5) in their study on 65 women with prolonged second stage of labor, mentioned that despite the positive correlation of head progression distance with fetal head station, there was no statistically significant correlation or predictive value between head progression distance and mode of delivery, and these results matched with the results of the current study, also these results were explained by Kalache et al. (13) and Barbera et al. (16) who reported that for the high fetal head stations the linear portion of the birth canal concurs with head progression distance, since the latter is a linear measurement. However this measurement may be less accurate with low stations for which the caudal birth canal is curved and the angle of progression may be more appropriate.

The data presented in this study indicate that the head progression distance correlated with fetal head station but cannot predict the mode of delivery, this may encourage its usefulness as an adjunct method for determination of fetal head descent during labor and these data and results were in agreement with Gilboa et al. (5).

The results of the current study indicate that the greater the angle of progression, the more likely it is the vaginal delivery will be successful. Logistic regression curve showed a strong correlation between the angle of progression and the need for cesarean section, in which when the angle of progression 100°, the fitted probability of spontaneous vaginal delivery or vacuum extraction was 10%, however this probability increased to 85.5% if progression angle was 120°, these results matched with the results obtained by Barbera et al. (10) and Kalache et al. (13), who found that in all the vaginal deliveries there was a constant increase in angle of progression and spontaneous delivery occurred in all cases in which the angle of progression exceeded 120°. An angle of 108° was reported as the average for patients needing a cesarean section (10).

The limitations of this study included small number of patients, lack of comparison with women in the 1st stage of labor and the study included only pregnancies with fetus in occipito-anterior position.

Finally, the results of this study emphasize the important role of the angle of progression measured by transperineal

![Box plot showing the range and median measurements of the angle of head progression vs. the mode of delivery (CS: cesarean section, SVD: spontaneous vaginal delivery, VAC: vacuum extraction).](image)

![Binary fitted line plot of the probability of vaginal delivery (including vacuum extraction) with different angles of progression. (VD: vaginal delivery).](image)

![Transperineal US measurements showed an angle of head progression of 99° and a head progression distance of 4.3 cm. This patient had a cesarean section.](image)
ultrasound, as an easy, simple, reliable, comfortable and non-invasive method for prediction of mode of delivery in women with prolonged second stage of labor, however our results showed the relatively poor role of head progression distance in prediction of mode of delivery on its own, but it may be used as an adjunct method for assessment of fetal head descent during labor.

5. Conflict of interest

We have no conflict of interest to declare.

References