Evaluation of sonographic assessment of the progress of labor

Ocena przydatności ultrasonografii do oceny przebiegu porodu

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Abstract

Objective: To evaluate the practical application of intrapartum sonographic assessment of the progress of labor.

Material and methods: Eighty three full-term pregnant women who delivered at the Obstetrics and Gynecology Department were enrolled into this study. Transperineal ultrasonographic examinations were conducted with a convex transducer at the onset of active labor, yielding mid-sagittal and coronal images. Three parameters were measured: **1)** the angle between the long axis of the symphysis pubis and the line joining its lowest margin to the contour of the fetal head (angle of progression); **2)** the distance between the presenting point and the line perpendicular to the symphysis pubis and passing through its lowest margin; **3)** the fetal head-perineum distance. The relationship between measurement results and the period from examination to delivery was also analyzed.

Results: There were 73 vaginal deliveries and 10 women underwent a cesarean section due to failure to progress. The two groups (vaginal vs. cesarean delivery) differed significantly in terms of the angle of progression (131 vs. 110 degrees, respectively, p<0.01) and the distance between the presenting point and the infrapubic line (34 vs. 20 mm, respectively, p<0.01). The inter-group difference in fetal head-peritoneum distances (53 and 61 mm, respectively) was noticeable but non-significant (p>0.05). The study also demonstrated a relationship between all three of the measured values and the time to second labor phase completion.

Conclusions: Ultrasonography may be useful in assessing the progress of labor as well as in predicting or early diagnosis of abnormal fetal head descent.

Key words: **intrapartum translabial ultrasonography** / **angle of progression** / **labor** /

Streszczenie

Cel pracy: Ocena przydatności zastosowania ultrasonografii śródporodowej do oceny postępu porodu.

Materiał, metody: Do badania losowo włączono 83 pacjentki w ciąży donoszonej, które rodziły w I Klinice Położnictwa i Ginekologii. Przy pomocy sondy convex wykonywano badanie ultrasonograficzne przez wargi sromowe na początku II okresu porodu, uzyskując przekroje w płaszczyźnie strzałkowej oraz czołowej. Obliczano 3 parametry: **1)** kąt między spojeniem łonowym, a linią styczną do główki płodu, przechodzącą przez dolny brzeg spojenia łonowego (tzw. kąt progresji) **2)** odległość między punktem prowadzącym, a linią prostopadłą do spojenia łonowego, przechodzącą przez jego dolny brzeg, **3)** odległość między główką płodu, a skórą sromu rodzącej. Przeanalizowano także związek pomiędzy uzyskanymi wynikami, a czasem jaki upłynął między badaniem USG i urodzeniem dziecka.

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Wyniki: *Drogami i siłami natury urodziły 73 pacjentki (88 %). Z powodu braku postępu porodu w II okresie, cięcie cesarskie wykonano u 10 rodzących (12 %). Wykazano istotne różnice pomiędzy tymi grupami (poród fizjologiczny oraz poród operacyjny) w wartościach kąta progresji (odpowiednio 131 i 110 stopni, p<0.01) oraz odległości punktu prowadzącego od linii podłonowej (odpowiednio 34 i 20 mm, p<0.01). W przypadku pomiaru odległości główki płodu od sromu pacjentki, stwierdzono różnice między uzyskanymi wynikami lecz nie były one istotne statystycznie (odpowiednio 53 i 61 mm, p>0.05). Wykazano również zależność między wynikami wszystkich 3 pomiarów, a czasem do zakończenia II okresu porodu.*

Wnioski: *Ultrasonografia może być pomocnym narzędziem do oceny postępu porodu i przewidywania lub wczesnego rozpoznawania zaburzeń w zstępowaniu główki płodu.*

Słowa kluczowe: **ultrasonografia śródporodowa** / **USG przezkroczowe** / **kąt progresji** /
/ **poród** /

Introduction

For a long time, the vaginal examination has been part of standard labor room practice as a means of assessing the progress of labor. Today, every pregnant woman receives multiple vaginal examinations throughout her labor. However, as recently as in the 1980s, the standard of obstetric practice in Poland was completely different. According to manuals of the time, conducting a vaginal examination required special indications. Such indications included: suspected failure to progress in labor, fetal heart rate disorders, or vaginal bleeding [1-2]. The purpose of this protocol was primarily to reduce the risk of intrauterine fetal infections. The main disadvantage of a vaginal examination is its subjective nature. There have been a number of analyses to assess the accuracy and repeatability of those examinations when conducted by different examiners. A birth simulator study by Dupis et al. conducted in a group of 57 physicians, including 25 specialists and 32 residents, showed a 30–34% error rate in both groups [3]. The accuracy of determining fetal head engagement in the pelvic inlet was low at 12%. Sherer compared the assessments of fetal head position in the birth canal during the active phase of labor via a vaginal examination and transabdominal ultrasound [4-5]. This study demonstrated a high rate of vaginal examination errors (up to 76%). These results were similar to those published by Souka [6]. The rate of accurate vaginal examinations of fetal head orientation in the birth canal was 31% during the first stage of labor and 65% during the second stage. These results were confirmed by subsequent studies by Chou, Dupuis, and Akmal, with the study by Dupuis additionally demonstrating a significant impact of caput succedaneum on vaginal examination results [7–9].

Due to the already described limitations of a vaginal examination, attempts have been made to make the progress of labor assessment more objective. There was an emergence of commercial systems based on various data collection methods. Sharf described a system that utilizes markers placed on the fetal head and on opposite lips of the cervix [10].

During the course of labor, information on cervical dilatation and fetal head station (leading point descent) is continuously recorded. Conversely, Farine presented a system based on the analysis of a camera feed, provided by a special probe placed in the vagina [11]. This method provides information on cervical dilatation as well as on the distance between the leading part and the probe sensor. A third, equally interesting approach, is a system described by Nizard that utilizes the data both from ultrasound examinations and from sensors placed on the patient's skin [12]. Processing of the collected data yields a 3-dimensional image showing the spatial relationship of the fetal head and the mother's pelvis.

These evaluation systems have obvious shortcomings. Firstly, they limit the patient's freedom, as she remains attached to numerous sensors. An equally important limitation is the necessity to purchase and service additional, specialist equipment. Thus, none of these systems are likely to be used in routine labor room practice.

Recent study results show promise in terms of providing more objective methods of assessing the course of labor. A 2003 study by Barbera presented an ultrasonographic method of fetal head descent assessment during labor [13-14]. This study measured the angle between the long axis of the symphysis pubis and a line extending from its most inferior edge tangentially to the fetal skull (angle of progression) and demonstrated that the angle of progression above 120 degrees was every time associated with a successful vaginal delivery.

Subsequent years saw further attempts to cast some light on this, in a way, novel method. Further trans-perineal ultrasound parameters were analyzed. The following assessments: the angle of progression, distance of progression of the fetal head in the birth canal (the distance between the infrapubic line and the leading point of the fetal head), distance between the fetal head and the symphysis pubis, and fetal head-perineum distance were shown to be potentially useful in evaluating the risk of abnormal progress of labor and estimating the time to stage II completion. (Figures 1–3).

Objectives

The objectives of our study were to determine the usefulness of intrapartum translabial ultrasound (ITU) in labor progress assessment and to find an answer to the question which of the parameters described in the literature best correlates with the actual course of the second stage of labor.

Material and methods

A total of 83 women, who gave birth between the 37th and 42th week of pregnancy while hospitalized at the Department of Obstetrics and Gynecology, Medical University of Warsaw, in the period between June 2012 and March 2014, were enrolled in the study. Pregnant women with suspected fetal hypotrophy or macrosomia and those with contraindications to spontaneous vaginal delivery were excluded from the study; as were the women who

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required termination via Cesarean section due to threatend intra-uterine asphyxia. Out of the 83 patients, 60 (72%) were primiparous, 16 (19%) gave birth for the second time and 7 (9%) – for the third time. A vast majority of women, i.e. 88%, received epidural analgesia upon request.

During the second stage of labor, an ultrasound examination was conducted with Mindray DP-50 Convex transducer probe (35C50EA 2–6 MHz), which was placed against the woman's perineum, yielding sagittal and coronal cross sections. (Figures 1–3).

Databases Astraia (Astraia Software Gmbh, Munich, Germany) and Excel 2000 (Microsoft, Redmond, US) were used to collect the data. Measurements were performed at obtained sagittal images, after identification of symphysis pubis, fetal head, and leading point. These measured parameters were 1) the *angle of progression* (the angle between the long axis of the symphysis pubis and a line extending from its most inferior edge tangentially to the fetal skull) and 2) distance of progression (the distance between the leading point on the fetal head and the line perpendicular to the long axis of the symphysis pubis and extending dorsally from its inferior *margin, i.e. the infrapubic line*).

The coronal-plane images were used to measure the distance between the fetal head and the skin surface of the perineum. Statistical analyses (Statistica, StatSoft, Tulsa, US) were based on the t-test with separate variance estimates, with the significance level set at P <0.05. The correlation of the obtained results and the time elapsed between the intrapartum ultrasound examination and delivery was analyzed with a correlation matrix test.

Results

Out of the 83 evaluated patients, 73 (88%) delivered vaginally, including 50 primiparas and 23 multiparas. Ten patients (12%) required Cesarean section due to failure to progress during the second stage of labor. This subgroup included only primiparous women. A mean duration of the second stage of labor was 46 minutes (5–125 minutes) and was significantly shorter in the multiparas subgroup (27 vs. 56 min; P<0.01). The mean neonatal birth weight was 3440 g.

Our study showed a significant difference between the vaginal delivery group and the Cesarean section group in terms of the angle of progression (P <0.01; Figure 4). This difference was observed both in the primiparas subgroup alone (110 vs. 133 degrees, C-section vs. vaginal delivery) and in the total evaluated population (110 vs. 131 degrees, C-section vs. vaginal delivery).

An analysis of the distance of progression also demonstrated a correlation between the obtained values and the route of delivery (Figure 5). The mean distance of progression in women who delivered vaginally was 35 mm in the primiparas subgroup and 34 mm in the total evaluated population. In both cases, the values differed significantly from the mean distance in women diagnosed with failure to progress during the second stage of labor (20 mm; P<0.01).

The obtained distance of progression values were significantly higher in primiparas versus multiparas (35 and 29 mm, respectively; P<0.05). The third parameter evaluated in our study was the fetal head-perineum distance, measured in ultrasonographic images depicting a coronal cross section (Figure 6). Although we observed inter-group differences (vaginal delivery vs. C-section), they were non-significant (53 vs. 61 mm, respectively; P>0.05).
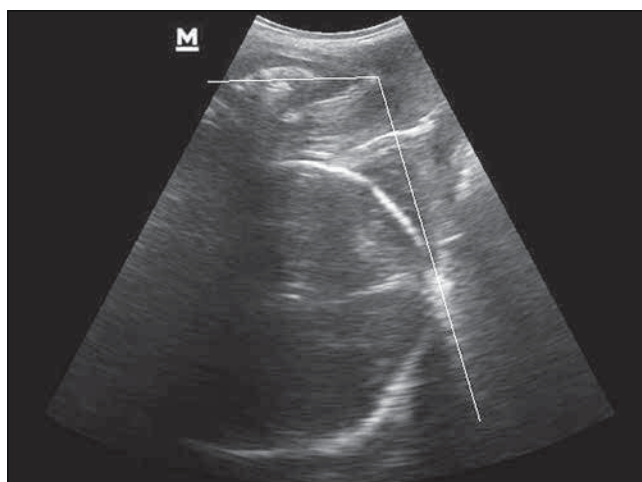

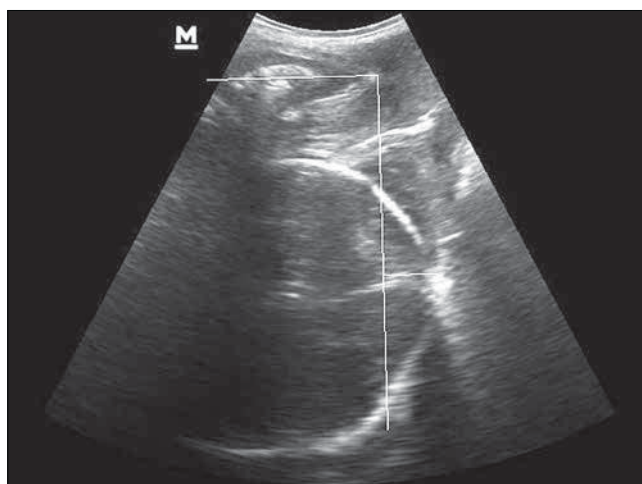**Figure 1.** A typical ITU image (sagittal cross section). Angle of progression is visible.

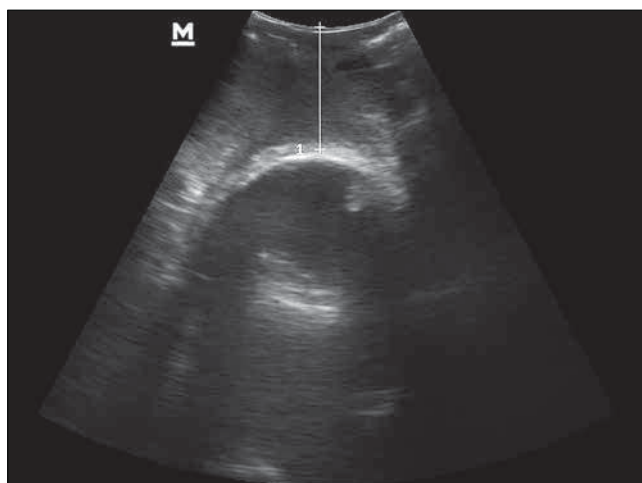**Figure 2.** A typical ITU image (sagittal cross section). Distance of progression is visible.

Figure 3. A typical ITU image (coronal cross section). Head-perineum distance is visible.

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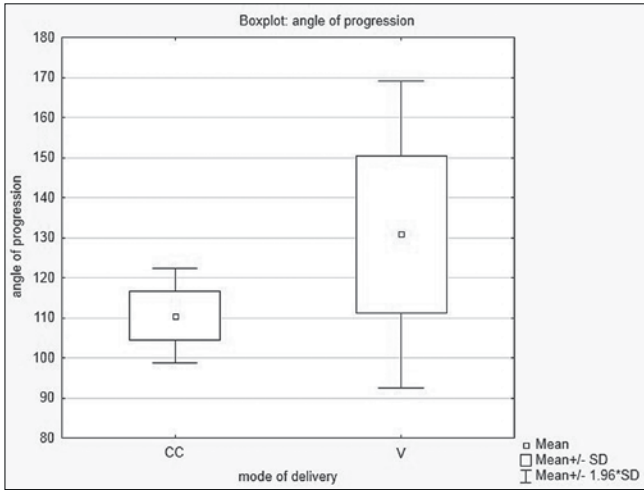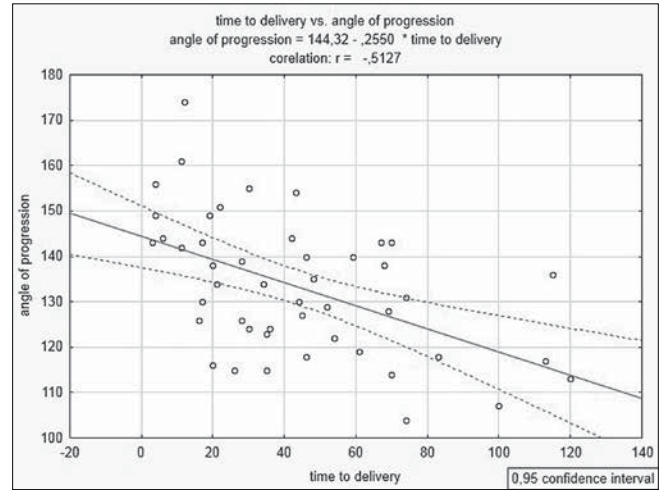

Figure 4. Boxplot: angle of progression (P <0.01).

Figure 7. Time to delivery – angle of progression corelation.
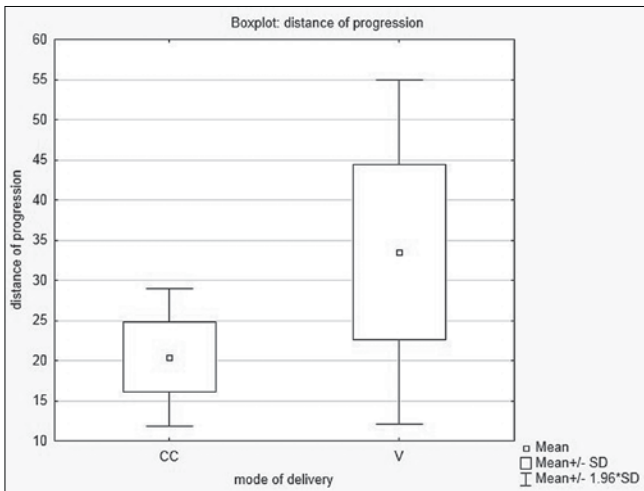

Figure 5. Boxplot: distance of progression (P <0.01).

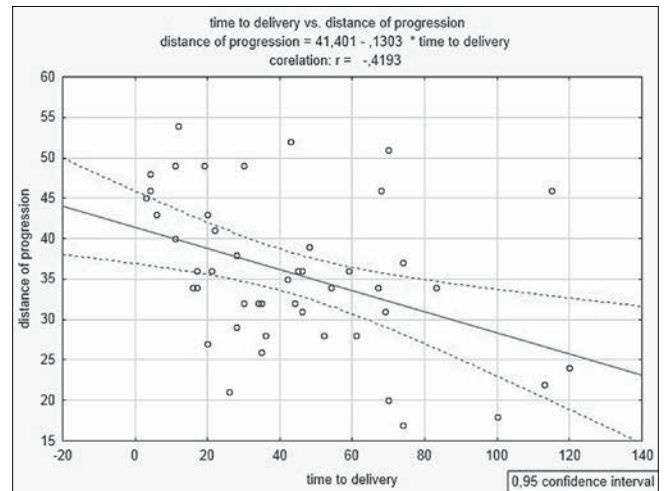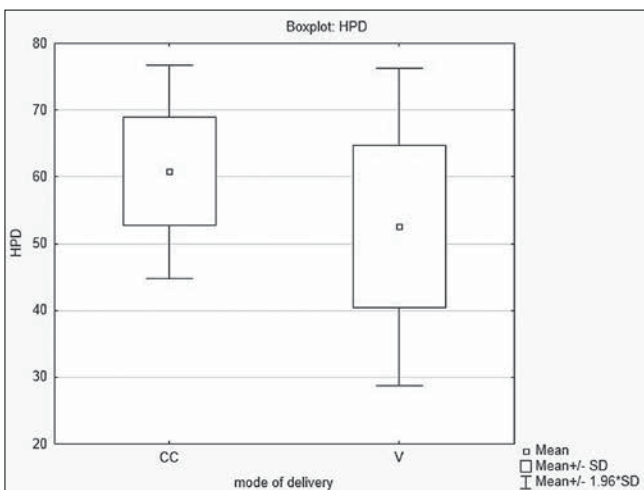**Figure 8.** Time to delivery – distance of progression corelation.
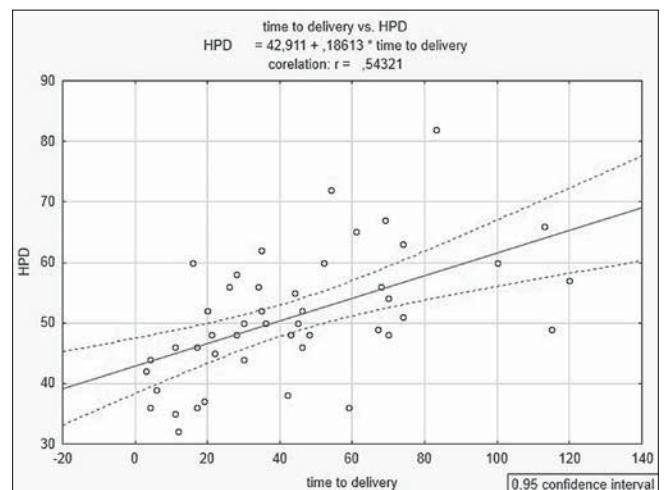

Figure 6. Boxplot: head-perineum distance (P >0.05).

Figure 9. Time to delivery – head-perineum distance corelation.

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Our study also evaluated a possible correlation between the measured angles and distances on the one hand and the time to delivery on the other.

In the case of the angle of progression, a correlation matrix test revealed an inverse proportional relationship between the measured values and mean time to completion of the second stage of labor. Namely, the greater the angle, the shorter was the time to delivery (Figure 7). In the subgroup of primiparas, in whom angle of progression measured less than 137 degrees, the mean time to delivery was 56 minutes (n=30). With the angle greater than or equal to 137 degrees, the time to delivery decreased down to a mean of 29 minutes (n=20; P<0.01).

The mean measured value of the distance of progression was 35 mm. Primiparas, in whom the distance of progression was less than 35 mm, delivered their babies after a mean of 54 minutes (n=25). When the distance was greater or equal 35 mm, the time to delivery decreased to 36 minutes (n=25; P<0.05) (Figure 8).

Similarly, in the case of the third measured parameter, i.e. the distance between the fetal head and the skin surface of the perineum, a correlation matrix test confirmed its correlation with time to delivery. With the measured distance >54 mm, a mean time to delivery was 62 minutes (n=17), while with results <54 mm, the time was reduced to a mean of 33 minutes (n=30; P<0.01). (Figure 9).

Discussion

One considerable limitation of a vaginal examination in the assessment of labor progression is its subjective nature. An introduction of objective and repeatable ultrasonographic parameters may help to eliminate this problem.

In a previously mentioned study, Barbera observed a correlation between the value of the angle of progression and the odds for a successful vaginal delivery [13]. Women whose angle of progression exceeded 120 degrees during the second stage of labor had successful vaginal deliveries. The value of the angle also correlated with the time to delivery. The mean time to delivery in the group whose angle of progression was <135 degrees was 42 minutes. Angle of progression values ranging from 136 to 167 degrees were associated with an over two-fold reduction in time to delivery. The mean angle of progression in six women who delivered via Cesarean section due to failure to progress was 108 degrees (in no woman was the angle greater than 120 degrees). These results were consistent with those by Kalache, who observed normal vaginal delivery in 90% of pregnant women whose angle of progression was at least 120 degrees in the second stage of delivery [15]. Ghi assessed changes in the angle of progression during the second stage of labor in 71 primiparas [16]. Ghi's study showed that in women who had vaginal delivery, the angle of progression increased with the duration of the second stage of labor. Conclusions from this study suggest that future partograms may include results of ultrasonographic measurements. Hassan has already suggested such 'sonopartogram' [17].

Dietz proposed another parameter to assess fetal head descent through the birth canal [18]. Dietz measured the distance between the leading point of the fetal head and an *infrapubic line* (i.e. the distance of progression) in a group of 139 pregnant women. The obtained results were consistent with those of clinical evaluation of the fetal head descent through the birth canal with an internal vaginal examination and an external exam.

Eggebø assessed the distance between the fetal head and the surface of the woman's perineum (HPD = head-perineum distance) in a coronal cross section [19]. The group of patients in whom this distance exceeded 45 mm had a higher rate of Cesarean sections as well as longer first and second stages of labor. A subsequent study by Eggebø evaluated the use of HPD and the angle of progression in 150 women with a prolonged first stage of labor [20]. The rate of vaginal delivery in pregnant women with HPD below 40 mm was greater in comparison with that in women with HPD of over 40 mm (92% and 52% of vaginal deliveries, respectively). When the measured angle of progression exceeded 110 degrees, 88% of pregnancies ended with vaginal delivery, while with the angle below 110 degrees, only 57% pregnancies ended with vaginal delivery. The results of this study are similar to those obtained by Torkildsen, who assessed the fetal head-perineum distance (HPD) and the angle of progression in a group of 110 primiparas with a prolonged first stage of labor [21].

Recently, Youssef proposed a new ultrasonographic parameter for the evaluation of labor [22]. Youssef's evaluation of 47 patients in the active phase of labor showed a significant correlation between the distance from the fetal head to the inferior margin of the symphysis pubis (head-symphysis distance – HSD), and the stage of fetal head descent in the birth canal evaluated via a vaginal examination or the already mentioned angle of progression in an ultrasound examination. As emphasized by the authors of this study, this method proved to be less susceptible to measuring errors resulting from incorrect ultrasound transducer placement (laterally to the mid-sagittal plane).

Tutschek is the author of two interesting studies comparing the use of various parameters to assess the progress of labor. One of those studies assessed fetal head orientation (the angle between the long diameter of a fetal head cross section and a line perpendicular to the symphyseal axis) during the second stage of labor, the distance between the leading point and the interspinal line, and the angle of progression [23]. The author noted that fetal head orientation of at least 22 degrees, the leading point of the fetal head at station ≥2 cm beyond the interspinal line and the angle of progression greater than 135 degrees, were associated with vaginal delivery rate of 94%. Another study by this author also provided valuable information. The study compared the use of 4 different parameters for fetal head descent through the birth canal in primiparas with a prolonged first stage of labor: the angle of progression (AoP), distance between the leading point of the fetal head and the infrapubic line, head-symphysis distance (HSD), as well as the head-perineum distance (HPD) [24]. Tutschek demonstrated that all these measured parameters correlate with one another and may help better assess fetal head descent than a vaginal examination. Interestingly, the author observed that with fetal head engagement, the angle of progression was 116 degrees, in contrast to the angle of 99 degrees described earlier by Barbera et al.

Our study confirmed the usefulness of an ultrasound examination during the second stage of labor. Our analysis of the angle of progression and the distance of progression (distance from the leading point to the infrapubic line) demonstrated significant differences between the spontaneous vaginal delivery group and the group of women diagnosed with failure to progress during the second stage of labor. The mean angle of progression values was 131 and 110 degrees, respectively. All women with the angle

exceeding 120 degrees delivered vaginally. Measurements of the distance from the leading point to the infrapubic line yielded a mean value of 34 mm in women who delivered vaginally and 20 mm in those who required a Cesarean section. All patients with the measured value exceeding 27 mm subsequently had a spontaneous vaginal delivery.

In terms of the third of the evaluated parameters, i.e. head-perineum distance, the observed differences were not statistically significant (53 vs. 61 mm in vaginal delivery vs. Cesarean section, respectively; P>0.05). Thus, this parameter seems to be of less importance in future clinical practice.

Our observations are consistent with the results of the study by Henrich who compared computed tomography scans and ultrasound images conducted in non-pregnant women [25]. Henrich stated that the interspinal line could be established 30 mm caudally from the infrapubic line in a trans-perineal ultrasonography image obtained in the sagittal plane. This means that the leading point visualized 3 cm below the infrapubic line should correspond to fetal head engagement within the pelvic inlet confirmed via a vaginal examination. Indeed, our observations confirm the conclusions drawn in the study described above.

Our study also aimed to answer the question whether or not obtained results correlate with the time to delivery. Statistical tests confirmed such a correlation in the case of each of the 3 measured parameters.

As earlier publications suggest, ultrasonography may be a valuable tool in routine labor ward practice [26–28].

Conclusions

The main benefits of ultrasonography are: higher objectivity in comparison to that of a vaginal examination as well as less opportunity for errors in the case of a considerable caput succedaneum. Ideally, an intrapartum ultrasound examination would help classify patients into groups of low, intermediate, or high risk for anomalies in the mechanism of labor. Such diagnosis would certainly facilitate further labor management. Objective measurements obtained via an intrapartum ultrasonographic examination may be a valuable contribution to documenting the course of labor, an aspect that is continuously gaining significance in contemporary obstetrics.

Oświadczenie autorów:

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