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Abstract of the Ph.D. Thesis

BENEFITS OF ULTRASOUND EVALUATION FOR THE PREDICTION OF THE DELIVERY MODE IN PRIMIPAROUS WOMEN AT TERM

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SUMMARY

I. CURRENT KNOWLEDGE

Obstetrics, which is considered to be the most primitive form of clinical medicine, has the main goal of ensuring the birth of a healthy foetus to a healthy mother. It is fundamental to fully understand the mechanism of birth, including every potential anomaly – such as distocia and subsequently the appropriate methods of managing such situation.

For several decades, many research groups have attempted to develop an easy – to-use, high resolution and objective method, which can be implemented in real-time in order to assist and facilitate the decision-making process during labor. Thus, since the 1990s, ultrasonographic evaluation has been berought forward with the aim of planning and monitoring of labor, since it enables an accurate determination of fetal head engagement (ACF) and the proper moment when instrumental delivery is required.

In addition, the prediction of prognosis and mode of delivery, preferably before the onset of labor, has become a suplimentary objective in modern obstetrics, as emergency caesarean delivery is associated with high morbidity and mortality for both foetus and mother.

In this thesis, we have tried to demonstrate the benefits of ultrasound investigation in primiparous women before the onset labor in order to predict the mode of delivery: vaginal (spontaneous or instrumental) or caesarean delivery. At the same time, we have investigated in an objective though empirical manner the frequency of fetal head engagement prior to the onset of labor, considering it a clinical parameter traditionally used to estimate the prognosis of the delivery mode.

Moreover, we aimed to follow the evolution of special cases within the studied group, through intrapartum ultrasound monitoring. In these rare cases we have noted the non-engagement of the fetal head before the onset of labor. This follow-up had the role of confirming the utility of intrapartum ultrasound parameters as cited by the current literature, with implications in appropriate obstetrical counseling by the medical staff involved in the mechanism of birth.

II. ORIGINAL CONTRIBUTIONS

The main objective was to establish through ultrasound evaluation the rate of fetal head engagement in primiparous women before the onset of labor.

Secondary objectives:

- the weekly evolution of the Bishop score depending on the mode of delivery.
- the weekly progression of fetal head and clinical station after 37 gestational weeks.
- to determine the fetal head situation and clinical station in the week prior to delivery (SaN) depending on the mode of delivery.
- to analyse the temporal evolution of the fetal head situation with the aid of ultrasound parameters in the case of primiparous women at term and to correlate the findings with delivery mode.

- to establish the correlations between measured ultrasound parameters according to the study protocol and mode of delivery.
- to establish the benefits of ultrasound assessment in predicting the mode of delivery in primiparous women at the term.

Methods and working steps

All primiparous women at term were enrolled consecutively in this study before the onset of labor, during a visit in the Prenatal Diagnostic Unit (UDA) of the County Emergency Hospital of Craiova. All eligible pregnant women were invited for a series of weekly ultrasound examinations, starting from the 37th week of gestation up to the time of delivery. Pregnancies with non-cephalic presentation, multiple pregnancies and pregnancies with elective indication for caesarean delivery were excluded from the study.

The working method involved:

- Registering all patients in the database, informing all patients and obtaining an informed consent about the study.
- Practicing a proper abdominal and vaginal examination. After the examinations, we noted the Bishop score and the fetal head clinical station in each case.

Subsequently, each of the eligible patients was invited to the UDA for the ultrasound examination, following these steps:

- Estimation of the estimated fetal weight.
- Evaluation of fetal well-being, such as the Manning score.
- Subsequently, a scanning protocol was compelled using the following plans:
 - the transabdominal suprapubic transversal plane (to determine the position of the fetal skull).
 - the transperineal infrapubic sagittal plane (to assess the progression angle (UdP), the progression distance (DP), the direction angle (UdD) and the cervical length (LC)).
 - the transversal transperineal plane (to assess the distance between the fetal head and the perineum (DCP)).

After delivery, the database was completed with additional information such as date of delivery, gestational age at delivery, fetal weight and fetal Apgar score at delivery, type of labor and type of delivery.

Three cases included in the study, were considered to be of interest in terms of ultrasound parameters and were monitored sonographically in labor. This cases are presented in detail in the thesis.

III. Results. Statistical analysis. Discussions

All results were statistically analyzed using IBM SPSS Statistics version 22 (IBM, Chicago, IL, USA).

Characteristics of the population included in the study

During the 12-month study period, a **significant number** of patients have been enrolled, respectively 276 primiparous women. We noted a normal distribution of the understudied population with respect to age. 74% of primiparous women were within the range of 21-30 years. The vast majority of the group, representing about three-quarters, regardless of the mode of delivery, were primigestas. In terms of **body mass index** (IMC), approximately 90% of the term pregnant women had acceptable IMC for the third trimester of pregnancy.

Because the study was conducted in a consecutive, unselected manner of enrollement, we presented this research to all patients at term. Fortunately, the vast majority, respectively two-thirds of cases, were included in the study at 37 weeks of gestation.

This study reported a 20% rate of caesarean section deliveries consistent with literature data, respectively about 22% for the group of primiparous women with cephalic presentation singletons.

Clinical situation of the fetal head at term

The results of the analysis showed that the Bishop score was constant around the values of 4 - 6. At 37 gestational weeks, the score was constant at a value of 4, with no differences between the two groups (primiparous women who delivered vaginally (NV) and primiparous women who delivered by caesarean section (OC), followed by a slow upturn to 6, with no significant differences, except in the 41st gestational week, when significantly higher values were noted for the NV group.

Clinical evaluation of the **fetal head station** in the general group showed a slow but continuous downward progression of the presentation towards station 0, which is considered the engagement station.

At each gestational age, anterior fetal head presentations were significantly more common in the group of pregnant women that delivered vaginally. The left occipital-anterior position (OA) was the most common presentation type, regardless the assessment time. This position represented about 40 % of all presentations, noted at term, in the NV group.

Ultrasonographic evaluation of the fetal head position through the birth canal (fetal head progression at term).

Progression angle (UdP) according to ultrasound evaluation

At 37, 40 and 41 gestational weeks, the **progression angle** values were significantly higher in the NV group than in the OC group. However these were not significant at 38 and 39 weeks. Globally, the median value of the progression angle increased from 90° to 101.5° in the NV group while in the OC group, the median value had an inconstant trend with a small increase from 84,45° to 89.7°.

Progression distance (DP) according to ultrasound evaluation

In the group of NV patients group, **DP** presented a distribution in which two-thirds of the values were found between 1.99 - 1.99cm at 37 and 38 gestational weeks. Starting from the 39th

gestational week, a significant turn was noted with values ranging from 1 - 1.99cm in more than half of the cases.

In the NV group, the DP was between -1.99 - -1cm in one third of cases, even at 40 gestational weeks, and between -0.99-0cm in over two thirds of cases, in the OC group, therefore these values were significantly smaller.

The statistical analysis of the data, showed no significant difference between the median of DP at 37, 38 and 39 gestational weeks, noted in the group of primiparous who delivered vaginally and the median of DP in the group of patients who delivered by caesarean section. However, notable median differences were recorded at 40 and 41 gestational weeks.

Direction angle (UdD) according to ultrasound evaluation

Direction angle assessment showed **UdD** values ranging from 50-59° and 60-69°, at 37 and 38 gestational weeks, in more than 50 % of the cases in the NV group. At 39, 40 and 41 gestational weeks, in more than 60 % of this cases UdD values ranged between 60-69° and 70-79°.

When comparing the data, more than 45% of the patients who delivered by caesarean section showed an UdD between 60-69° and 70-79° at the 37, 38, 39 and 40 gestational weeks. 81% of patients who delivered by caesarean section showed a UdD value lower than 69°. In addition, all the patients with a UdD above 70° delivered vaginally. Based on the statistical analysis, we recorded a median UdD value above 70° at 40, 41 gestational weeks and in the week prior to delivery (SaN) in the NV group, while median UdD was 67°, at the same time, in the group who delivered by caesarean section.

Fetal head - perineum distance (DCP) according to ultrasound evaluation

Up to the 39th gestational week, more than 50 % of the cases in the NV group, presented a slow variation of the **DCP**, with values ranging between the 4 - 4.9cm and 5-5.9cm. At 40 and 41 gestational weeks, 50% of the patients who delivered vaginally had DCP values ranging between 4-4.9cm. Over 50% of patients who delivered by caesarean section, had a DCP value that varied between 4-4.9cm to 5-5.9cm from the 38 to 41 gestational weeks. Following statistical analysis, the median of DCP values varied slightly around 5cm, and no significant differences were noted from one week to another or depending on the mode of delivery. At 40 and 41 gestational weeks, we noted a DCP median of about 4.5cm in the NV group, and 5cm in the OC group. In the SaN, the DCP assessment showed that 15% of the patients who delivered vaginally presented a value lower than 4 cm. In terms of percentages, we noted similar values of DCP namely 4-4.9cm independent of the mode of delivery.

Cervical length (LC) according to ultrasound evaluation

In this study, in over 50% of primiparous women who delivered vaginally, the values of the LC varied slowly between the interval 1-1.9cm and 2-2.9cm at 40 gestational weeks. At 41 gestational weeks, over 60% of patients in the NV group, presented a LC value in the range of 1-1.9cm. In the NV group, in over 50% of cases, the LC ranged slowly between 2-2.9 - 3-3.9cm by the 40th gestational week. At 41 gestational weeks, more than 60% of the pregnant women who delivered by caesarean section had a LC in the 2-2.9cm range. The data suggests that progressive cervical shortening towards the onset of labor may be a favorable prognostic factor to vaginal delivery.

Evolution (progression) of the fetal head at term

None of the studied ultrasound parameters showed an ascending trend from the 37th gestational week to the 41th gestational week, except the UdP. The fetal head presented a low progression to term, regardless of the mode of delivery. DP values showed a sinuous trend, with an initial decrease, and subsequently increased at 41 gestational weeks in the NV group. The DCP values initially showed a slight decrease followed by a slight increase at 41 gestational weeks in the NV group and a slight increase at 40 gestational weeks in the OC group and subsequently a decrease at 41 gestational weeks. UdP was considered the most appropriate ultrasound parameter because it is an angular parameter that allows to better assess the curvature of the birth canal. Indeed, UdP was the only parameter with a constant progression.

Prediction of mode of delivery based on associations between ultrasound parameters

Since singular values of the ultrasound parameters proved unsatisfactory, I took into consideration a combination of ultrasound parameters in order to evaluate the progression and position of the fetal head for the prediction of the mode of delivery. Even in this approach, the prediction model, through the ROC curves, was rejected. But for certain gestational weeks and for certain parameters, I noted high correlations. For example, at 37 gestational weeks, the association between the OA position of the occiput and UdP and DP presented correct correlations (AUC-0.79). A poor correlation was noted between the DP and the anterior position of the occiput. At 38 gestational weeks, OA position of the fetal head together with DCP had a poor association (AUC-0.73). A strong correlation was observed at 40 gestational weeks (AUC 0.885, 0.802, 0.793, 0.754, respectively) for the anterior occiput position, associated with UdP, UdD, DP and DCP. Therefore, we have not been able to highlight solid and stable correlations nor by examinations, or with the aid of pre-labor parameter combination.

Weekly assessment of occiput position variability

During the weekly evaluations, all collected data have proved a true and important mobility and change of fetal head position, from anterior to non-anterior from one week to another (variations were observed in of up to half of the cases). Therefore, we should not assume that the fetal head position is constant before the onset of labor, as considered in the previous statistical analysis, even if SaN is to be taken in consideration.

Correlations between the estimated parameters in the week prior to delivery (SaN) and the mode of delivery

Certain ultrasound measurements performed in SaN showed statistical significance for the prediction of the mode of delivery, namely UdP and DP. At the same time, these are the most commonly used parameters, in practice, and whose clinical validity was demonstrated in multiple studies. The attempt to increase the accuracy of these determinations by associating the determination of the position of the fetal head, however, led to ROC curves that rejected the investigative model.

Statistical correlations between fetal head progression parameters

This study noted strong, moderate direct or inversely proportional relationships between all ultrasound parameters. This represents a positive fact, confirming that sonographic determinations are objective and correlated with each other, having essentially the same significance, namely that

of the situation and progression of the fetal head through the birth canal. Still, not all of these statistical relationships have the same value. A strong relationship has only been detected between UDP and DP, the most useful parameters used in evaluating the progression of the fetal head.

Engagement of the fetal head (ACF) in the primiparous women before the onset of labor

The main objective of this thesis was to determine the rate of fetal head engagement in primiparous women at term through ultrasound assessment, respectively 5% of the foetuses were engaged at term, before the onset of labor. In our study, 46.6% of cases with ACF presented simultaneous cut-off values for several ultrasound parameters. The remaining 53.4% of ACF cases presented only one positive diagnostic ultrasound criteria. After the exclusion of these cases, in which there was only one positive parameter, though unconfirmed by the other ultrasound measurements, the diagnosed ACF rate dropped from 5.41% to half, respectively 2.52%.

The term of fetal engagement has traditionally been associated with a favorable prognosis for vaginal delivery, whereas non-engagement of the fetal head was considered an important risk factor for indication of caesarean delivery. However, another interesting aspect noted in this study is that the vaginal delivery rate in the group of patients who had ACF before onset of labor (considered after at least one ultrasound criteria) was 66.6%. By contrast, vaginal delivery rate in the group of primiparous women who presented with non-engagement of the fetal head (NACF) before the onset of labor was higher, 78.9% respectively. This result contradicts previous conceptions of traditional obstetrics. Two of the 5 caesarean deliveries in the ACF group of patients were due to lack of progression of labor as a consequence of persistent occipital posterior position of the fetal head. After excluding these cases, the caesarean delivery rate is approximately 20%, similar to caesarean delivery rate in the general population of the primiparous women. Thus, we can suggest that ACF should not be considered a basic element of classification of primiparous women in terms of risk for a caesarean delivery.

Where is the fetal head positioned on term if it is not engaged?

The data suggests that the fetal head is at the beginning of the term period (37 weeks of gestation) at station -4 (UdP mean at 37 weeks = 89°), and at 41 weeks of gestation at station -2 (UdP at 41 weeks = 98°).

IV. CONCLUSIONS

In this thesis, we have tried to confirm the benefits of ultrasound evaluation in primiparous women before the onset of labor. Unfortunately, no ultrasound parameter showed a satisfactory accuracy in the prediction of the mode of delivery .

Additional correlations of ultrasound parameters measurements did not provide solid prediction on the mode of delivery

The only clinical situation with significant statistical importance was obtained during the week before delivery, with significant differences between the cases with vaginal delivery compared to cases where birth had to be completed by Caesarean section.

However, the position of the fetal head should not be considered a stable parameter prior to the onset of labor. The data collected, in this study, shows a high frequency of change of the fetal

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head position from one week to another. So, in clinical perspective, we should not consider the position of the fetal head constant from one ultrasound examination to the other, not even during the same week.

I wished that this thesis could represent a pleading for the benefits of routine ultrasound in examining pregnant women before labor, but the results of the study do not confirm all other encouraging theories and information previously produced by the literature in this field.

Key words: transperineal ultrasound, progression of fetal head, engagement of fetal head, mode of delivery.