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**DOCTORAL THESIS**

**ABSTRACT**

**Monitoring labor with transperineal ultrasound - the  
sonopartogram**

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**Craiova, 2013**

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## **General considerations**

It is known that clinical assessment during labor does not have increased accuracy, is subjective and depends on the experience of the examiner, with potential implications in determining prognosis and method of birth. Numerous studies demonstrate the superiority of imaging methods in determining the position of the fetal skull, location and progression during labor. The estimation by vaginal touch of the fetal skull in the pelvic canal and labor progression are hardly reproducible between obstetricians.

On the other hand, it must be emphasized the important role that Emanuel Friedman had in developing clinical obstetrics through his research, which proved of great help in standardizing the management of labor, the curve that bears his name guiding obstetrical management in the U.S. since its description in 1954, being used in Romania also at present.

Recent studies on large groups that included primiparous patients at term, with singleton pregnancies, cranial presentation also who gave birth spontaneous to eutrophic fetuses, showed that the pattern of labor progression in contemporary obstetrics differs significantly from the Friedman curve depending on the different attitudes of obstetricians (epidural analgesia, active management during labor). The discussion can be extended by the observation that subjective parameters classically used during labor provides less information than an objective model developed to predict the outcome of birth. Recent studies have suggested that the use of ultrasound can overcome these problems by providing objective assessment of the position of fetal skull and its progression during labor and thus a better predictions for spontaneous or instrumental birth.

## **State of knowledge**

**Chapter II** - Birth mechanism. Friedman curve - reviews the general concepts about the mechanism of birth and renders historical and current details about Friedman curve and its importance in classical and modern obstetrics.

**Chapter III** - Basics in ultrasound - briefly describes the physical principles and also some details about the main modes of operation for ultrasound machines.

**Chapter IV** - Applicability of ultrasound in obstetrics - the chapter contains a brief description of the utility of ultrasound in fetal diagnosis and evaluation broken down by trimester of pregnancy.

**Chapter V** - Labor in terms of ultrasound. Transperineal ultrasound. Defining labor with ultrasound markers - the chapter of resistance for this thesis describes the main ultrasound markers to be used in the personal contribution part for assessment of the study group, reviewing some of the most significant studies about these markers. This chapter contains two important subsections, prelabor ultrasound (new field that attempts to go a step further in terms of precocity of evolutive outcome in labor), and ultrasound in labor.

## **PERSONAL CONTRIBUTION**

### **Objectives of the doctoral thesis –**

- Assessment of the feasibility of measuring the station and the descent of the fetal skull during labor using transperineal ultrasound.
- Assessment of the usefulness of transperineal ultrasound in differentiating patients who will require caesarean section for the lack of progress of labor from patients who will have a vaginal delivery
- Analysis of improvement of neonatal outcome by using this technique
- The extent to which the sonopartogram can replace the Friedmann curve objectively
- Temporal variation of ultrasound measurements in normal labor vs labor dystocia in fetuses with occiput anterior or posterior

- The relationship between different ultrasound parameters
- Sonographic - clinical correlation between any type of cephalic presentation
- cut-off values that may help clinicians to choose between natural birth or caesarean section
- psychological benefits of patient who is able to watch the ultrasound screen as the fetal head descent and position are objectively assessed

**Methods** - The study group included 330 patients in labor with gestational age over 37 weeks and estimated fetal weight 2500 g, single fetus pregnancies, cranial presentation, emptied bladder, labor started. Exclusion criteria were the indications for cesarean established due to antepartum maternal or fetal pathologies associated. Sonographic measurements we used an ultrasound probe 3,5-5MHz which was introduced in a glove covered with ultrasound gel. TPU (transperineal ultrasonography) was performed immediately after clinical examination and the data were obtained during uterine contractions. TPU was carried out at different times in accordance with the stages of labor: every hour until complete dilatation (the first phase) and every 10 minutes at complete dilatation (the second stage). Clinical examination and TPU for the same patient has been practiced by different examiners.

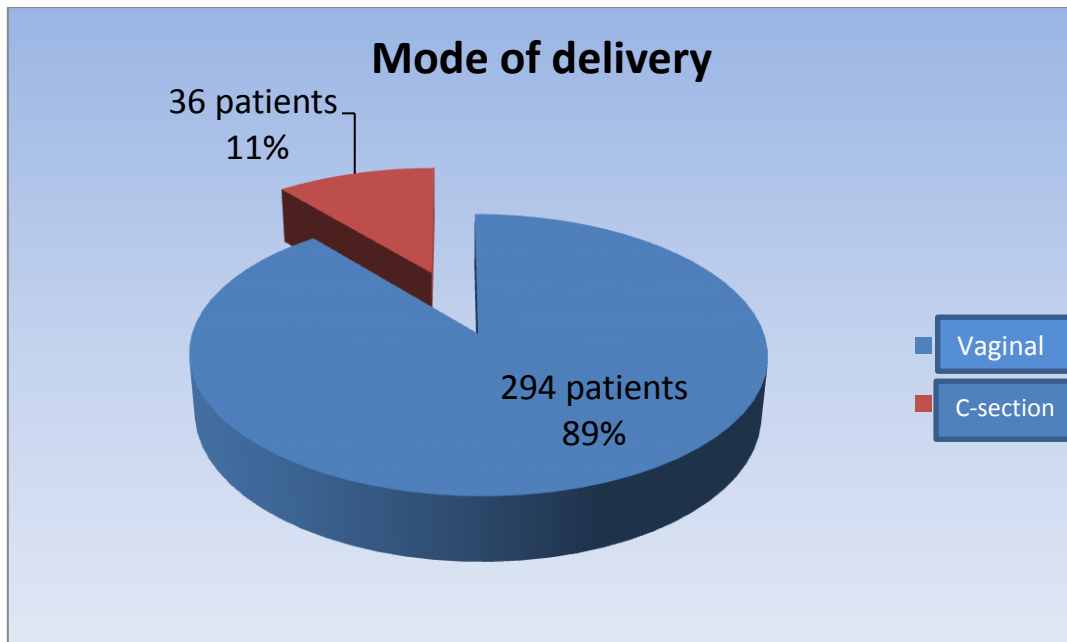
Patients were examined in the delivery room. Patients were informed of the the experimental nature of transperineal ultrasound and agreed to be evaluated in this way. The probe was first positioned suprapubic using occiput position to identify signs of fetal skull (orbits, thalamus), then the probe was positioned across the labia to evaluate meadiane line angle formed between the cerebral median line (defined as a hyperechoic line between the two brain hemispheres) and anterior-posterior axis of the maternal pelvis. This angle decreases when the occiput rotates to the symphysis pubis.

To examine patients the ultrasound machines used were GE Voluson Pro (multifrequency convex probe 3D/4D model RAV 4-8 L, multifrequency convex probe 2D model 4C) and ultrasound GE Logic.

- The probe coated with a latex glove containing ultrasound gel and then covered by ultrasound gel pubis placed between the labia under the symphysis.

- Sagittal image, the long axis of the symphysis pubis was obtained by sweeping the probe slightly.
- Meanwhile in the same plane the distal point of fetal skull descends easily.
- The image of a sagittal line drawn on the screen between the calipers placed between two points that identify the long axis of the symphysis pubis.
- The second line created between calipers on a static image that extends from the lowest point of the symphysis pubis tangent to the contour of fetal skull
- The angle between these two lines was measured directly on the screen.
- All images were obtained with the bladder emptied and stored for subsequent analysis.
- TPU scans performed in the second stage of labor for patients included in the study, with measurements taken latter in most of the cases, at each examination, and scans were averaged to give the angle of progression.
- The time noted and later used to calculate the range from scanning to delivery.
- In all cases the measurements were made simultaneously with digital clinical examination performed by the physician reviewing the case.
- transabdominal sonography was used to assess fetal occiput position according to Akmal et al.
- Measurements of fetal skull station performed digital by the clinician treating the case, not involved in the study and without seeing ultrasound assessments.

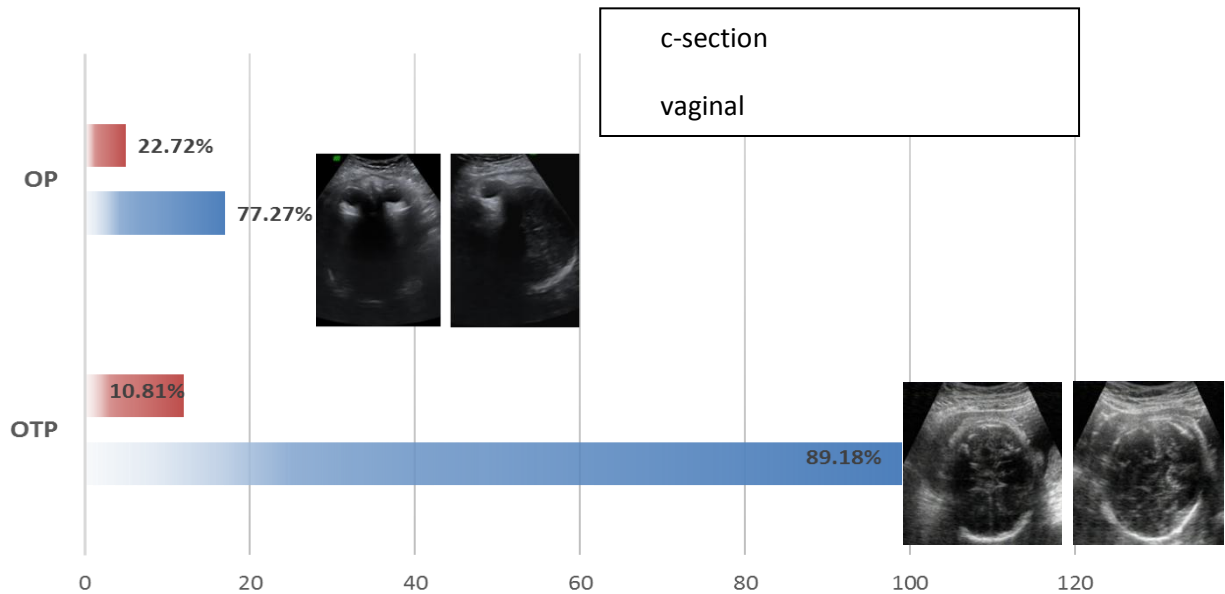
**Results and discussions** - The study included 330 parturient for which we analyzed: the way of delivery, variety of position, weight at birth, Apgar score, the average number of examinations, the time between the first examination and delivery, the correlation between clinical examination and ultrasonography regarding fetal skull station and rotation and the 5 sonographic parameters. The following results were obtained:



The distribution of patients according to the mode of delivery

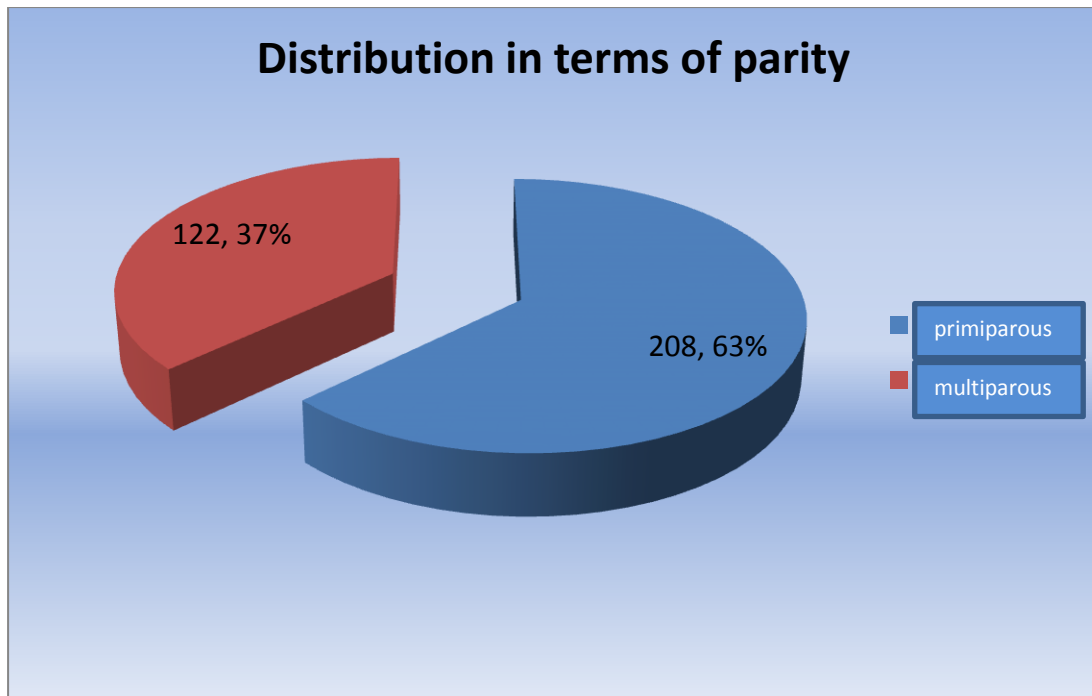
- At the 36 patients who gave birth through caesarean section accounting for 11% of the study group, the indications for the extraction were: the lack of progress of labor, acute fetal distress uncorrected medical and cefalo-pelvic disproportion through fetal macrosomia;
- 32 of the 36 patients who gave birth to through OCST were primiparous.
- The percentage of delivery through caesarean section obtained in our study falls within WHO recommendations (10-15%) and is significantly lower than the national average (about 30%) or the percentage of university centers exceeding 50%. However bear in mind that in our study were excluded the indications of cesarean set antepartum due to maternal or fetal associated pathology.





Mode of delivery in posterior varieties at the onset of labor

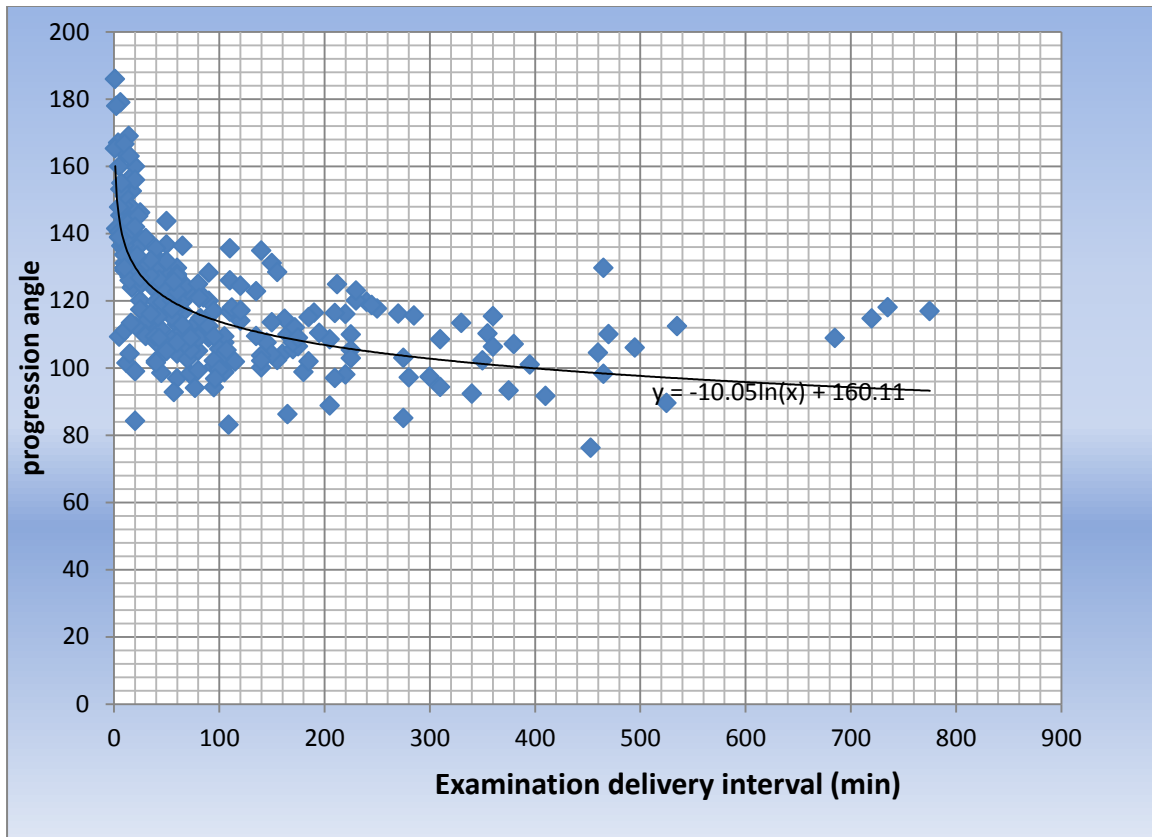
Of the 330 patients studied, 36 had a c-section delivery. 118 of them had an initial posterior / transverse position variety. 89.18% of this group gave birth vaginally, the remaining 10.81% requiring caesarean section. If we consider only patients with persistent posterior variety (20 cases), the percentage of surgical deliveries doubles (22.72%). None of the 212 cases with initial anterior variety have rotated posterior. The findings of our study are in contradiction with classical literature which states that almost 90% of occiput posterior presentations are consequence of a malrotation from an anterior position, which is found in none of our study patients, aligning to recent research which also demonstrate the persistence of occiput posterior. Future studies on larger groups are needed because even recent studies using modern imaging technology have yielded conflicting results.



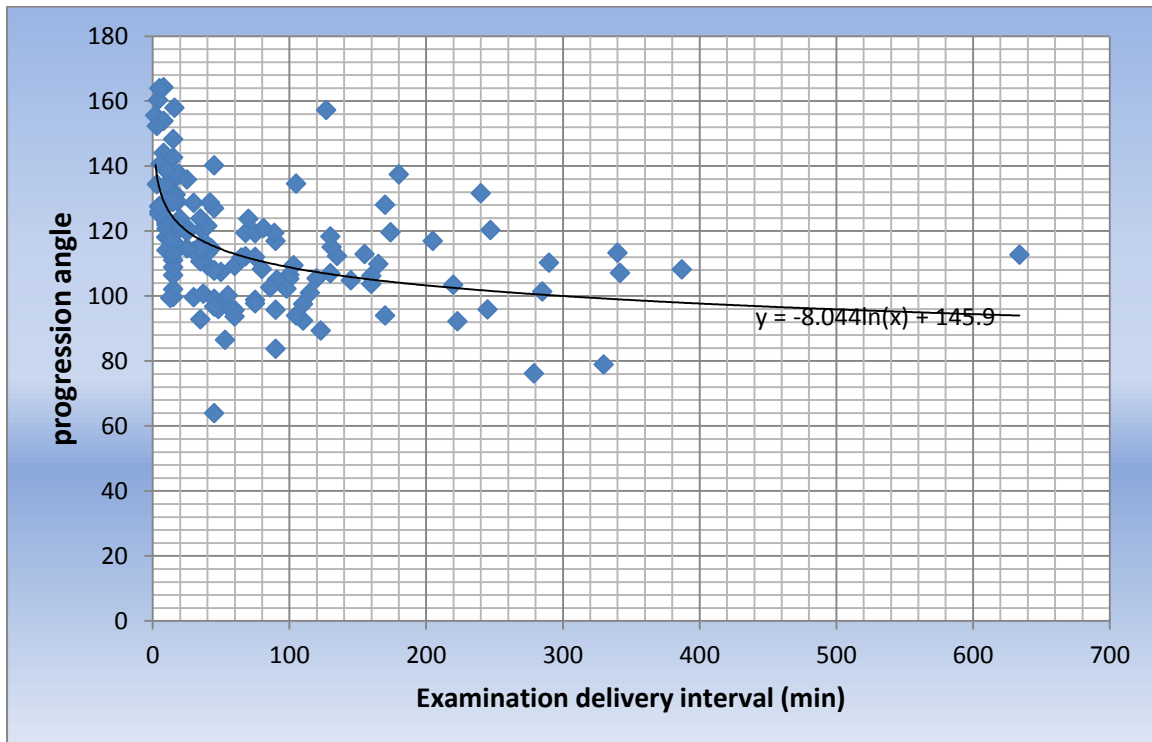
The distribution of patients according to parity

An important factor that influenced the evolution of labor was parity, resulting in significant differences between primiparous and multiparous in studied parameters. A strong point of this paper is the high percentage of primiparous studied, given that the majority of dyskinetic labors and instrumental deliveries occur in this group of patients (88% in our study). Ultrasonographic monitoring of these patients in labor has allowed for a percentage of only 11% of deliveries to be made by caesarean section, thus checking one of the objectives of the thesis: the usefulness of transperineal ultrasound in differentiating patients who will require caesarean section for the lack of progress of labor from patients who will have a vaginal delivery.

Analysis of ultrasound parameters used in the study to monitor labor:



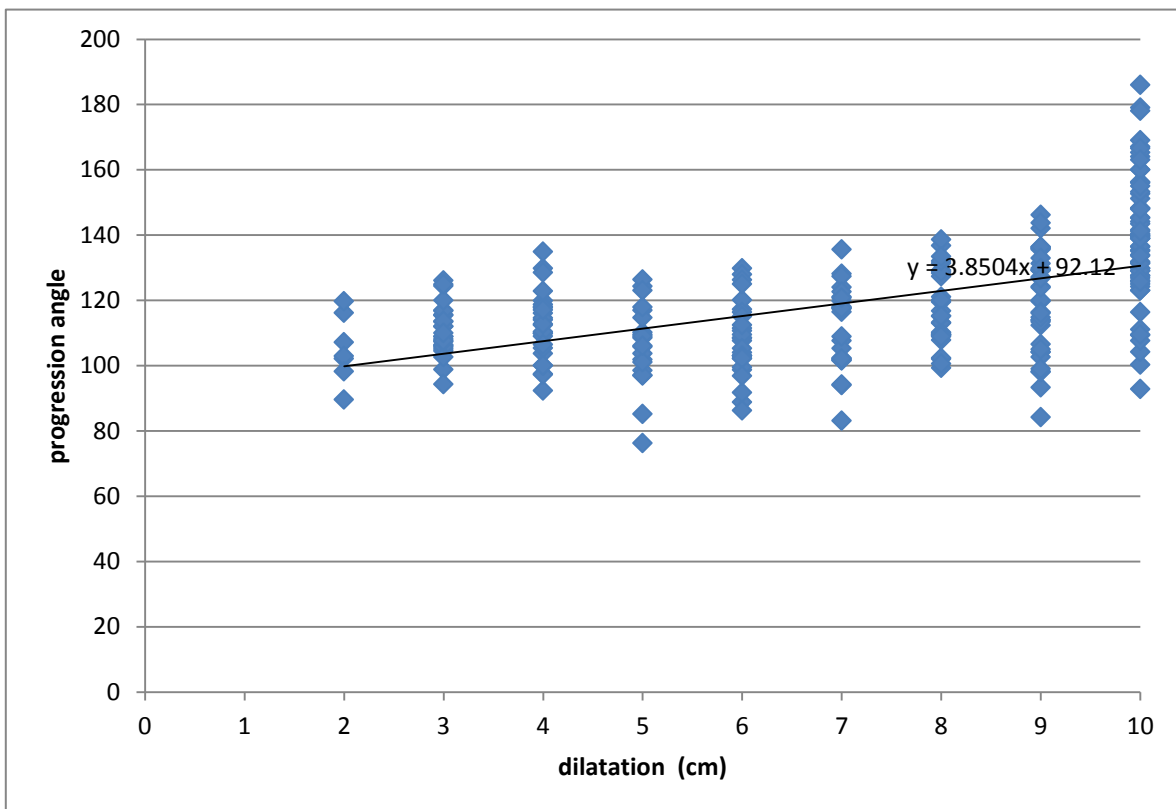
Evolution of the angle of progression in time in primiparous.



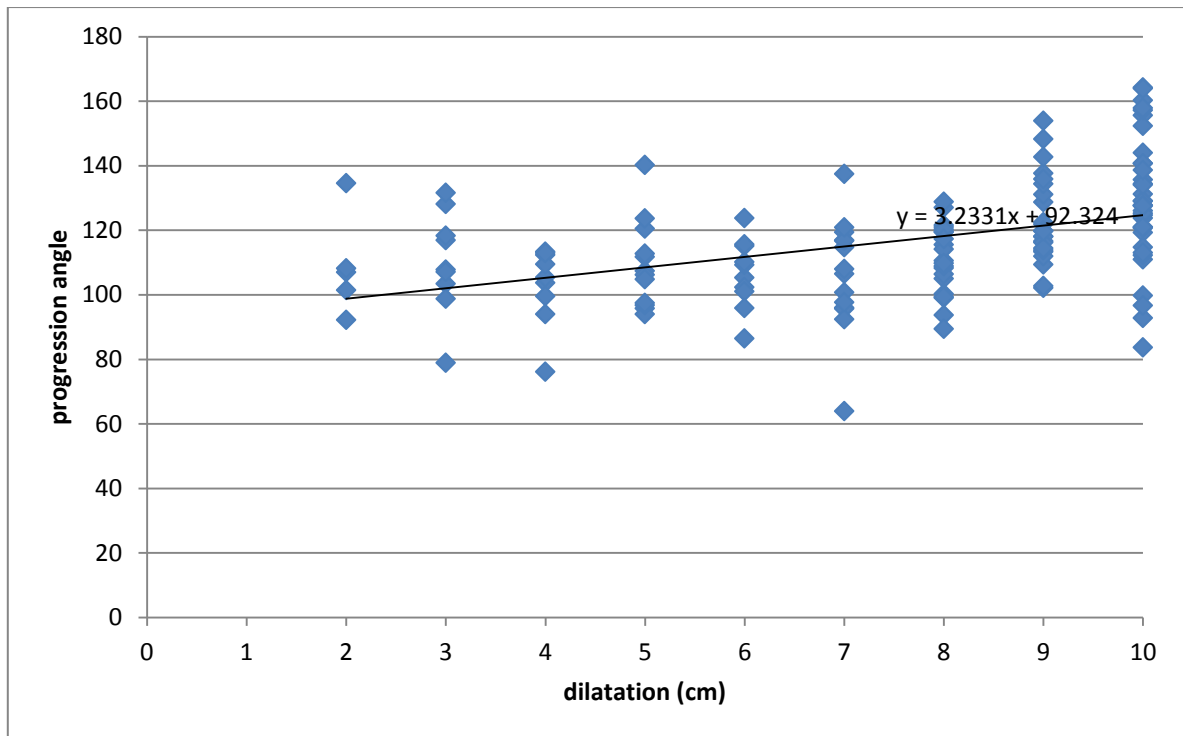
Evolution of the angle of progression in time in multiparous.

In the specialized literature, using ultrasound and magnetic resonance imaging it was established by consensus an angle of 120 ° as a correspondent for the station 0. Analyzing the graphs resulting from our study we observe that the trendline intersects the 120° axis different in primiparous and multiparous. Thus, primiparous starts from higher progression angles at the onset of labor, having a slowly progressive development even beyond the angle of 120 °, multiparous behavior being different in that they start at small angles at the onset of labor and after the fetal head engagement the evolution is very fast, usually at least two times faster than the primiparous.

The value of this parameter can be exploited by standardizing its evolution in the time frame, so instrumental maneuvers or caesarean section can be safely delayed as long as the angle of progression evolving within confidence intervals.



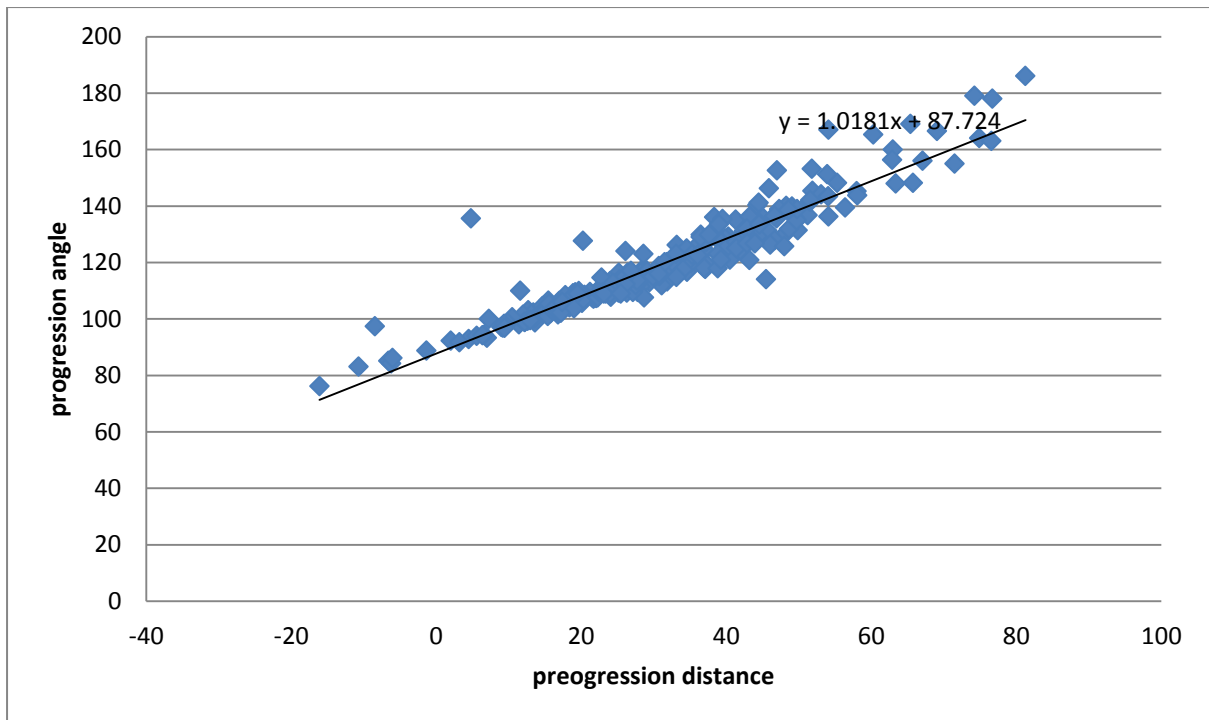
Evolution of the progression angle depending on dilatation in primiparous



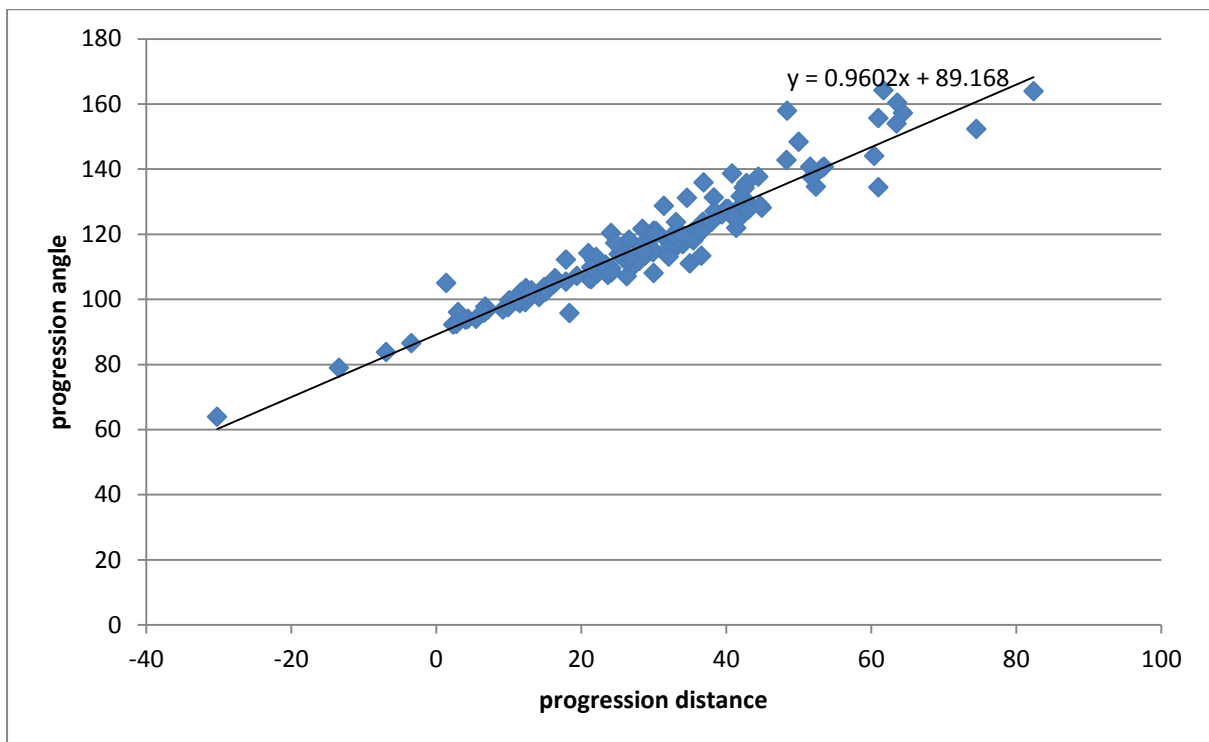
Evolution of the progression angle depending on dilatation in multiparous

Analyzing the literature, digital pelvic examination in labor has a higher accuracy in large dilatation in the determination of the position and station of the fetal skull. However, from the same point of view, ultrasound was clearly superior in the evaluation of the same parameters, reducing also the large differences between primary physician and residents examinations. The need for accurate assessment of fetal skull position and station early in labor derives from the possibility of establishing a diagnosis of early dyskinesia based on the parameters proposed by transperineal ultrasonography.

Data from our study indicate that dilatation of the cervix does not correlate with fetal skull station nor to multiparous or to primiparous, meeting the angle corresponding to station 0 (120 °) both at large dilatation and at small dilatation, thereby supporting the use of transperineal ultrasound for proper diagnosis of fetal skull station. However, there is a difference between primi and multiparous, namely the different evolution of the progression angle, meaning that primiparous will start at wide angle at small dilatation and they slowly progress and multiparous remain on small angles of progression until small large dilatation and then they evolve rapidly, consistent with clinical assessments formulated in specialized treaties.



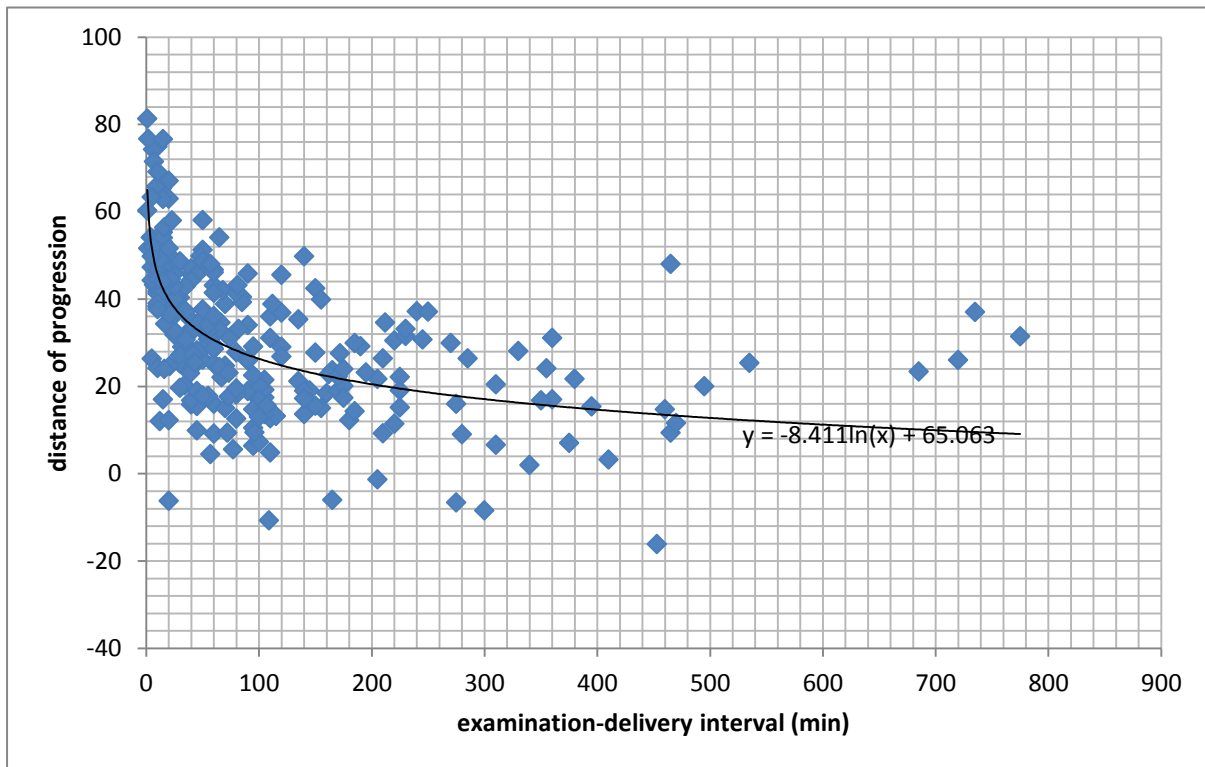
Correlation of progression angle-distance of progression at primiparous



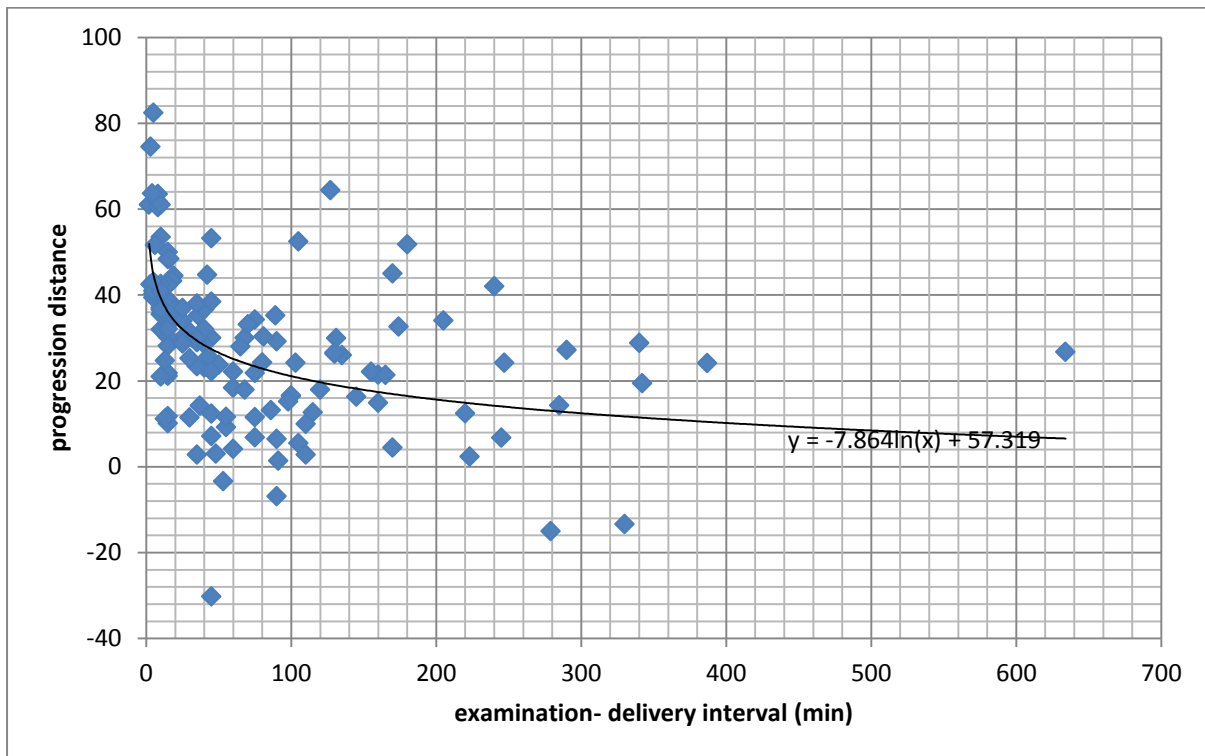
Correlation distance of progression-angle of progression at multiparous

From the previous graphs we see a clear correlation between progression angle and distance of progression. With regard to the consensus that the progression angle of  $120^\circ$  corresponds to station 0, in our study the shared distance of progression for this angle at both primiparous and multiparous was about 3 cm, as

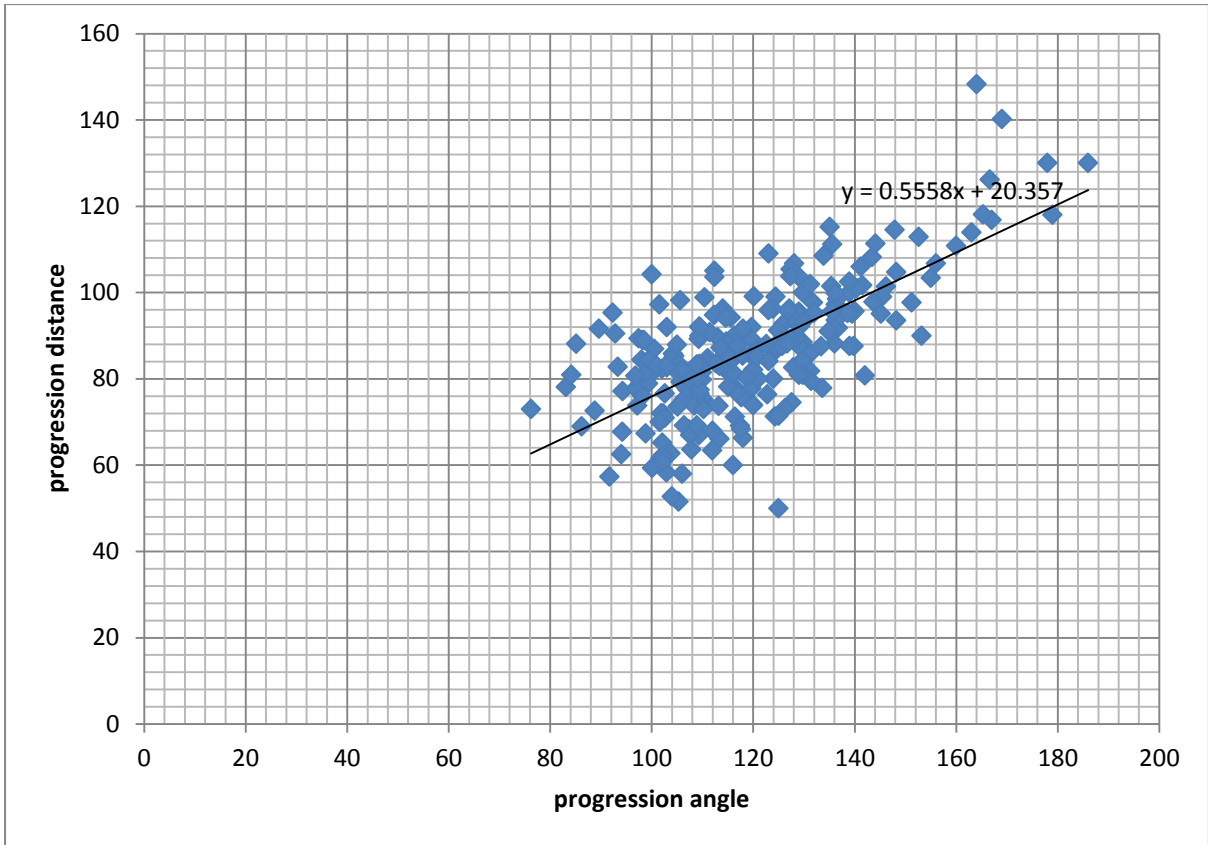
opposed to other parameters which have different values depending on parity.



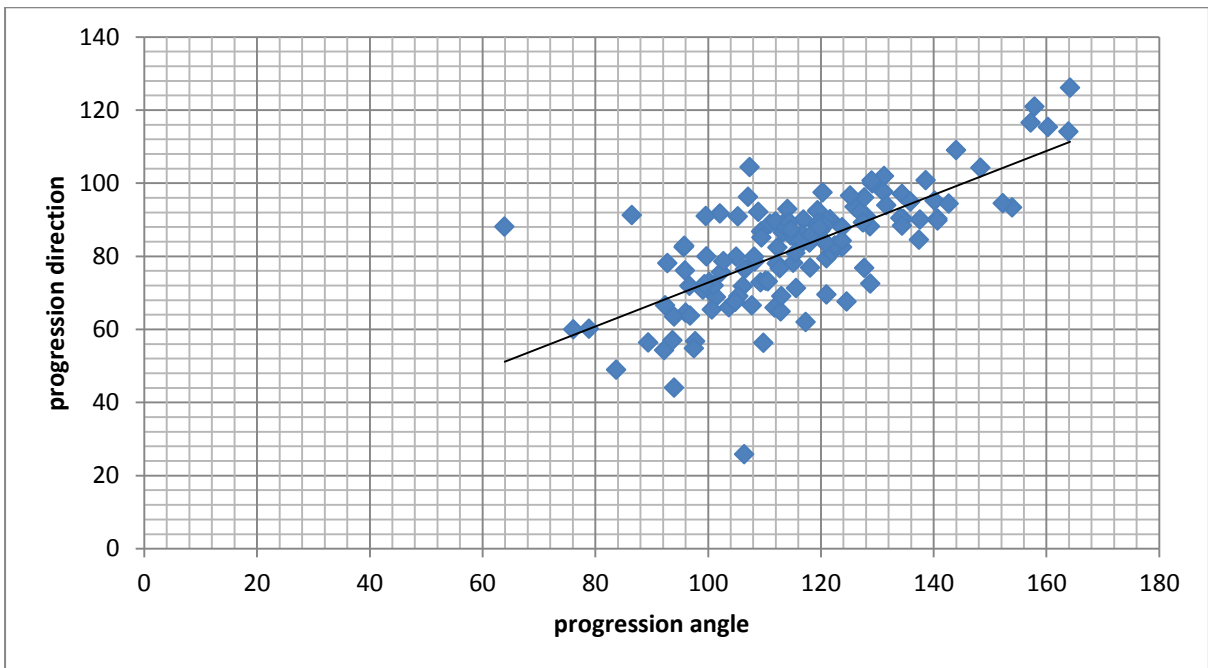
Evolution of the progression distance against time at primiparous



Evolution of the progression distance against time at multiparous



Correlation between direction of progression-angle of progression to primiparous

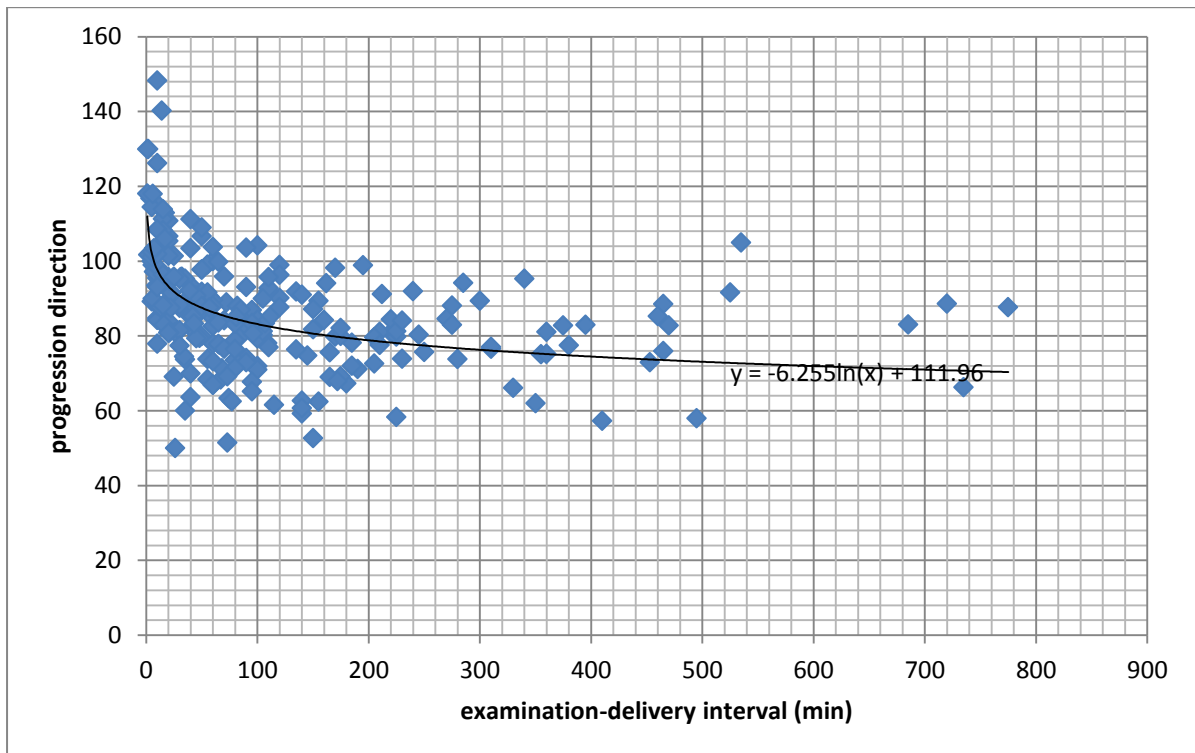


Correlation between direction of progression-angle of progression to multiparous

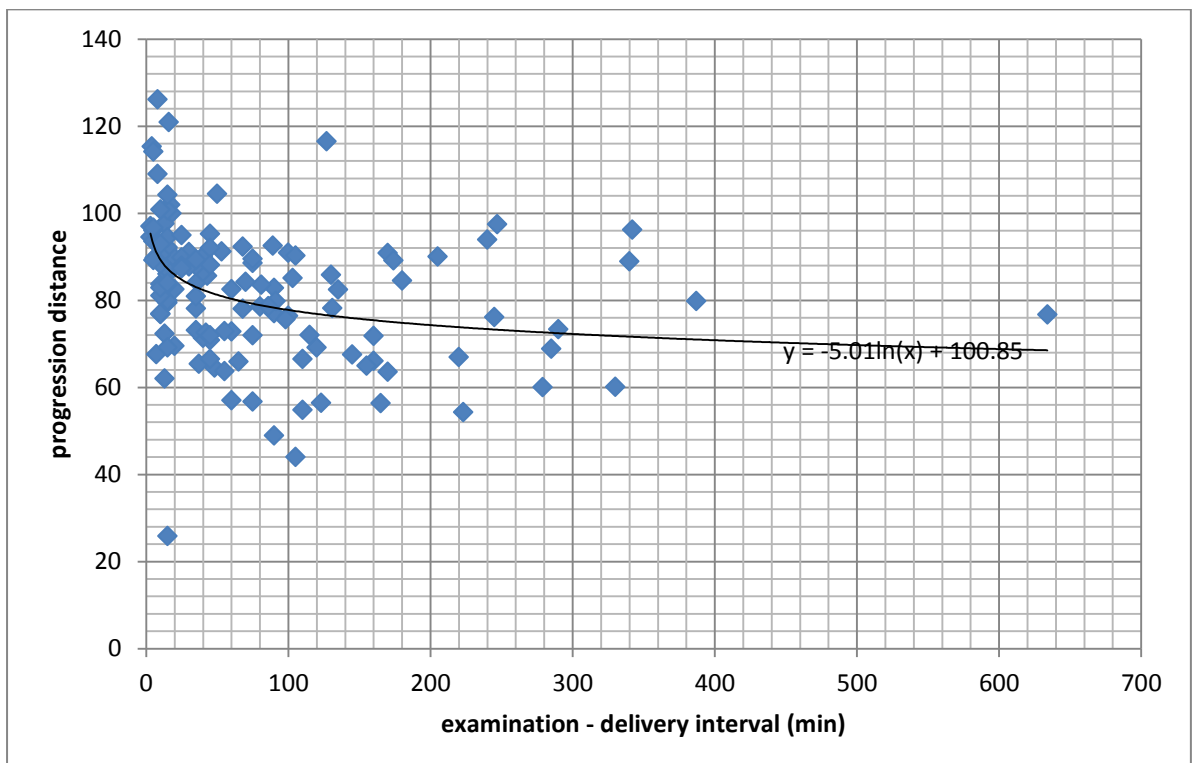
Based on the consensus that station 0 is consistent with a progression angle of 120 ° and correlating progression angle values with direction angle values (direction of progression) in our study we obtained values of approximately 90 ° to



the direction of skull progression corresponding to engagement of the fetus. These values were consistent at both primiparous and multiparous.

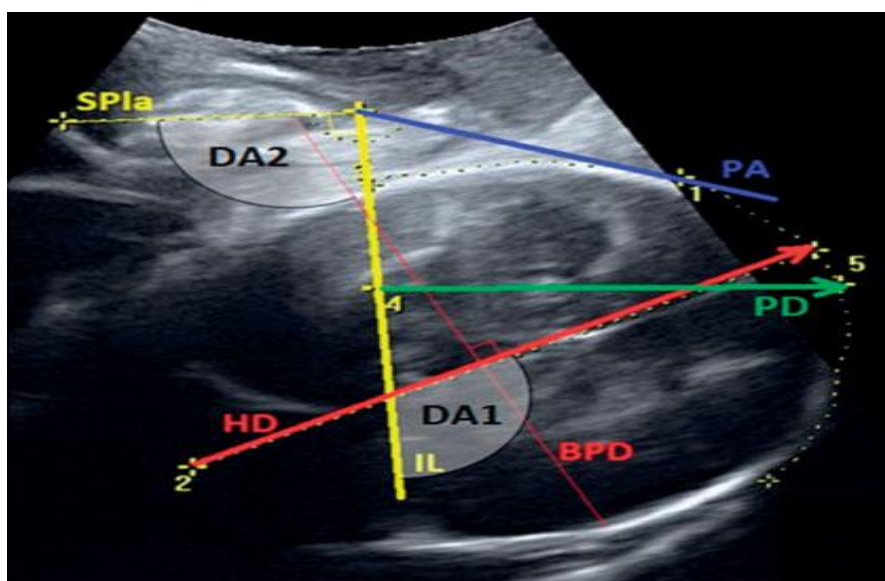
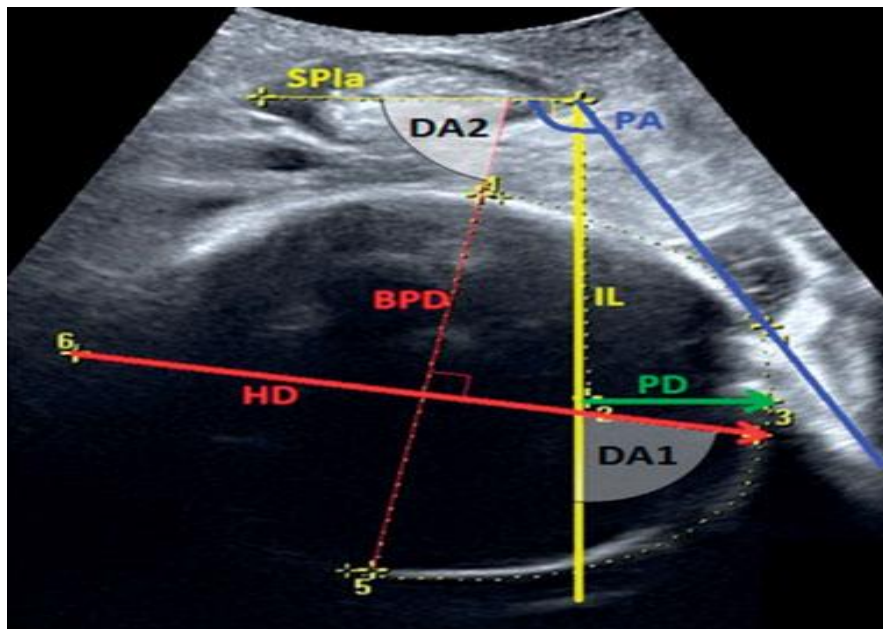


Evolution of the direction of progression against time at primiparous

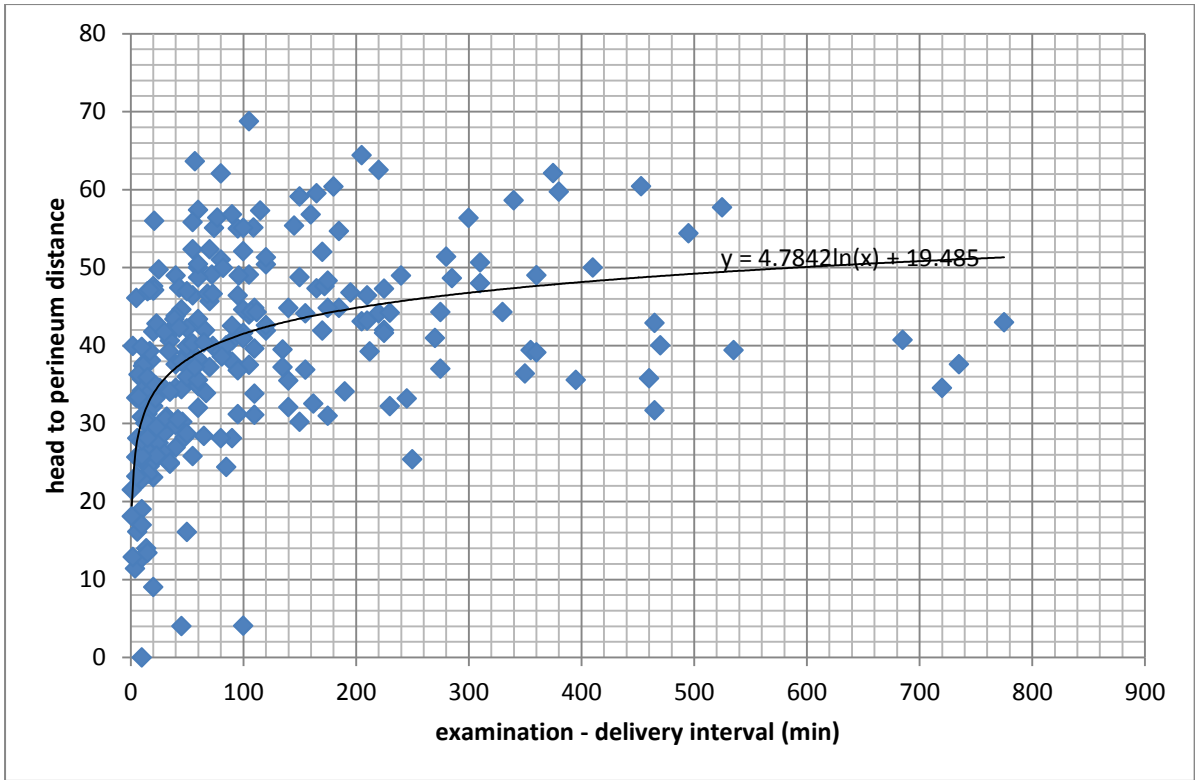


Evolution of direction of progression versus time in multiparous

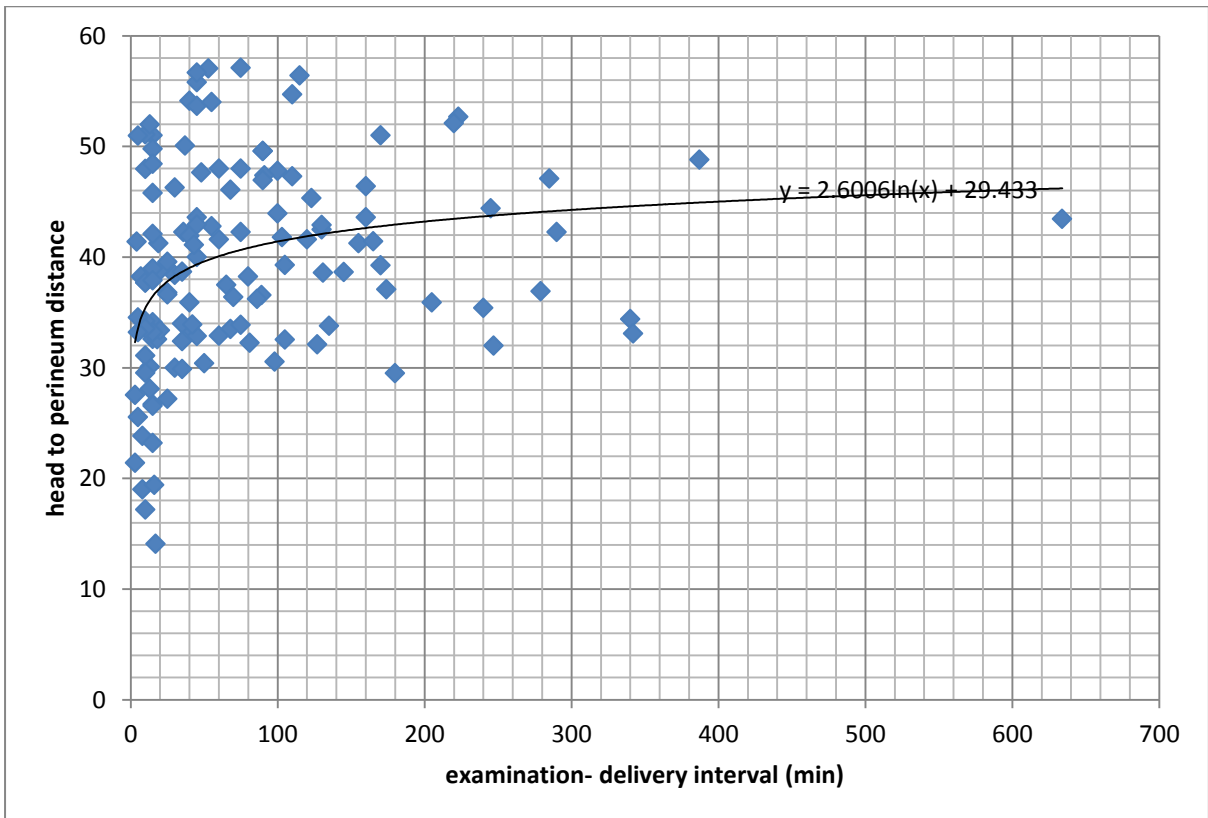
Comparing to the evolution of progression angle with the direction of progression per time unit, we see a line of these parameters separately for primiparous and multiparous. As a result of the research we have proposed a new method for assessing the direction of progression as following: knowing the initial method of evaluation of the direction of the geometric progression we have demonstrated the equivalence between the previously measured angle and the angle formed by the long axis of the symphysis pubis and biparietal diameter. The advantage of this new measurement technique consists in a more accessible and faster method and also reduces errors and increases the rate of reproducibility. Measurement technique is illustrated in the figures below:



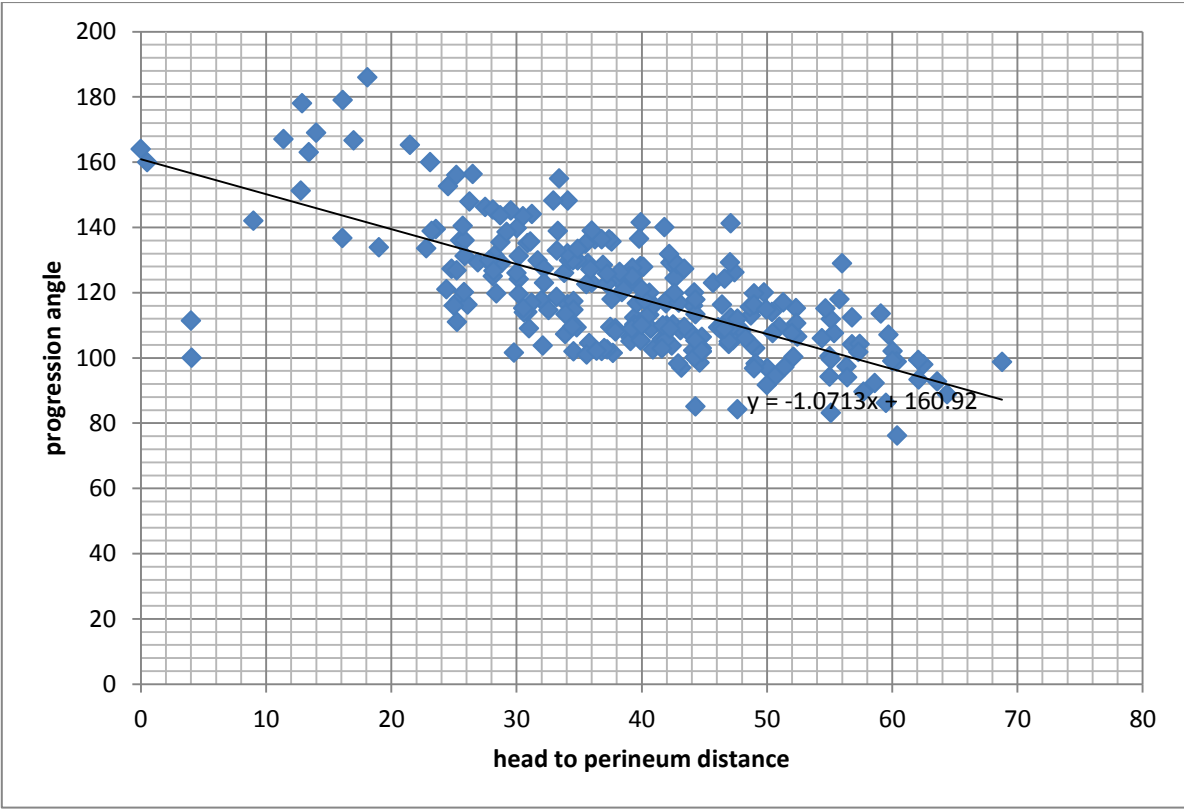
New technique for measuring the direction of progression



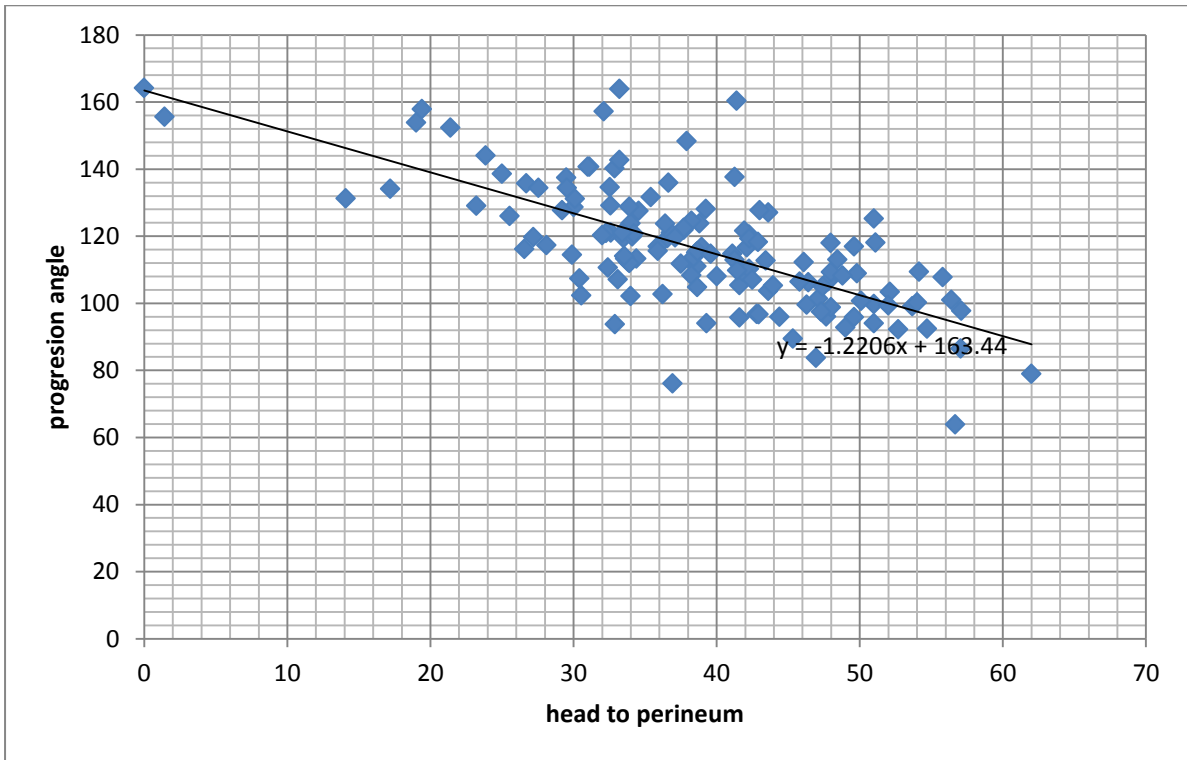
Evolution of head to perineum distance per time unit in primiparous



Evolution of head to perineum distance per time unit in multiparous



Correlation head to perineum distance - angle of progression to primiparous



Correlation head to perineum distance - angle of progression to primiparous

Following along the trendline the evolution of head to perineum distance per time unit and linking this development with the progression angle, we find that the equivalent angle of  $120^\circ$  is the DCP-4 cm in primiparous and 3.6 cm in multiparous. Beyond these values there is a positive development and rapid delivery. These findings verify the data in the literature, where most studies present DCP cut-off around 4 cm for the prediction of vaginal births.

Considering ultrasonographic parameters only in cesarean delivery we notice their different evolution in the labors that were resolved through vaginal delivery. Thus, with reference to our previously established cut-off values for the four parameters we see that the majority of patients who delivered by cesarean, the cut-off value was not reached, the exception to this rule is represented by measurements in patients with occiput persistent posterior.

The result of this thesis is to launch the idea that the combination of the four ultrasound parameters with their values cut-off in terms of labor can produce a sonopartogram installed to serve as a model for further studies, exceeding the threshold for each individual parameter studies and focusing on establishing a protocol on ultrasound in monitoring labor.

**Conclusions** - Despite significant advances in clinical obstetrics, assessment of the fetal head and strategies of prediction regarding the method of delivery still remains a matter of controversy. TPU was at first considered a useful tool for clinicians in the management of labor and delivery.

Ultrasound used in our study allowed us to:

- dramatically increase the accuracy of diagnosis,
- increase the safety of waiting
- Take a more timely decision regarding cesarean section, depending on the position of the fetal head.

Ultrasonographic assessment of fetal position during labor is feasible in a delivery room and is useful in the prediction and diagnosis of a prolonged / extended labor. Ultrasonography seems to be a solution to planning and monitoring of labor, and at least equally in guiding instrumental deliveries, because: it is available, we have small and compact ultrasound, is safe, non-invasive and provides an immediate and most important objective outcome. Enables recording of data and is

easy to learn and simple to use.

Using the TPU in the measurement of the progression is:

- Objective (using precise ultrasound signs for true evaluation of fetal head station)
- Reproductive
- Non invasive
- Easy technique

Analyzing the results of the study there were registered as follows:

- Precise identification of fetal head position variety, superior to clinical assessment
- A significant linear association was established between digital clinical assessment and measurement of the angle of progression ( $P < 0.001$ ).
- An angle of at least  $120^\circ$  measured during second stage of labor was associated with spontaneous vaginal birth.
- TPU provides an objective method to assess the fetal head descent during labor.
- Analysis of the incidence of cesarean delivery for fetal distress and Apgar score in both groups had no statistical significance. Immediately fetal prognosis is apparently not improved by using this technique.
- All patients tolerated TPU into labor and apparently conferred confidence to the patients.
- Our results showed that transvaginal assessment of fetal head station is not reliable, which means that clinical training should be promoted.
- Choosing not to give birth vaginally when the head is in the middle position strongly decreases the risk for application on a high undiagnosed station. Instead, obstetricians who practice instrumental deliveries only in low stations delivers fetuses from previously unrecognized mean stations.

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