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Original article

Intrapartum Ultrasound Measurement of Fetal Head Circumference for Prediction of Prolonged Second Stage of Labor

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ABSTRACT

Background: Fetal head circumference was suggested to play a role in determination of the mode of delivery in nulliparous women.

Aim of the work: To determine the capability of intrapartum ultrasound measurement of head circumference to monitor second stage of labor progress in an accurate and objective manner as well as its role as a predictor of successful normal vaginal birth.

Patients and Methods: 130 females who attended to the labor room and fulfil the inclusion criteria underwent ultrasonographic examination prior to the start of labor, and then followed up until delivery. Every woman was followed up by cervical dilatation, and head station every 4 hours. Woman was transferred to operating room when the cervix is fully dilated and head is engaged to determinate the duration of second stage. Fetal heart sounds were auscultated every 30 minutes and plotted on partogram. Shifting to cesarean section was considered when delivery failed to progress, delayed second stage or fetal bradycardia.

Results: By using value of 37.0 for Intrapartum head circumference as a cut-off point, we observed a significant difference between both groups [smaller or larger than 37.0] regarding duration of the 2nd stage of labor [P=0.00] & Mode of delivery [P=0.00]. No statistical difference was observed regarding Maternal morbidity [P=0.374] or Neonatal outcome [P=0.412].

Conclusion: There was significant relation between intrapartum head circumference and length of second stage. Intrapartum fetal head circumference is a useful tool to expect the progress of delivery.

Keywords: Intrapartum head circumference; Mode of delivery; Second stage of labor; Nullipara; Ultrasound

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* Main subject and any subcategories have been classified according to researchers' main field of study.

INTRODUCTION

World Health Organization (WHO) defines normal delivery as "spontaneous in onset, low risk at the start of labor and remaining so throughout labor and delivery. The infant in vertex position, born spontaneously between 37- and 42-weeks' gestation. Both mother and her neonate are good after birth[1].

The Mechanics of labor depends on three interrelated and interacting factors ['power', "passenger' and 'passage']**[2]**.

The second stage starts just after complete dilatation of the cervix and ends with delivery of fetus. It is recognized as a prolonged when it exceeds 3 hours with administration of regional anesthesia or if it exceeds 2 hours without regional anesthesia in nullipara**[3].**

Several researches had been evaluated the obstetric outcome in relation to postnatal head circumference, finding that larger head circumference is associated with higher rates of obstructed vaginal delivery and cesarean delivery**[4].**

Fetal head circumference ≥35 cm and neonatal birth weight ≥3900g were considered as cut-off points above which there is a high risk of cesarean delivery rate. A previous work found that prenatal and neonatal head circumference strongly correlates with a steady 1-cm increase, and that a larger head circumference is associated with higher risk of cesarean sections and neonatal comorbidities in full term [37-42 weeks] neonates**[5]**.

Women with prolonged second stage were found to be at high risk for obstetric trauma, postpartum hemorrhage, puerperal sepsis and composite maternal complications, while their neonates were at higher risk for low 5-minute Apgar score, neonatal intensive care unit admission, and composite perinatal complications. Mode of delivery altered the effect of duration of second stage of labor among nulliparous females**[6].**

The second stage of labor is associated –if prolonged- with increased risk of neonatal asphyxia. Maternal bearing down efforts, stronger and frequent uterine contractions, may decrease placental perfusion. In addition, umbilical cord could be compressed by the descent of the fetal head. Head compression may reduce cerebral perfusion. Fetal lactic acid values increased with maternal bearing down**[7].**

If the ultrasound device has ellipse measurement function, head circumference could be measured directly through placement of ellipse around the outside of bony skull echoes. On the other side, the BPD and occipitofrontal diameter [OFD] could be used to calculate the head circumference. The following Equation: HC = 1.62× [BPD+OFD] was used **[8].**

AIM OF THE WORK

The present study designed to assess the ability of intrapartum ultrasound estimation of head circumference to monitor the progress of second stage of labor accurately and objectively as well as to predict successful vaginal delivery.

PATIENTS AND METHODS

This descriptive study was performed at labor ward, included 130 primigravida, in spontaneous labor after 37 weeks, who attended the emergency room for delivery.

The **Inclusion criteria** were: Primigravida; 18-35 years of age; mature pregnancy ≥37 weeks gestation; singleton fetus; viable fetus; with vertex presentation. On the other side, **the exclusion criteria** were: absolute indication of caesarian section e.g. shoulder presentation, cord prolapse; head circumference >38 cm; and occipito-posterior.

Women attended to the labor room undergo ultrasonographic examination and followed up until delivery. Every woman was followed by cervical dilatation every 4 hours and head station also every 4 hours according to recommendations of World Health Organization (WHO).

Woman then transferred to operating room when the cervix was fully dilated and head was engaged to determinate the duration of second stage.

Fetal heart sounds were auscultated every 30 minutes and the results were plotted on the partogram. Shifting to cesarean delivery was considered when delivery failed to progress, delayed second stage or fetal bradycardia.

The prolonged second stage of labor was considered when the second stage of labor exceeds 2 hours. In addition, a preformed questionnaire was filled by each participant.

It included personal data (age, residency, educational level, occupation and contact numbers), menstrual history (regularity, menstrual length, number of days, amount of blood, intermenstrual bleeding and dysmenorrhea), obstetric history (e.g., first day of last menstrual cycle, estimated gestational age, expected day of delivery and any medical illness throughout antenatal care), any medications, previous operations, medical problems or any surgery involving the uterus, ovaries and adnexa.

In addition, all females were submitted to general examination (body weight, height and calculation of body mass index, vital signs), laboratory study (complete blood count, coagulation profile, liver function tests, and kidney function tests), and ultrasound evaluation

Ultrasound evaluation:

All women underwent standard abdominal examination with convex 5 MHz abdominal ultrasound probe for assessment of fetal biometry [bi-parietal diameter (BPD), occipito-frontal diameter (OFD), femur length (FL), abdominal circumference (AC), and estimated fetal weight (EFW)] & biophysical profile. HC is then calculated using the equation: HC = 1.62 × [BPD + OFD][8].

All women were examined by the same type of Ultrasound which was DP-10 Mindray.

Analysis of the data was performed using the Statistics Package for Social Sciences V 23 [SPSS, Chicago, IL, USA].

Descriptive data presented as frequency, percentage & mean ± SD. Correlation of the data is tested by one-way ANOVA test by comparing the means of variables. The confidence interval was settled to be 95%. Statistically significant value sets at the level of $P < 0.05$.

RESULTS

One-hundred & thirty women have participated in this study to test our theory regarding the using of the ultrasonographic measuring of intrapartum fetal head circumference to predict the delivery outcome.

Our results were as detailed below. The mean age of the studied population was 22.17 ± 2.65 years, & near about 80% of the participated women were in the age group of 20-25. The average weight of the pregnant women was 75.49 ± 9.86 kg & more half of cases were weighted about 60-70 kg.

Regarding the BMI, the average of all cases was 27.2260 ± 3.53 & 42.30% of women had a BMI in a group of 2530. Average Gestational age of all cases was 38.26 ± 1.06 weeks & 34.6% of pregnant were had a gestational age of 38 weeks. All details were presented in table 1.

The intrapartum head circumference (IPHC) ranged between 36.05 and 37.81 cm, while postnatal head circumference (PNHC) ranged from 36.36 and 39.75 cm; and there was significant decrease of IPHC when compared to PNHC (36.65±0.39 vs 38.36±0.61 cm, respectively, $p < 0.001$).

In the present work, the mode of delivery was normal vaginal delivery in 112 females (86.15%), cesarean delivery among 12 females (9.2%) and instrumental delivery among 6 females (4.6%).

The maternal morbidity was in the form of perineal injury among 6 females (4.6%), cervical injury among 4 females (3.1%), para-urethral tear among 6 females (4.6%) and post-partum hemorrhage among 4 females (3.1%).

The duration of the second stage of labor ranged between 38 and 124 minutes, the mean values were 68.85±17.86 minutes.

The neonates were normal among 115 deliveries (88.5%), while 9 neonates had caput (6.9%) and 6 neonates (4.6%) need admission to neonatal intensive care unit (NICU). The post-natal fetal weight ranged between 3170.20 and 3818.8 g with a mean value of 3411.666±143.76 g.

When considering head circumference of 37 cm as a cutoff value, there was statistically significant increase of the second stage of labor duration among subgroup of values ≥37cm when compared to those with values < 37cm. In addition, there was significant increase of instrumental and CS deliveries among group with values ≥37cm.

Otherwise, maternal morbidity and neonatal outcome did not associate with this cutoff value (Table 2).

Table [1]: Demographic data of the studied population

	Min	Max	Mean ±SD	Sub-groups	N	%
Patient age [years]	18	35	22.17 ± 2.65	<20	18	13.84 %
				20-25	104	80 %
				26-30	7	5.380 %
				31-35	1	0.77 %
Patient weight [Kg]	59.5	97.5	75.49 ± 9.86	60-70	51	39.23 %
				71-80	33	25.38 %
				81-90	30	23.07 %
Patient Height [meter]	1.60	1.75	1.6655 ±0.03			
Patient BMI	20.59	36.77	27.2260 ± 3.53	20-25	43	33.07 %
				>25-30	55	42.30 %
				>30	32	24.61 %
Gestational age [weeks]	37	41	38.26 ± 1.06	37	36	27.7 %
				38	45	34.6 %
				39	31	23.8 %
				40	15	11.5 %
				41	3	2.3 %

Table (2): Descriptive data of the delivery outcome regarding the cutoff point

		Cut-off point				p
		< 37.0 cm		≥ 37.0 cm		
Number of cases	Frequency	114		16		
	Percent	87.69 %		12.30 %		
		frequency	%	frequency	%	
MOD	NVD	109	83.85 %	3	2.31 %	<0.001*
	instrumental	4	3.08 %	2	1.54 %	
	CS	1	0.77 %	11	8.46 %	
Maternal morbidity	NAD	99	76.15 %	13	10.00 %	0.376
	PPH	5	3.85 %	1	0.77 %	
	cervical injury	3	2.31 %	0	0.00 %	
	para-urethral tear	3	2.31 %	1	0.77 %	
	Perineal injury	3	2.31 %	1	0.77 %	
Neonatal outcome	Normal	101	77.69 %	15	11.54 %	0.412
	Caput	7	5.38 %	1	0.77 %	
	NICU	6	4.62 %	0	0.00 %	

MOD = Mode of delivery, NVD =Normal vaginal delivery, CS = Caesarian section, NICU = Neonatal intensive care unit, PPH = Postpartum hemorrhage.

DISUCSSION

This study assesses intrapartum fetal head circumference as sensitive major method for diagnosis of prolonged second stage. Fetal head circumference has been suggested to play a role in the determination of the mode of delivery, especially in the nullipara. Therefore, the study clinically aims to determine a cutoff point which could be used to predict the mode of delivery (vaginal or cesarean) before it becomes too late. In addition, potential bias was minimized by masking obstetrician from sonographer results. In addition, ultrasound measurement was done twice to minimize observer variation. The normal vaginal delivery could be affected by several factors, especially fetal biometry. The fetal head size has a significant importance to predict successful labor by adaptation between the bony pelvis of the mother and her infant head[9]; the interaction between passenger and passageway[5].

Obstetric practice usually aims to reduce difficult vaginal delivery, which could have a negative effect on the health of the mother (physical and psychological health), her newborn and healthcare cost[10]. The operative delivery usually the results of cephalopelvic disproportion [CPD], narrow maternal pelvic diameter in relation to fetal head circumference [FHC][11].

The high rates of cesarean sections are a persistent concern for females and their care providers[12]. Reduced rates of CS is a significant goal of professional societies [3], to avoid unnecessary interferences and associated

complications, as well as to avoid high rate of complications in the future such as placenta accrete[13].

Intrapartum HC is a complementary part of sonographic models and significant for the purpose of fetal weight estimate as well as in females where abnormal fetal head growth is assumed, it is considered the interface between maternal pelvis and fetus [14]. Once the pregnant women enter the delivery ward, a full medical history and complete physical examination were done, then ultraso-nography examination were done for routine obstetrics data, with focusing on measuring of the fetal head circumference. All fetuses whose had IPHC < 37 cm were enrolled in the study while whose head circumference > 37 cm were excluded.

The average intrapartum head circumference was 36.65 ± 0.39 cm, while the average for postnatal head circumference was 37.87 ± 0.78 cm, with an average of 1.71 ± 0.22 cm. That difference between IPHC and PNHC are with agreement with results reported by **Dückelmann et al.**[15] despite that her values were smaller [the mean intrapartum HC [35.90±2.84 cm] and postnatal HC [36.17±3.03 cm]]. The smaller the values of IPHC related to the overriding of the bone of the fetal skull while he passes through the birth canal.

Each pregnant woman was follow-upped regularly and examined hourly and findings were plotted on partogram chart. One-handed twelve pregnant proceeded into spontaneous vaginal delivery within 2 hours of the second stage of the labor. There is 6 women [4.6%] undergone Instrumental delivery, while 12 women [9.2 %] had prolonged second stage and shifted to perform CS. Maternal complications or morbidities were as the following: 6 women had perineal injuries that were repaired easily, 4 women had a cervical injury, 6 women had a para-urethral tear which sutured with absorbable vicryl 2-0. However, 4 women suffered from PPH. The average duration of the second stage was 68.85 ± 17.86 minutes. It is worth to be mentioned that most cases suffered from complications were had a prolonged labor, this is in agreement with observations of **Konje et al.**[10], and **Mocanu et al.**[16].

On plotting the IPHC in the opposite of duration of the second stage regarding the deliveries outcome, and with using regression analysis we found that the measured intrapartum fetal head circumference of 37.0 cm can be used as a cut-off point for predicting the delivery outcome and suspecting cases who's gone into the prolonged second stage of the labor with increases the susceptibility for CS or instrumental delivery. We test the validity of the cut-off point were the Sensitivity of this cut-off point was 81.3 % while the Specificity was 4.4 %. This cut-off point has a sensitivity grater that the cut-off point [36.8-cm] tested by **Dückelmann et al.**[15], that had sensitivity of 44.7%.

In conclusion, there was a significant relation between intrapartum head circumference and length of second stage of labor. Head circumference could serve as a good predictor of prolonged second stage, and intrapartum fetal head circumference could be a useful tool to expect the progress of the delivery in the nullipara at a cutoff value of 37 cm with high sensitivity to predict cases that will fail to progress normally through vaginal delivery.

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None

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