The Effects of Fetal Head Circumference on The Duration of Labor and Cesarean Section in Term Pregnancy

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Abstract

Background: To investigate whether fetal head circumference (FHC), independent of estimated fetal weight (EFW), is a risk factor for prolonged second stage of labor and cesarean delivery in term pregnancy.

Methods: A single-center, non-randomized cross-sectional study including 580 cases was conducted. Cases included singleton primigravida term pregnancies.

Results: In the vaginal delivery and cesarean groups, the FHC was 35.01 ± 1.18 cm and 35.02 ± 1.32 cm, respectively (P = 0.95); biparietal diameter (BPD) was 94.99 ± 0.65 mm and 94.96 ± 0.65 mm, respectively (P = 0.66); EFW was 3366.18 ± 207.04 g and 3363.03 ± 251.54 g, respectively (P = 0.34). The lengths of the first and second stages of labor were not associated with the type of delivery ($P_1 = 0.92$; $P_2 = 0.79$). BMI was significantly associated with the duration of the first stage of labor ($P_1 = 0.04$), but not the second stage ($P_2 = 0.87$). BPD was significantly associated with the duration of the first stage ($P_1 = 0.007$), but not the second stage ($P_2 = 0.57$). EFW was not associated with either stage ($P_1 = 0.68$; $P_2 = 0.73$). FHC was significantly correlated with the duration of the second stage of labor ($P < 0.01$).

Conclusions: Among various maternal and fetal parameters, FHC was correlated with prolonged second stage of labor without increasing the risk of cesarean delivery. The decision regarding planned cesarean should not be based on FHC in uncomplicated pregnancies.

Keywords: Fetal Head Circumference (FHC); Estimated Fetal Weight (EFW); Cesarean Section; Ultrasound in Pregnancy

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Introduction

Despite recommendations in favor of normal vaginal delivery (NVD), an apparently normal labor may lead to cesarean section (CS) as a result of prolonged or poor progression. Traditionally, the course of labor is determined by three elements: the power, the passage, and the passenger, with the latter being the least modifiable factor [1].

Big babies are more prone to ending up with assisted delivery and/or CS [2]. Although most studies have considered fetal weight as the main measure of fetal size, it may not solely affect labor outcomes. Some investigators have noted that increased neonatal head circumference (HC) is associated with inappropriately prolonged second stage of labor, poor progression, perineal trauma, unplanned CS, and lower Apgar scores [3–5]. These findings have led to the retrospective deduction that fetal head circumference (FHC) may adversely affect the course of labor. According to recent publications specifically focused on ultrasound measurements of FHC at the beginning of labor, it appears that larger FHC is associated with prolonged labor, labor

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complications, and CS [6–17].

It is not yet known whether FHC is an independent risk factor for prolonged labor and cesarean delivery, or simply a participant in the generalized increase in fetal size. The goal of this study was to determine whether FHC, among other parameters, is associated with the length of labor phases and the likelihood of CS due to lack of progression.

Synopsis

Problem

Pregnancies with normal estimated fetal weight may still show prolonged labor course and require cesarean delivery

What is already known

Fetal head circumference may be an important factor affecting the prolonged labor and the risk of cesarean delivery

What this paper adds

Although fetal head circumference is correlated with the duration of phase 2 labor, it is not associated with increased risk of cesarean delivery and labor complications

Materials and Methods

This is a single-center, non-randomized cross-sectional study designed and conducted at Yas Complex Hospital, a specialty teaching hospital of Tehran University of Medical Sciences (TUMS), Tehran, Iran. The study design was approved by the Ethical Review Board of Tehran University of Medical Sciences, in accordance with the tenets of the Declaration of Helsinki. The study spanned three years, from December 2017 to December 2020. All participants were consulted regarding the impact of the intervention, and informed consent was obtained.

Subjects included every primigravida singleton pregnant woman with a gestational age between 37 to 42 weeks who had presented to the emergency room or delivery facilities of Yas Hospital with signs and symptoms suggestive of ongoing parturition. Subjects were excluded from the final analysis if the following characteristics were noted: multiparity, prematurity, intrauterine growth retardation (IUGR), fetal heart rate (FHR) abnormalities, administration of epidural or spinal anesthesia, and cardiopulmonary diseases.

At presentation, demographic data including maternal age, weight, and height were collected. Gestational age was calculated according to the last menstruation period (LMP) date. The history of systemic diseases such as diabetes and hypertension, as well as medications and supplements, were documented. The use of medications for induction of labor was also recorded. Fetal characteristics such as estimated fetal weight (EFW), biparietal diameter (BPD), and fetal head circumference (FHC) were measured by the attending obstetrician at the time of admission.

Data analysis was conducted using SPSS version 26 for Windows (IBM Corporation, NY). Categorical and continuous variables are presented as number (percent) and mean ± SD, respectively. For comparison of categorical variables, the chi-square test was used. Paired t-test and Wilcoxon signed-rank test were applied for comparing continuous variables with parametric and non-parametric distributions, respectively. P-values less than 0.05 were considered statistically significant.

Results

General characteristics

A total of 580 pregnant women were registered. After applying exclusion criteria, data from 500 individuals were analyzed. The mean age of the mothers was 26.89 ± 3.33 years. The gestational age was 39.22 ± 1.43 weeks. The calculated body mass index (BMI) was 26.91 ± 2.94 kg/m². The fetal head circumference (FHC) and neonatal head circumference (NHC) were 34.79 ± 0.53 cm and 35.01 ± 1.20 cm, respectively. The biparietal diameter (BPD) was 94.99 ± 0.65 mm. The estimated fetal weight (EFW) was 3365.62 ± 215.36 g. The length of phase 1 and phase 2 labor was 25.35 ± 18.09 hours and 37.32 ± 10.23 minutes, respectively.

The prevalence of normal vaginal delivery (NVD) and cesarean section (CS) was 420 (83%) and 89 (17%), respectively. Labor pain was the most common presenting complaint [188 (38%)], followed by rupture of membranes (ROM) [120 (24%)], medically indicated termination [61 (12%)], maternal request [40 (8%)], decreased fetal movements [34 (7%)], hypertension [28 (6%)], and bloody show [22 (4%)]. In Table 1, a comparison between pregnancies that concluded in NVD or CS is presented.

Maternal characteristics

The length of phase 1 and phase 2 labor was not associated with the type of delivery ($P_1 = 0.92$; $P_2 = 0.79$; Mann–Whitney U test) (see Table 1). Neither maternal age ($P_1 = 0.77$; $P_2 = 0.20$; ANOVA test) nor maternal blood group ($P_1 = 0.09$; $P_2 = 0.90$; Kruskal–Wallis test) was associated with the length of phase 1 or phase 2 labor.

Applying the generalized linear model, a significant association was found between BMI and the length of phase 1 labor ($P_1 = 0.04$; 95% CI: [−1.25, −0.01]), but not phase 2 labor ($P_2 = 0.87$; 95% CI:

Table 1: General characteristics of pregnancies that concluded in normal vaginal delivery and cesarean section

	NVD	CS	P value
Phase 1 (hours)	25.51 ± 19.23	24.64 ± 11.53	0.92*
Phase 2 (minutes)	37.33 ± 9.55	37.28 ± 12.98	0.79*
Sex			
Male	198	48	0.72+
Female	213	41	
Hypertension			
Yes	23	3	0.39$
no	388	86	
Diabetes mellitus			
Yes	15	3	0.81$
No	396	86	
Pelvic exam			
Normal	388	87	0.21$
Abnormal	22	2	
Induction			
Yes	390	87	0.27$
No	20	2	
FHC (cm)	35.01 ± 1.18	35.02 ± 1.32	0.95*
BPD (mm)	94.99 ± 0.65	94.96 ± 0.65	0.66*
EFW (gr)	3366.18 ± 207.04	3363.03 ± 251.54	0.34*
BMI (w/m^2)	26.91 ± 2.99	26.87 ± 2.71	0.90*
Wrist size	12.88 ± 0.86	12.82 ± 0.26	0.60*

*Mann-Whitney U test
+Chi-square test
$Spearman's rho-test
FHC: Fetal head circumference; BPD: Biparietal diameter; EFW: Estimated fetal weight; BMI: Body mass index;

[−0.49, 0.15]). Neither maternal weight ($P_1 = 0.67$; $P_2 = 0.89$) nor maternal height ($P_1 = 0.66$; $P_2 = 0.90$) was independently associated with the length of phase 1 or phase 2 labor.

Applying the generalized linear model, a significant association was found between BMI and the length of phase 1 labor ($P_1 = 0.04$; 95% CI: [−1.25, −0.01]), but not phase 2 labor ($P_2 = 0.87$; 95% CI: [−0.49, 0.15]). Neither maternal weight ($P_1 = 0.67$; $P_2 = 0.89$) nor maternal height ($P_1 = 0.66$; $P_2 = 0.90$) was independently associated with the length of phase 1 or phase 2 labor.

Although preliminary analysis showed that wrist circumference was a factor affecting the duration of phase 1 labor ($P_1 = 0.02$; Kruskal–Wallis test), further analysis using the generalized linear model did not support this ($P_1 = 0.30$; R = 0.002; 95% CI: [−0.95, 3.07]). Phase 2 labor was not associated with wrist circumference ($P_2 = 0.67$; Kruskal–Wallis test).

In this series, 430 mothers (86%) had no history of abortion. The number of individuals with one, two, and three previous abortions was 60 (12%), 8 (1.6%), and 2 (0.4%), respectively. The length of phase 1 labor was significantly longer in pregnancies without prior abortion ($P_1 = 0.03$; Kruskal–Wallis test). However, no significant difference in the length of phase 2 labor was found based on abortion history ($P_2 = 0.53$; Kruskal–Wallis test). Application of the logistic regression model showed that abortion history was not significantly correlated with the type of delivery (P = 0.74).

We found that phase 1 labor was longer in mothers who received vitamin D_3 supplements (26.44 ± 19.28 vs. 21.05 ± 11.41 hours, P < 0.001; Mann–Whitney U test). However, the length of phase 2 labor was not statistically different according to vitamin D_3 supplementation (37.31 ± 10.50 vs. 37.37 ± 9.13 minutes, P = 0.99; Mann–Whitney U test). Nevertheless, the rates of NVD and CS did not differ based on vitamin D_3 prescription.

In Table 2, the length of phase 1 and phase 2 labor is presented based on the amount of vaginal dilatation at presentation. We found no differences between groups ($P_1 = 0.42$; $P_2 = 0.67$; ANOVA test). Likewise, there was no difference between vaginal dilatation groups regarding the type of delivery (P = 0.45; Kruskal–Wallis test).

We stratified the level of maternal activity in the third trimester as follows: low activity, where mothers walked less than half an hour per day for two days or fewer per week; and moderate activity, where mothers walked for more than half an hour per day on three or more days per week. The length of phase 1 labor in low and moderate activity groups was 25.34 ± 18.20 and 25.75 ± 14.82 hours, respectively (P = 0.84; Mann–Whitney U test). The length of phase 2 labor in low and moderate activity groups was 37.27 ± 10.34 and 39.00 ± 6.04 minutes, respectively (P = 0.32; Mann–Whitney U test).

Table 2: Duration of phase 1 and phase 2 labor based on the amount of vaginal dilatation at presentation

TV (cm)	phase 1 (hour)	phase 2 (min)
0	25.79 ± 18.70	37.37 ± 10.38
1	23.00 ± 11.16	34.38 ± 8.48
2	19.19 ± 10.33	38.80 ± 8.50
3	25.25 ± 10.83	38.62 ± 11.01

TV: touche vaginal

Fetal characteristics

BPD was significantly associated with the length of phase 1 labor ($P_1 = 0.007$; 95% CI: [0.92, 5.80]), yet it was not associated with the length of phase 2 labor ($P_2 = 0.57$; 95% CI: [−1.64, 0.90]). EFW was not associated with the duration of either phase 1 or phase 2 labor ($P_1 = 0.68$; $P_2 = 0.73$). Based on the generalized linear model, neither BPD nor EFW was associated with the type of delivery ($P = 0.67$ and $P = 0.34$, respectively).

Preliminary analysis showed that although FHC was not significantly associated with phase 1 labor, it was approaching significance ($P_1 = 0.06$; Kruskal–Wallis test). However, in the generalized linear model, FHC was not associated with phase 1 labor ($P = 0.45$; 95% CI: [−67.22, 30.00]). On the other hand, FHC was significantly correlated with the duration of phase 2 labor ($P < 0.01$; 95% CI: [41.56, 92.15]). Despite this, FHC was not associated with the type of delivery based on regression analysis ($P = 0.65$).

Discussion

The goal of this study was to investigate fetal and maternal factors associated with a prolonged labor course and unplanned caesarean delivery. We found that although FHC, irrespective of fetal weight, was associated with longer phase 2 labor, it did not affect the rate of CS. We also found that none of the maternal or fetal factors in the antenatal period were associated with increased unplanned CS.

The adverse effects of large fetal size on pregnancy outcomes have been extensively acknowledged in the literature [2,18–23]. These include prolonged phase 2 labor, labor arrest, increased device-assisted delivery, emergent CS, shoulder dystocia, facial and brachial nerve palsy, asphyxia, maternal pelvic trauma, and bleeding. Traditionally, EFW has been used as the primary indicator of fetal size and its influence on pregnancy outcomes [2]. EFW has also been incorporated into obstetric guidelines [6]. However, evidence suggests that EFW is not sensitive enough to predict actual fetal size and macrosomia accurately [24–27].

In recent years, the adverse effects of FHC on pregnancy outcomes have garnered attention. For instance, Lipschuetz and colleagues demonstrated that FHC is a more predictive parameter for unplanned CS or device-assisted delivery compared to EFW [4]. Valsky and colleagues also showed that a large FHC may be the sole risk factor for rupture of the anal levator muscle [2].

We found that while fetal weight was not correlated with the duration of labor phases 1 and 2, FHC was significantly correlated with the duration of labor phase 2. Despite this correlation, FHC was not significantly associated with an increased rate of CS. This contrasts with findings by Lipschuetz and colleagues, who reported both increased duration of phase 2 labor and elevated CS rates in neonates with larger FHC [4]. Likewise, Elgarhy and colleagues reported a significant association between the duration of phase 2 labor and CS rates with FHC [17]. Although Cohen and colleagues reported a higher risk of CS in neonates with FHC greater than 35 cm within a week prior to delivery, this was not observed in our study [15].

On the other hand, we found a correlation between FHC below 32.5 cm and increased CS, which has also been described in previous reports [4]. This finding likely reflects placental insufficiency or intrauterine growth retardation (IUGR).

Similar to earlier studies, we observed no significant difference between antenatal ultrasound measurements of FHC and postnatal neonatal measurements [4,6,17]. In alignment with these findings, Aviram and colleagues reported that neonatal HC above the 75th percentile was associated with longer phase 2 labor, elevated CS rates, and increased neonatal complications [8]. Additionally, they found that BPD greater than 97 mm was linked to a higher likelihood of obstetric interventions, though not neonatal complications. In contrast, our study found no correlation between BPD and neonatal complications, CS, or the duration of phase 2 labor.

Vitamin D_3 supplementation did not influence the duration of phase 2 labor or CS rates. However, phase 1 labor was approximately five hours longer among mothers who received vitamin D_3 supplements. We did not identify similar findings in the literature, and further investigation may be required to determine any potential impact of vitamin D_3 on labor progression.

Our study is limited by the fact that most pregnancies in our cohort had EFW values below 4000 g. Therefore, the influence of FHC on the outcomes of pregnancies involving larger fetuses could not be determined. Moreover, although our sample size was relatively substantial, a larger population may be more appropriate for the accurate assessment of fetal anthropometric variables.

Conclusion

In conclusion, our study showed that while FHC was correlated with both neonatal HC and prolonged phase 2 labor, it did not influence the rate of CS. None of other maternal and fetal factors were associated with increased risk of CS. Hence, the decision regarding planned CS should not be based on the FHC in normal pregnancies.

Conflict of interest

The authors declare to conflict of interests.

Clinical trial number

Not applicable.

Ethical Consideration

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Ethical approval was obtained from Tehran University of Medical science. Written informed consent was obtained from all participants prior to their inclusion in the study. Participants were assured of the confidentiality and anonymity of their responses.

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Author contribution

Masomeh Sabzevary: Conceptualization, methodology, investigation, formal analysis, writing original draft; **Mahboobeh Shirazi:** Conceptualization, project administration, supervision, review and editing; **Fatemeh Rahimi:** Conceptualization, methodology, review and editing; **Fatemeh Golshahi:** Formal analysis, review and editing, project administration; **Zahra Moghimi-Ehsan Sobhanian- Morteza Naderan:** Investigation, formal analysis.

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