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CLINICAL ARTICLE

Association between sonographic measurement of fetal head circumference and labor outcome

Amir Aviram *, Yariv Yogev, Ron Bardin, Liran Hiersch, Arnon Wiznitzer, Eran Hadar

Helen Schneider Hospital for Women, Rabin Medical Center, Petah Tikva, Israel
Sackler Faculty of Medicine, Tel-Aviv University, Ramat-Aviv, Israel

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ABSTRACT

Objective: To evaluate the association between sonographically measured head circumference (HC) and labor outcome. *Methods:* In a retrospective study at a tertiary medical center in Israel, data were reviewed for all term singleton deliveries between July 2007 and December 2012 with HC measurements up to 7 days before delivery. HC was compared between women with operative vaginal delivery (OVD) or cesarean delivery for prolonged second stage and those with normal vaginal delivery. The impact of HC above the 75th percentile on pregnancy outcome was analyzed. *Results:* The study included 2351 women, of whom 2045 (87.0%) had a normal vaginal delivery, 259 (11.0%) underwent OVD, and 47 (2.0%) cesarean. Each 10 mm increase in HC was associated with increased risk for obstetric intervention because of a prolonged second stage (adjusted odds ratio [aOR] 1.26; 95% confidence interval [CI] 1.08–1.46). HC above the 75th percentile was independently associated with increased odds of OVD (aOR 1.77; 95% CI 1.30–2.41), 1-minute Apgar score less than 7 (aOR 2.91; 95% CI 1.50–5.66), and neonatal asphyxia (aOR 2.19; 95% CI 1.02–4.71). *Conclusion:* Term HC above the 75th percentile was associated with increased rates of obstetric interventions because of a prolonged second stage and might be associated with neonatal asphyxia.

1. Introduction

Increased birth weight is a recognized risk factor for several obstetric and neonatal complications, including prolonged labor [1–4], cesarean delivery [1,2], operative vaginal delivery [1,2], maternal and neonatal birth trauma [5–7], and shoulder dystocia [8,9]. Measurement of fetal head circumference (HC) by sonography is one of the basic components of fetal weight estimation, and is mostly combined with other sonographic biometric measures such as femur length, abdominal circumference, and biparietal diameter [10–12].

The association between neonatal HC measured after delivery and maternal and neonatal outcome is not well established. One study [13] found that postnatal HC equal to or bigger than 355 mm was associated with a more than fivefold risk for levator ani injury, whereas another [14] found that larger HC could serve as a protective measure against recurrent sphincter injury. It has also been reported that larger postnatal HC is associated with labor dystocia [15,16], fetal and maternal distress [15], increased rate of operative vaginal and cesarean delivery [15,17], and shoulder dystocia [18]. One study [17] found no association between fetal outcome in terms of low Apgar score and postnatal HC, but there are few data on neonatal outcomes such as rate of neonatal intensive care unit (NICU) admission, scalp injuries, or neonatal asphyxia.

Notably, all previous reports have addressed the association between postnatal HC and obstetric outcome; however, this measurement reflects a potential bias because fetal HC can be modulated and undergo extensive molding as the fetus passes through the birth canal. Sonographic measurements of HC and actual postnatal HC have been compared with conflicting results. Whereas some studies found that the difference was negligible [19,20], another reported consistent underestimation by the sonographic measurement [21]. Moreover, the association between postnatal HC and obstetric or perinatal adverse outcomes has limited value for prepartum counseling.

In view of the scarcity of data, the aim of the present study was to determine the association between prenatal sonographically measured HC and labor and perinatal outcomes.

2. Materials and methods

In a retrospective cohort study, data were reviewed from women who delivered at Rabin Medical Center—a university-affiliated, tertiary medical center in Petah Tikva, Israel—between July 1, 2007, and December 31, 2012. The local institutional review board approved the study (Helsinki committee, reference number 0450-13-RMC). Informed consent was not required because it was a retrospective study based on an existing database.

* Corresponding author at: Helen Schneider Hospital for Women, Rabin Medical Center, 39 Jabotinsky St, Petah-Tikva 49100, Israel. Tel.: +972 54 4301364; fax: +972 77 2016632.
E-mail address: amiraviram@yahoo.com (A. Aviram).

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The inclusion criteria were singleton pregnancy at or beyond 37 weeks and sonographic measurement of fetal HC in the 7 days before delivery at the study institution. Because routine pregnancy follow-up among the study population was carried out at community clinics, sonographic measurements were made at the study ultrasonography unit only for women with no ultrasonography examinations during the third trimester or those suspected to have a clinical issue necessitating further evaluation (e.g. fetal growth abnormalities, amniotic fluid disorders, etc.).

Women with a fetus or neonate with structural or genetic anomalies were excluded, as were those with primary cesarean delivery or previous cesarean delivery. Women with gestational diabetes or prediabetes mellitus (diagnosed based on a glucose challenge test, oral glucose tolerance test, and relevant history) were also excluded to avoid a selection bias concerning neonatal body composition. Fetuses with an HC below the 10th percentile were excluded to avoid a bias concerning microcephaly or intrauterine growth restriction. To assess the impact of HC on labor outcomes in relation to labor dystocia alone, women who underwent cesarean delivery or operative vaginal delivery (OVD) due to non-reassuring fetal heart rate were also excluded. Finally, women undergoing cesarean delivery because of dystocia in the first stage of labor were excluded to focus on variables contributing to prolonged second stage of labor.

Data were retrieved from the computerized databases of the ultrasonography unit, delivery ward, neonatal unit, and NICU, and were cross-tabulated by assigning a unique admission number to each woman and neonate. The information collected included demographic characteristics, obstetric data, biometric sonographic measurements, labor and delivery outcomes, and neonatal data.

For all study women, gestational age was calculated from the self-reported last menstrual period and was confirmed by a crown–rump length measurement in the first trimester. All biometric measurements were obtained in a specialized obstetric ultrasonography unit either by senior physicians who were experienced in sonography or by experienced ultrasonography technicians. When measurements were made by a technician, they were confirmed by a senior physician. For all women, HC was measured after detecting the correct plane of measurement by an ellipse around the calvarial wall [22].

Local, gender-specific, population based growth curves were used to calculate the birth weight percentile. Birth weight above 4000 g was considered macrosomia, and birth weight above the 90th percentile was defined as large for gestational age.

Grade 1 and 2 perineal tears and episiotomy were defined as minor perineal tears, whereas grade 3 and 4 perineal tears were considered as obstetric anal sphincter injuries. Prolonged second stage of delivery was diagnosed on the basis of the following cutoffs: 3 hours for nulliparous women with regional analgesia, 2 hours for nulliparous women with no regional analgesia or multiparous women with regional analgesia, and 1 hour for multiparous women with no regional analgesia. Head injuries were diagnosed by the treating pediatrician at the neonatal unit or the NICU, and included skull or facial fractures or contusions. Neonatal asphyxia was diagnosed according to guidelines reaffirmed in 2012 [23].

To identify the contribution of different factors including HC to pregnancy outcome, women who underwent cesarean or OVD because of prolonged second stage of labor were compared with women who underwent normal vaginal delivery. All OVDs were performed with a vacuum extractor and no woman was operated on owing to failed vacuum extraction. A second subanalysis for labor and neonatal outcome was performed comparing women whose fetuses had an HC above the 75th percentile with those whose fetuses had an HC at or below the 75th percentile.

Data were analyzed by SPSS version 20.0 (IBM, Armonk, NY, USA). Continuous variables were compared via Student *t* test, and categorical variables by χ^2 or Fisher exact tests. For the subanalysis on HC, a multivariate logistic regression model was constructed by incorporating variables that differed significantly in univariate analysis to provide adjusted odds ratios (aORs) and confidence intervals (CIs) for the effect of HC on labor and neonatal outcomes. $P < 0.05$ was considered significant.

3. Results

Among 44 263 women who delivered during the study period, 2351 (5.3%) had a sonogram at the ultrasonography unit in the 7 days before delivery and met the inclusion criteria (Fig. 1). Of these, 306 (13.0%) women underwent obstetric intervention because of a prolonged second stage, resulting in 259 (84.6%) OVDs and 47 (15.4%) cesarean deliveries.

Fetal HC was significantly higher for women undergoing intervention for prolonged second stage ($P < 0.001$) (Table 1). In a multivariate logistic regression analysis accounting for maternal age, parity, gestational age at delivery, neonatal birth weight and epidural use, each additional 10 mm of HC was independently associated with an increased risk of OVD or cesarean due to prolonged second stage (aOR 1.26; 95% CI 1.08–1.46).

Because the logistic regression analysis showed a dose-like response association between HC and labor outcome, a receiver operator characteristics curve was constructed (Fig. 2). The curve did not allow the identification of a clear threshold (area under curve 0.58) of HC from which adverse events occur at a significant level. Because HC was distributed normally, pregnancy and perinatal outcomes of the fourth quartile of the cohort (>75th percentile, 341 mm) were therefore compared with those of quartiles 1–3 (≤75th percentile) in subsequent analyses.

Women whose fetuses had a sonographically measured HC above the 75th percentile (study group) delivered at a more advanced gestational age as compared with the other women (control group); they also had a higher frequency of male newborns and polyhydramnios (all $P < 0.001$) (Table 2). There were significant differences in gravidity and parity between the groups ($P < 0.05$), and fewer women in the study group were primiparous ($P = 0.034$) (Table 2). There were no differences in the incidence of hypertensive disorders, number of pregnancies conceived by artificial reproductive techniques, or incidence of induced labor between the groups.

Mean birth weight and birth weight percentile were higher among newborns in the study group than in the control group ($P < 0.001$ for

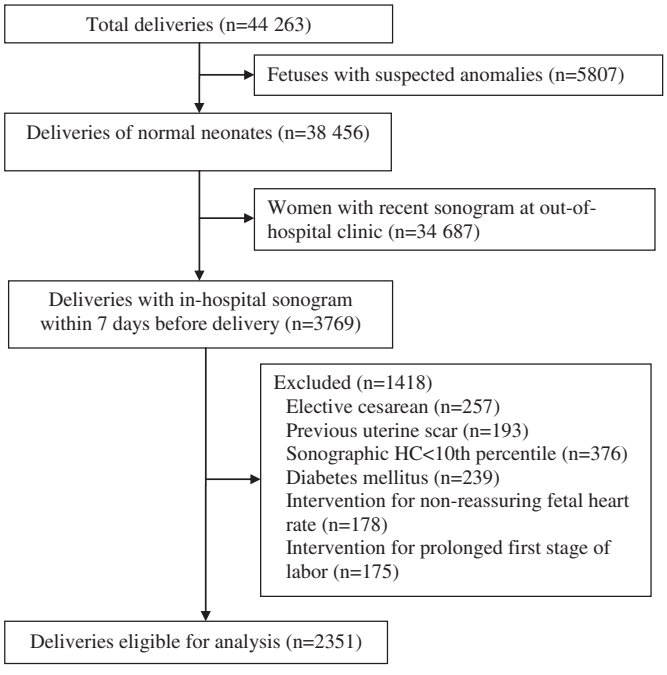

Fig. 1. Study population. Abbreviation: HC, head circumference.