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CLINICAL ARTICLE

Assessment of fetal growth using the ratio of the transverse cerebellar diameter to abdominal circumference

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ABSTRACT

Objective: To evaluate use of the transverse cerebellar diameter to abdominal circumference (TCD/AC) ratio in predicting intrauterine growth restriction (IUGR). *Methods:* A prospective observational study was conducted at a prenatal clinic in Udaipur, India, between August 2011 and December 2012. Women with a singleton pregnancy and a confirmed gestational age of 20–36 weeks were enrolled. Transverse cerebellar diameter and abdominal circumference were measured by ultrasonography on two prenatal visits at early (20–28 weeks) and late (30–36 weeks) gestation. A TCD/AC ratio above the 90th percentile was considered to indicate IUGR. Birth weight was recorded. *Results:* Overall, 100 women completed the study. Among 15 neonates with IUGR, the mean TCD/AC ratio was 14.17 ± 0.89 at early gestation and 15.61 ± 1.18 at late gestation. The TCD/AC ratio for appropriate-for-gestational-age neonates was significantly lower: 13.50 ± 0.97 and 13.80 ± 0.97 at early and late gestation, respectively ($P<0.05$ for both). Among 14 fetuses with a TCD/AC ratio above the 90th percentile at early gestation, 9 (64%) were small for gestational age, 5 (36%) were appropriate for gestational age, and none was large for gestational age at the neonatal examination. *Conclusion:* The TCD/AC ratio was fairly accurate in recognizing abnormal fetal growth at an early gestational age.

1. Introduction

Intrauterine growth restriction (IUGR) is estimated to affect approximately 3%–5% of pregnancies, depending on the population examined [1]. Its prevalence in the general population ranges from 3% to 10% [2,3]. After prematurity, IUGR is the second largest cause of perinatal mortality [4]. Indeed, 52% of stillbirths have been associated with IUGR and 10% of perinatal mortality is a consequence of IUGR [5,6]. Up to 72% of unexplained fetal deaths have been associated with a small-for-gestational-age (SGA) status (i.e. below the 10th percentile of growth) [4]. Furthermore, the perinatal mortality and morbidity of neonates with IUGR is 3–20-times greater than that of neonates without IUGR [7].

In 2001, the American Congress of Obstetricians and Gynecologists defined IUGR as a fetus that fails to reach his/her potential growth [8]. Sonographic fetal parameters are routinely measured both to predict gestational age and to manage pregnancies with fetuses who have growth disturbances [9]. Ultrasonography is the most useful tool with which to diagnose IUGR, differentiate between symmetric and asymmetric IUGR, and monitor the fetal condition [10]. Indeed, ultrasound biometry of the fetus is now the gold standard for assessing fetal growth [11].

There is evidence that the fetal cerebellum grows progressively throughout gestation [12,13], and therefore can provide information for prediction of gestational age during the whole pregnancy. Fetal abdominal circumference (AC) is the parameter that is affected first during impaired fetal growth [14]. The aim of the present study was to evaluate use of the ratio of transverse cerebellar diameter to abdominal circumference (TCD/AC) for the prediction of growth restriction at an early gestational age to facilitate timely obstetric interventions for the better survival of the growth-restricted fetuses.

2. Materials and methods

The present prospective observational study was conducted among women with a singleton pregnancy of 20–36 weeks attending the prenatal clinic of a tertiary care teaching hospital in Udaipur, Rajasthan, India, between August 1, 2011, and December 31, 2012. Only women with a regular menstrual history and known date of last menstrual period were included. The exclusion criteria were multiple pregnancy and identification of a major structural anomaly on ultrasonography. Participants were recruited after study approval was received from the institutional ethics committee. Written informed consent was taken from all participants.

Gestational age of the fetus was determined from the date of the last menstrual period. A thorough medical history was taken from all

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participants, and clinical and ultrasonographic examinations were undertaken on two prenatal visits. The first ultrasonography examination was done between 20 and 28 weeks of pregnancy; the second was done between 30 and 36 weeks. An Aloka (SSD 4000 SV) ultrasound machine (Trivitron Healthcare, Abhirampuram, Chennai, India) with a 2.5–6-MHz convex transducer was used for all examinations. Electronic callipers were used for biometric measurements, which were obtained in millimeters. In addition to routine sonographic fetal biometrics (biparietal diameter, head circumference, femur length, and AC), the transverse cerebellar diameter (TCD) was also measured.

The TCD was measured using the method of Goldstein et al. [15]. A transverse view of the fetal intracranium was obtained, and the thalami, cavum, septum pallucidum, and third ventricle were identified. The transducer was then slightly rotated below the thalamic plane to view the butterfly-like structure (cerebellum) in the posterior cranial fossa. The measurement was obtained by placing electronic calipers of the ultrasound machine at the outer to outer margins of the cerebellum (Fig. 1). The AC was measured via a transaxial view of the abdomen at the level of the junction of the umbilical vein with the left portal vein.

For each fetus, the TCD/AC ratio was calculated by dividing the TCD by the AC and then multiplying by 100. A TCD/AC ratio above the 90th percentile at 20–28 weeks or 30–36 weeks of gestation was taken to indicate IUGR [16].

The participants were followed up until delivery, and neonates were assessed for gestational age and birth weight. Growth abnormalities at birth were defined in accordance with birth weight. Lubchenco percentile charts of weight by gestational age were used. All neonates were categorized as SGA, appropriate for gestational age (AGA), or large for gestational age (LGA) on the basis of birth weight below the 10th percentile, between the 10th and 90th percentile, or above the 90th percentile, respectively.

Excel version 7 (Microsoft Corporation, Redmond, WA, USA) was used to analyze the data. The mean ± SD of TCD and TCD/AC ratio were determined at the two gestational ages at which they were calculated (20–28 weeks and 30–36 weeks). Additionally, the 5th, 50th, 90th, and 95th percentiles of TCD/AC ratio were calculated. Statistical analysis was performed by the χ^2 test when applicable. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were calculated using SPSS version 16.0 (SPSS Inc, Chicago, IL, USA). A receiver operating characteristic curve analysis was also performed. $P<0.05$ was considered to be statistically significant.

Fig. 1. Sonogram showing measurement of the transverse cerebellar diameter.

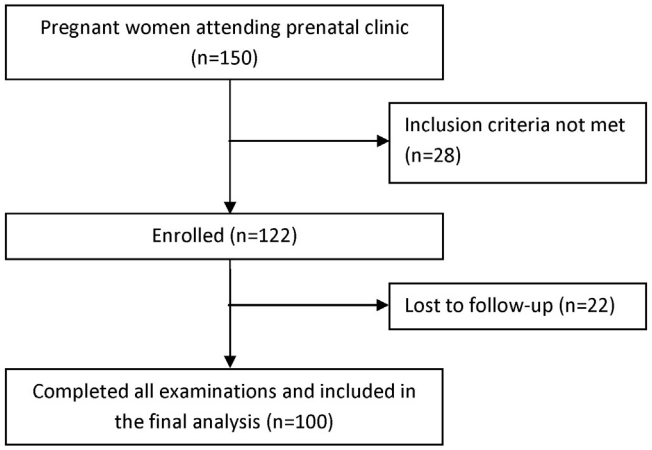

Fig. 2. Flow of patients through the study.

3. Results

Final analyses included 100 women for whom both ultrasonography examinations and neonatal assessment were completed (Fig. 2). The mean age of the women was 24.82 ± 3.31 years; 85 (85%) women were aged 21–30 years.

The TCD/AC ratio remained fairly constant between 20 and 36 weeks of gestation (Table 1). The mean TCD/AC ratio was 13.57 ± 0.97 at 20–28 weeks of gestation and 14.02 ± 1.20 at 30–36 weeks. The 90th percentile of the TCD/AC ratio at the early and late gestational ages was 14.79 and 15.97, respectively.

Overall, 15 (15%) neonates were SGA, 79 (79%) were AGA, and 6 (6%) were LGA. Among neonates with IUGR, the mean TCD/AC ratio was 14.17 ± 0.89 at 20–28 weeks, and 15.61 ± 1.18 at 30–36 weeks. Among AGA neonates, the mean TCD/AC ratios were 13.50 ± 0.97 and 13.80 ± 0.97, respectively. Finally, among LGA neonates, the mean TCD/AC ratios were 13.04 ± 0.28 and 12.99 ± 0.61, respectively. Thus, at early and late gestational ages, the mean TCD/AC ratio was higher for neonates with IUGR than for AGA neonates ($P=0.015$ for early; $P<0.001$ for late) and for LGA neonates ($P<0.001$ for both) (Fig. 3).

Overall, 14 (14%) of the 100 fetuses had a TCD/AC ratio above the 90th percentile at 20–28 weeks. On neonatal examination, 9 were SGA, 5 were AGA, and none was LGA ($P<0.001$) (Table 2).

At 30–36 weeks, 20 (20%) fetuses had a TCD/AC ratio above the 90th percentile. On neonatal examination, 12 were SGA, 8 were AGA, and none was LGA ($P<0.001$) (Table 2). Overall, 3 (20%) of the 15 SGA

Table 1
Percentiles of the TCD/AC ratio relative to gestational age.

Gestational age, wk	5th percentile	50th percentile	95th percentile
20	12.88	14.29	15.14
21	12.78	14.00	14.89
22	11.57	13.68	14.82
23	12.84	14.10	14.89
24	12.23	13.53	15.42
25	12.52	13.59	14.31
26	11.44	13.41	14.83
27	13.08	13.43	14.16
28	12.34	13.04	13.38
30	12.85	16.03	16.59
31	15.03	15.97	16.46
32	13.11	14.03	16.21
33	12.07	13.67	15.04
34	12.76	13.53	14.31
35	13.35	13.91	15.18
36	12.52	12.94	13.89

Abbreviation: TCD/AC ratio, transverse cerebellar diameter to abdominal circumference ratio.

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