Original Article

Clinical significance of head circumference \ abdominal circumference ratio in low risk pregnancy

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Abstract

Introduction: The ratio of HC and AC is the best conventional sonographic criterion for detection of intrauterine growth retardation. This study was conducted to determine the relationship of the ratio with GA in Nepalese population.

Methods: This prospective longitudinal study was based on 211 low-risk pregnancies.

Results: The ratio showed a continuous descending pattern until term.

Conclusion: The HC\AC ratio is around 1 and showed a continuous descending pattern until term.

Keywords: Abdominal circumference, head circumference, HC\AC ratio, intrauterine growth retardation

Introduction

Head circumference [HC] and abdominal circumference [AC] are usually measured during estimation of gestational age [GA]. The ratio of HC and AC is the best conventional sonographic criterion for detection of intrauterine growth retardation [IUGR] with positive predictive value of 62 % and sensivity of 82%.[1] This study was conducted to determine the relationship of the ratio with GA in Nepalese population.

Methods

This prospective longitudinal study was based on 211 low-risk pregnancies at a tertiary hospital in Kathmandu in 2015. The women, who visited the author's hospital from January to June 2015, participated voluntarily in the study and gave their written consent. Gestational age was computed from last menstrual period [LMP]. Head circumference [HC] and abdominal circumference [AC] were measured using ultrasound. The ratio of HC and AC was calculated.

The criteria for HC used were that the correct plane of section is through the third ventricle and thalamus in the central position of the brain showing cavum septi pellucidi in the anterior portion of the brain giving rise to 'arrow' appearance, calvaria must be smooth and symmetrical bilaterally and the cursors should be positioned at the outer edge.

The criteria for AC used were that the correct cephalo-caudal plane is position where the right and left portal veins are continuous with one another depicting the shortest length of the umbilical segment of the left portal vein giving rise to 'hockey stick' appearance, the appearance of the lower ribs is symmetrical and the ellipse is fit to the skin edge.

The inclusion criteria were history of amenorrhea, certain date of the first day of the last normal menstrual period and regular menstrual cycles (26 – 30 days) prior to pregnancy. The exclusion criteria were multiple gestations uncertain first day of last normal menstrual period, irregular menstrual cycle, IUGR, menstrual cycles less than 26 or greater than 30 days, major fetal abnormalities and maternal complications – hypertension, pre-eclampsia, abnormal glucose tolerance test, diabetes mellitus, abruptio placentae, isoimmunisation.

Results

This was a prospective study in which obstetric ultrasound was performed on 211 women and fetal biometric parameters namely – HC and AC were recorded. The subjects ranged from 16 to 38 years with a mean of 26 years. The ratio was calculated and is presented in a tabulated form [Table 1]. The maximum ratio was 1.162 and minimum 0.975 at 26 and 40 weeks of gestation respectively. Statistically significant ratios were at 27-28 and 37-39 weeks of gestation range. The ratio was around 1 and showed a continuous descending pattern until term.

Table 1 Ratio of HC and AC derived from this study

GA	Number	Mean	Pearson Correlation	P Value
25	8	1.123	-.378	.356
26	8	1.162	-.345	.401
27	11	1.127	-.814	.002
28	10	1.138	-.747	013
29	10	1.089	-.590	.073
30	11	1.088	-.303	.366
31	18	1.081	.143	.571
32	13	1.052	-.270	.373
33	10	1.007	-.569	.086
34	15	1.053	-.122	.664
35	8	1.023	-.491	.216
36	12	1.042	.148	.646
37	16	1.007	-.846	.000
38	18	0.992	-.631	.005
39	13	0.997	-.665	.013
40	12	0.975	-.489	.107
41	28	0.975	-.381	.045

Discussion

Gestational age and birth weight are the two most powerful determinants of both neonatal survival and morbidity. It has been shown that the practice of analyzing neonatal mortality or morbidity by birth weight rather than GA strata, may lead to misleading conclusions on risk factors associated with adverse neonatal outcomes.[2]

The HC is measured along the outer margin of the calvarium [not the scalp] from the same image used to measure biparietal diameter [BPD]. Tracing the perimeter with a map measure or electronic digitizer can make direct measurement, but accurate results can be achieved by calculating the circumference using the longest and the shortest axes of the fetal head measured from outer margin to the outer margin. HC is shape-independent measurement than BPD. HC is more accurate than BPD in predicting GA. [3]

AC measurement is made from an axial section of the fetal trunk at the level of the liver. The main landmark is the portal-umbilical venous complex, with the fetal stomach as a secondary landmark if the vein cannot be visualized. The image of the abdomen should be as round as possible to prelude the possibility of an off-axis or oblique reaction. The measurement can be calculated from the shortest and the longest diameters of the fetal abdomen [D1 + D2 X 1.57], provided that the abdomen is not grossly misshaped. AC is as accurate as HC [2SD± 3.2 weeks] in predicting GA in the third trimester and the abdomen is often much easier to see than a deeply engaged head. The maximum observed errors are also generally less than those with BPD, and this is again thought to be due to its relative shape independence. However, significant errors can occur when this measurement is used in macrosomic features and in those features affected by growth retardation. [4]

The ratio showed a continuous descending pattern until term. The values were similar to the study conducted by Campbell and Thoms in which the mean head to abdomen circumference ratio with 95 percent confidence limits was determined in 568 normal pregnancies from 17 to 41 weeks menstrual age. The mean ratio was 1.18 at 17 weeks. The ratio was also determined in 31 small-for-dates fetuses within one week of delivery. In all these cases the fetal weight was below the 5th centile weight for gestation. The ratio was above the 95th centile limit in 22 [71 percent] of these fetuses and evidence to suggest that the ratio can be used to distinguish between symmetrical and asymmetrical growth retardation. [5]

Table 2. Ratio of HC and AC derived from study conducted by Campbell and Thoms

Gestational age	Upper limit of HC\AC	Lower limit of HC\AC
25	1.04	1.22
26	1.04	1.22
27	1.05	1.22
28	1.05	1.22
29	0.99	1.21
30	0.99	1.21
31	0.96	1.17
32	0.96	1.17
33	0.96	1.11
34	0.96	1.11
35	0.93	1.11
36	0.93	1.11
37	0.92	1.05
38	0.92	1.05
39	0.87	1.06
40	0.87	1.06
41	0.93	1.00

Intrauterine growth retardation [IUGR] is associated with a fourfold to eight fold increase in perinatal mortality. Serious short or long-term morbidity- including interpartum fetal distress, neonatal hypoglycemia, hypocalcemia, polycythemia, and muconium aspiration pneumonia- is found in one-half of the affected surviving infants. Accurate antepartum diagnosis offers the best opportunity to prevent stillbirth and intrapartum hypoxia damage associated with IUGR. One should suspect IUGR if there is oligohydramnious and either effective fetal weight [EFW] are below the tenth percentile.[6]

The proposed sonographic criteria for IUGR have included elevated HC\AC ratio, elevated FL\AC ratio, presence of oligohydramnios without ruptured membranes and presence of advanced placental grade. The proposed Doppler criteria have included elevated systolic\diastolic ratio or pulsality index [PI] in fetoplacental or uteroplacental circulation and decreased volume flow through the umbilical vein. Accurate diagnosis might be achieved by using multiple parameters. [7]

In small fetuses, fetal growth failure as determined by the serial assessment of AC and estimated fetal weight was superior to the final AC and EFW, umbilical artery PI and aortic-middle cerebral PI ratio in the prediction of abnormal neonatal morphometry indicative of fetal growth retardation. The diagnosis of which is particularly important in small fetuses because the incidence of perinatal morbidity in this subgroup is significantly higher than in small fetuses with normal growth.[8]

The accuracy of 4 ultrasonic parameters and their combined use for detecting fetal growth retardation in a group of 260 small – for – dates infants were analyzed. AC was the most accurate single ultrasonic technique. During the last 10 years, ultrasonography has proved an accurate method for detecting this condition. The relationship between poor fetal growth and severe perinatal problems is well known. The influence of this pathologic condition has proved more accurate than any other clinical or biochemical method for diagnosing fetal growth retardation.[9]

The term small for gestational age [SGA] is generally applied to infants born with a birth weight below the tenth percentile for gestation. These infants have not necessarily suffered from fetal growth retardation, but they are at increased risk of peri-natal morbidity and mortality as well as poor neuro- developmental outcome. AC and EFW are superior to umbilical artery and uteroplacental waveform indices for predicting SGA at birth.[10]

Transcerebellar diameter\ abdominal circumference [TCD\AC] is used to determine the correct GA and to predict IUGR. [11, 12] TCD may be altered in abnormal fetuses and could be used for diagnosing congenitally abnormal fetuses.[13] TCD is valuable in identifying babies with asymmetrical IUGR. [14, 15]

Intrauterine growth restriction (IUGR) is a common diagnosis in obstetrics and carries an increased risk of perinatal mortality and morbidity. Identification of IUGR is crucial because proper evaluation and management can result in a favorable outcome. [16]

The HC/AC ratio can be used to distinguish between symmetrical and asymmetrical growth retardation.[17.] An elevated head-to-abdomen ratio is an adverse risk factor for pregnancy outcome. [18] High rates of severe

preeclampsia (53%), abnormal amniotic fluid (70%), and abnormal uterine artery Doppler studies (78%) indicated placental insufficiency. Fetuses with severe placental IUGR in the second trimester are more likely to have an asymmetric phenotype. This is in contrast to the current belief that asymmetric IUGR is confined to third trimester IUGR.[19.]

Fetal growth restriction (FGR) remains a leading contributor to perinatal mortality and morbidity and metabolic syndrome in later life. [20.] Asymmetrical intra-uterine growth restriction is a type of intra-uterine growth restriction (IUGR) where some fetal biometric parameters are disproportionately lower than others as well as falling under the 10th percentile. The parameter classically affected is the abdominal circumference.[21] Although many definitions of IUGR have been used, the most common definition is an estimated fetal weight (EFW) in less than the 10th percentile for GA at any point in gestation.[22] Symmetrical growth restriction was defined as a birth weight below the 16th percentile (–1 SD) compared with full-terms and a head circumference (HC) *z* score not exceeding the infant's birth weight *z* score by >1 SD. Asymmetric growth restriction was defined as a HC *z* score exceeding that for by >1 SD as a proxy of brain sparing. Developmental delay was more likely in growth-restricted preterms independent of HC at birth.[23]

Symmetrical IUGR (normal HC/AC ratio) is found mostly in the second trimester and suggests a sinister diagnosis of aneuploidy, whereas an elevated HC/AC ratio is found mostly in the third trimester and suggests a more benign diagnosis of fetal starvation due to placental insufficiency. Asymmetric IUGR was assigned categorically as an HC/AC ratio ≥ 95th percentile for gestational age. Severe, early-onset IUGR in a euploid fetus presenting in the second trimester was more likely to be asymmetric than symmetric. An asymmetric phenotype was, in contrast to current opinion, more likely when the IUGR was due to severe placental insufficiency. [24]

Conclusions

The HC\AC ratio was similar to other studies. The HC\AC ratio is around 1 and showed a continuous descending pattern until term.

Acknowledgements

The author thanks all the subjects as well as the assistants who helped in the process of this research.

Conflict of interest: None declared.

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