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Intrauterine Growth Restriction: Review of Current Calculations for Fetal Well-being

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Abstract*: Intrauterine Growth Restriction occurs when a fetus weighs less than the 10th percentile at birth. Infants with intrauterine growth restriction are at an increased risk for fetal/neonatal mortality and morbidity can experience long-term complications. A review was conducted on current fetal growth measurements to explore how accurate universal calculations and Doppler ultrasound is to diagnose intrauterine growth restriction.*

Keywords—ultrasound, Doppler; middle cerebral artery; umbilical artery; fetal biometrics; Hadlock; IUGR

1.Introduction

Intrauterine growth restriction (IUGR) affects 10% of births worldwide, contributing to higher maternal and perinatal morbidity and mortality. The placenta is the main contributor to overall fetal growth and well-being. Insult on the placenta results in second and/or third trimester IUGR. Fetal growth is determined by a calculation that includes the femoral length, abdominal circumference, head circumference, and biparietal diameter. Growth charts by Intergrowth-21st and Hadlock are two standards used to derive the fetal percentile. A review was conducted to explore the consistency and reliability of current standards used in diagnosing IUGR.

2.Methods

A broad search was conducted relative to intrauterine growth restriction utilizing various databases, including PubMed, MEDLINE (EBSCO), and CIINAHL. Keywords identified to specifically address the topic were (including synonyms and related words) "intrauterine growth restriction,""doppler," umbilical artery (UA)/middle cerebral artery (MCA), "doppler and IUGR," "IUGR biometrics,"and "accuracy" in July 2023. The sources were chosen based on the criteria of being peer-reviewed, including one or more of the keywords above, and having been published between 2018 and 2023. Studies were excluded if they were performed on multi-gestational pregnancies. After filtering the criteria and excluding any duplicated text, nine articles were reviewed.

3. Umbilical Artery and Middle Cerebral Artery

Studies have been conducted to examine the accuracy of Doppler ultrasound on the UA and MCA. A review was conducted on four studies to explore the similarities and differences between them. The UA and MCA were held for comparison by various other fetal methods, including a biophysical profile (BPP) score to indicate fetal well-being based on fetal tone, gross body movement, practicing breathing, and amniotic fluid index (AFI). AFI is a subjective assessment of fetal amniotic fluid by measuring the largest pockets of fluid in each quadrant and adding them together. Adverse perinatal outcome (APO) parameters used include Apgar score at 5 minutes, caesarean section for distress, admission to the NICU (Neonatal Intensive Care Unit), and perinatal death [1].

3.1 Review

Reference [2] conducted research on 161 women, 114 pregnant with abnormal BPP and a history of IUGR pregnancy and 47 with normal BPP, from February 2021 to April 2022 at the Radiology Department of Allied Hospital Faisalabad. Color Doppler was used to examine the pulsatility index (PI) and resistive index (RI) of the MCA compared to the BPP. Another study was performed to examine Doppler ultrasounds of the UA and MCA to predict APOs in IUGR fetuses [3]. In this study, 172 singletons with 33- to 36-week gestational pregnancies with an abdominal circumference in the 5th percentile or less and an estimated fetal weight less than the 10th percentile were elected to have serial ultrasound Doppler of the UA and MCA [2]. Reference [4] conducted a prospective study of singleton pregnancies between 36 and 37 weeks' gestation, collecting Doppler PI of the UA and MCA, compared to perinatal outcomes. Reference [1] also conducted a study on the PI and RI of the UA and MCA as well as the S/D ratio on 55 IUGR fetuses with abnormal Dopplers and compared them to 55 fetuses with normal Doppler. Along with serial doppler studies, fetal movement and BPPs were performed from 2016 to 2018. Data was collected and compared to the perinatal outcomes. In reference [5], one hundred and twenty-six singleton pregnancies with a gestational age given in the first trimester and fetal biometry estimating a fetal weight (EFW) below the 10th percentile in the third trimester and at birth were included in this prospective study. The EFW and the growth of the percentile, doppler of the UA, and MCA were assessed. The participants were divided into early SGA (small for gestational age) (before 32-week gestational age) and late SGA (after 32-week gestational age), and the data collected was compared to perinatal outcomes [5].

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3.2 Results

Looking at the effect of the PI of the MCA compared to the BPP score showed that an MCA PI of a lower value, 0.5–0.6, and a higher MCA PI indicated a better result when conducting a BPP [2]. References [1, 3] showed that an abnormal MCA PI was related to more cases of absent or reversed end-diastolic flow (AEDF/REDF), while reference [5] saw an increase in MCA abnormalities in early SGA rather than late SGA, giving a more descriptive timeline. Reference [5] also demonstrated that early SGA, specifically, had more cases of AEDF/REDF UA doppler. Additionally, those with a decrease in overall amniotic fluid were found to be more likely to have abnormal dopplers [1, 4].

4. Growth Charts

Estimated fetal weight (EFW) is determined by calculating the head circumference (HC), biparietal diameter (BPD), abdominal circumference (AC), and femur length (FL) after 14 weeks. Before 14 weeks, the gestational age is calculated by the crown-rump length to determine the estimated fetal due date [6]. The HC and BPD should be taken in a symmetrical plane, demonstrating the thalami and cavum septi pellucidi; AC is taken showing the stomach buddle and portal sinus without the kidneys or diaphragm within the image; and FL is taken at 45 degrees horizontal with both ends clearly visible and measuring the more anterior femur [6]. Accurately and properly placing calipers helps calculate the fetal growth rate, which is represented by a percentile. Two parameters, the Intergrowth-21st standard, and three parameters, Hadlock, are examined to see the accuracy of each standard of percentiles.

4.1 Review

Intergrowth 21st is a two-parameter EFW standard formula using the HC and AC. The Intergrowth-21st project created the EFW standard to be more accessible and efficient due to its being derived from an international, multicenter study of urban populations [7]. A cohort study was conducted on 690 singletons; patients were scanned at 28, 32-, 36-, 38-, and 40-weeks' gestation using the Intergrowth and Hadlock Standard [7]. The measurements were used to predict possible adverse perinatal outcomes (APO) and assess each standard's accuracy. In a study [7], thirty-three women delivered infants with APOs; this study showed a correlation between lower EFW and a higher risk of having an APO. In another study, Intergrowth and Hadlock age-specific percentiles were compared by comparing the last EFW if within 3 days of birth to the neonatal birth weight to get a mean percentage difference [8]. The data of 840 of the 10,336 possible participants were included, meeting the criteria of having an EFW three days before birth; the average difference was +3.3%, and 67% had an absolute difference that was within 10% of the actual birthweight.

4.2 Results

The predicted values for adverse perinatal outcomes in the study [7] were analyzed: intergrowth EFW sensitivity of 87.9%, specificity of 80.5%, and a positive predictive value of 18.5%, while Hadlock EFW showed 93.9%, 81.2%, and 20.1%, respectively. In a comparative study of growth charts [8], Intergrowth 21st resulted in a sensitivity of 11% and a positive predictive value of 15%, meaning it would miss nearly 90% of adverse perinatal outcomes, while Hadlock placed 1.8–5.8% of low-risk pregnancies in the 3rd and 10th percentiles and had a sensitivity of 12%. Hadlock has a longer history and is therefore more commonly used than Intergrowth 21st. When comparing the two, both resulted in similar sensitivity, specificity, and positive predictive value [7, 8]. Study [7] found Hadlock better predicted the risk of adverse perinatal outcomes in comparison to Intergrowth, while Intergrowth and Hadlock performed similarly in estimating the number of fetuses that would have adverse perinatal outcomes in study [8]. In the chart represented by Fig. 1, the two were compared at the 3rd, 5th, 50th, 90th, and 97th percentiles to examine the differences in each [9].

5. Discussion

Intergrowth and Hadlock standards both have errors and perform similarly in comparison. However, sonographers can make errors and be inconsistent, so it would be

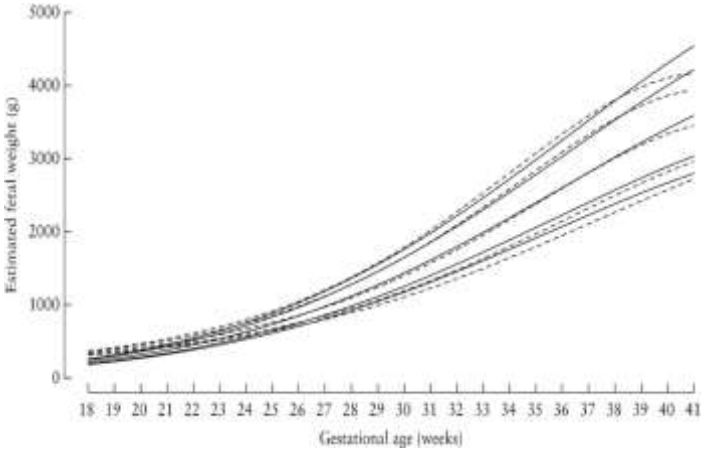

Figure 1: Age standards for the 3rd,5th, 50th, 95th and 97th percentile for Hadlock EFW (——) and Intergrowth EFW (- - - -)

unreasonable to use them as the only component for tracking IUGR [6]. In a study [5], results showed that diagnosing SGA before 32 weeks had a lower overall percentile at the third trimester ultrasound and greater adverse perinatal outcomes. Being able to diagnose and prepare with greater time is critical for the fetus to get the perinatal care needed to have the best outcome. Abnormal MCA and UA Doppler ultrasound

compared to other fetal- wellbeing tests showed collaboration needed to further understand and diagnose IUGR [1,2,4]. This review showed how independently ultrasound Doppler and EFW standards are useful in diagnosing IUGR. However, further research is needed to understand how both connect to established when and if Doppler ultrasound is warranted to aid in diagnosing IUGR.

6.Conclusion

Intrauterine growth restriction is an obstetric anomaly that affects fetuses across the world. It is not easy to diagnose this complex disease, but with recent developments IUGR is closer to being more accurately diagnosed and reducing perinatal outcomes. A review of studies displayed MCA and UA Doppler as effective tools to indicate early indicators of IUGR as well as a comparison of two common EFW standards showed similar results when placing fetuses into a growth percentile.

7.References

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