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Original Research Article

A prospective study to evaluate the role of routine early third trimester ultrasound in the diagnosis of intrauterine growth restriction and prediction of adverse perinatal outcome using color Doppler

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ABSTRACT

Background: Intrauterine growth restriction (IUGR) is a major and silent cause of perinatal morbidity and mortality. Rate of IUGR in developing countries is 6 times higher than that of developed countries. 14 to 20 million infants are affected with IUGR in developing countries annually. The highest incidence is found in south central Asia (33%) and India (21%). Aim of study was to evaluate the role of early 3rd trimester ultrasound in diagnosis and role of color Doppler in prediction of adverse perinatal outcome in IUGR.

Methods: A prospective case-control study was conducted on 720 women admitted in GMH Rewa for one year. 360 antenatal cases diagnosed as IUGR on ultrasound were taken as study group, same number of non IUGR cases were taken as control. Study cases were followed with Doppler. The umbilical artery pulsatility index (UA PI), middle cerebral artery pulsatility index (MCA PI) and cerebro-placental ratio were calculated and the results were analysed.

Results: Inferences drawn from the study were: rate of caesarean section was significantly higher (31%) in study group, perinatal outcome was poor in more number of cases (10.8%) in study group than the control group (3.4%), and the sensitivity and specificity of cerebroplacental ratio was more reliable indicator in comparison to that of UA PI and MCA PI in prediction of adverse perinatal outcome.

Conclusions: Looking at the high burden of IUGR cases in our country and its adverse effects on perinatal outcome, if early third trimester ultrasound is made mandatory for all pregnant women, most of the IUGR cases can be detected and managed timely and perinatal outcome can be significantly improved.

Keywords: IUGR, Colour Doppler, Cerebroplacental ratio, Perinatal morbidity

INTRODUCTION

Intrauterine growth restriction (IUGR) is a multi-factorial condition which leads to significant fetal morbidity and mortality. Its importance was timely established when Battaglia and Lubchenco classified small-for-gestational age (SGA) neonates as those whose weights were below the 10th percentile for their gestational age.¹

IUGR is defined as birth weight below the 10th percentile of the recommended gender specific birth weight for

gestational age reference curves by Williams and the World Health Organization (WHO).² It is a major burden in developing countries attributing to 14 to 20 million infants being affected annually. The highest incidences are found in south central Asia (33%), that too India accounts for 21% of cases in the world.^{3,4} The rate of IUGR in developing countries is about 6 times higher than that in developed countries.

Impairment in fetal growth has consequences in infancy and childhood in terms of mortality, morbidity, growth and

performance. So screening for IUGR in a new-born is necessary for the diagnosis, management and prognosis. IUGR infants not only have higher association with congenital anomalies, they have long term neurological deficits. Also the Barker hypothesis states that IUGR is a major cause for the development of chronic diseases such as cardiovascular diseases, stroke, hypertension, type-2 diabetes and obesity later in life.⁵ A modern classification system of stillbirth, Recode, has shown that IUGR is the most common factor identified in stillborn babies (43%).⁶

Timely diagnosis of IUGR is a challenge which was earlier solely based on serial physical examinations such as maternal weight charting, abdominal girth and fundal height charting. Later with the advent of sonography, serial biometry became the significant tool.

The advent of color Doppler has enabled more precise examination of the uteroplacental and fetoplacental circulation.

Timely diagnosis and management of IUGR is one of the major achievements in contemporary obstetrics. If the growth-restricted fetus is identified and appropriate management instituted, perinatal mortality and morbidity can be reduced, underscoring the need for assessment of fetal growth at each prenatal visit.

This study was conducted with the aim of improving the diagnostic, preventive and curative facilities for the healthiest outcome of neonates in our institute.

METHODS

The study protocol was approved by the Institute's ethics committee. All subjects were included in the study after an informed written consent. Participation in the study was voluntary.

This prospective study was conducted on 720 antenatal patients admitted in Gandhi Memorial Hospital, associated with Shyam Shah Medical College and Hospital, Rewa (Madhya Pradesh) for a period of one year from 01 July 2016 to 30 June 2017.

Inclusion criteria

Patients with antenatal cases with gestational age between 28-36 weeks. Singleton pregnancy, patients attending antenatal outpatient department (OPD), admitted in antenatal ward and labour room, were included in this study.

Exclusion criteria

Patients in labour, patients with mistaken dates, patients with intrauterine fetal demise, were excluded from this study.

Detailed history was obtained. Gestational age was carefully determined, in cases with mistaken dates help of first trimester ultrasound was taken. A general and relevant systemic examination performed followed by a thorough obstetric examination to know gestational age, lie, presentation, amount of liquor, baby weight, fetal well-being, symphysio-fundal height, and abdominal girth. All routine blood and urine examination were done.

Routine ultrasound was done to measure biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL), estimated fetal weight (EFW), amniotic fluid index (AFI) and placental changes. On the basis ultrasound patients were divided into cases i.e. with IUGR and control i.e. non-IUGR. IUGR cases were followed with Doppler studies. All the patients were followed till delivery and neonatal birth weight, ponderal index and perinatal outcome were noted.

The data were entered into Microsoft excel spread sheet and analyzed. Frequency and present values were computed for qualitative variables. Mean values were compared using analysis of variance. Frequency distributions were compared using Chi-square/Fisher's exact test as appropriate. Sensitivity and specificity analyses were done for comparing umbilical artery (UA) and middle cerebral artery (MCA) Doppler indices and cerebroplacental ratio was calculated.

RESULTS

Total 720 antenatal women who fulfilled the inclusion and exclusion criteria with consent were studied. They were divided into study group (N=360) with IUGR on sonography and control group (N=360) without IUGR.

Demographics

Maximum number of cases were between 20-29 years age group in study (87.8%), as well as in control group (92.7%). In age group >35 years incidence of IUGR was highest i.e. 75%. Most of cases were un-booked in both study (83.9%) and control group (73.3%). Out of all the un-booked cases, 53.35% were found to be having IUGR (p=0.0008).

IUGR was more common in illiterate cases (52.4%). Among labourers, 59.63% women were found to be having IUGR foetuses (p=0.0175).

Incidence of IUGR was higher in lower socioeconomic status (54.21%) (p=0.0139).

Among underweight women, 63.63% were found to be having IUGR. Similarly among obese women, 61.53% were having IUGR. Incidence of IUGR was highest in grand multipara (63.63%).

The study shows that majority of women are primigravida in both study (54.44%) and control group (62.2%).

Incidence of IUGR was higher in grand multipara (63.63%).

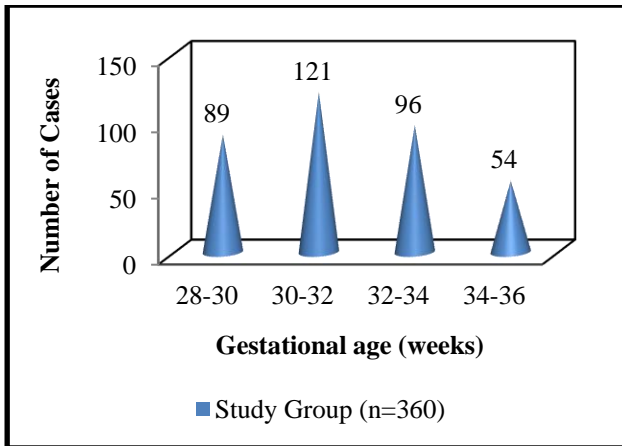


Figure 1: Distribution of cases according to gestational age.

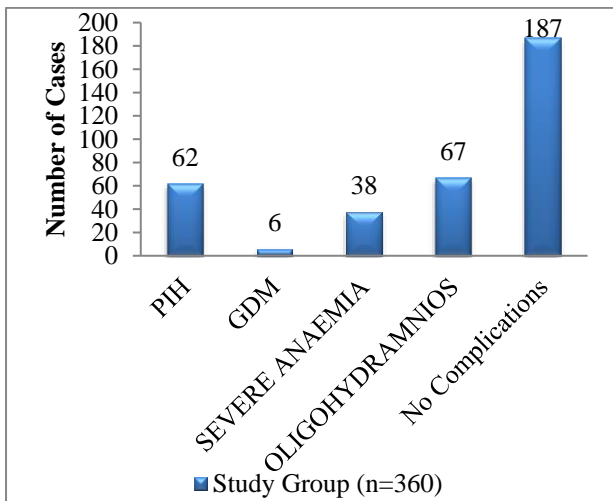


Figure 2: Distribution of cases according to maternal complications.

In study group, out of 360 cases, 48.1% of women had some maternal complications. Incidence of IUGR was 71.2%, 60%, 77.5% and 80.72% in cases of pregnancy-induced hypertension (PIH), gestational diabetes mellitus (GDM), severe anaemia and oligohydramnios respectively.

Most of the cases in the study as well as control group were delivered at term gestational age (GA) (>37 weeks) i.e. 80.6% and 91.9% respectively.

Incidence of preterm delivery was higher in study group which was 19.4%.

Incidence of stillbirth, intrauterine device (IUD), early neonatal death and late neonatal death was more in study group (1.6%, 1.1%, 5.3% and 0.83%) as compared to

control group (0.27%, 0.5%, 1.66% and 0.27%) respectively.

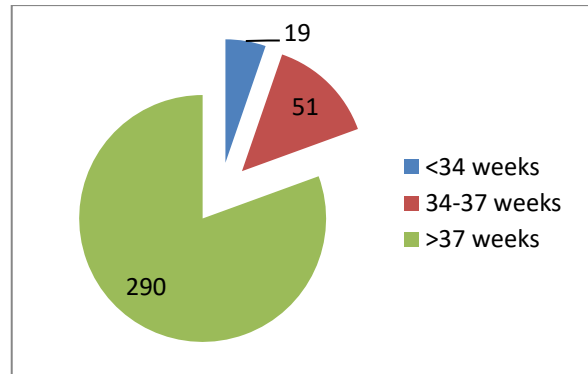


Figure 3: Gestational age at delivery in the study group

Majority of women had term vaginal delivery in both study (58.05%) and control group (83.9%). Percentage of caesarean was higher in the study group (31.7%) as compared to the control group (11.1%).

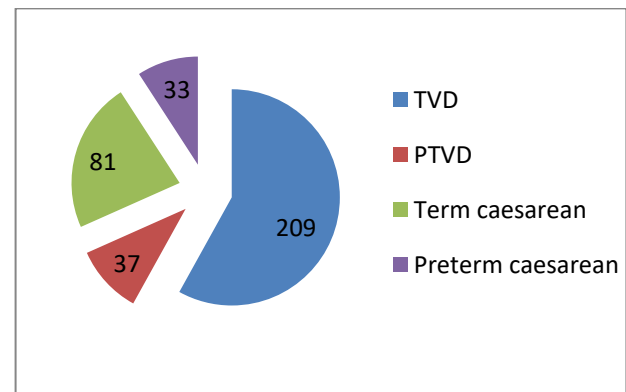


Figure 4: Mode of delivery in the study group.

Maximum babies had birth weight between 2-2.5 kg in study (54.44%) and 2.5-3 kg in control group (55.3%).

Incidence of birth weight below 2 kg was 15.83% in study group and 4.4% in control group.

14.72% of babies in study group were admitted in neonatal intensive care unit (NICU) for less than seven days and 7.5% were admitted for longer.

Biometry

In study group abdominal circumference (AC) was the most reliable indicator for diagnosing IUGR i.e. in 91.1% of study cases AC was below 10th centile. Head circumference (HC) and femur length (FL) were found to be less than 10th centile in 10.8% and 3.3% of cases respectively.

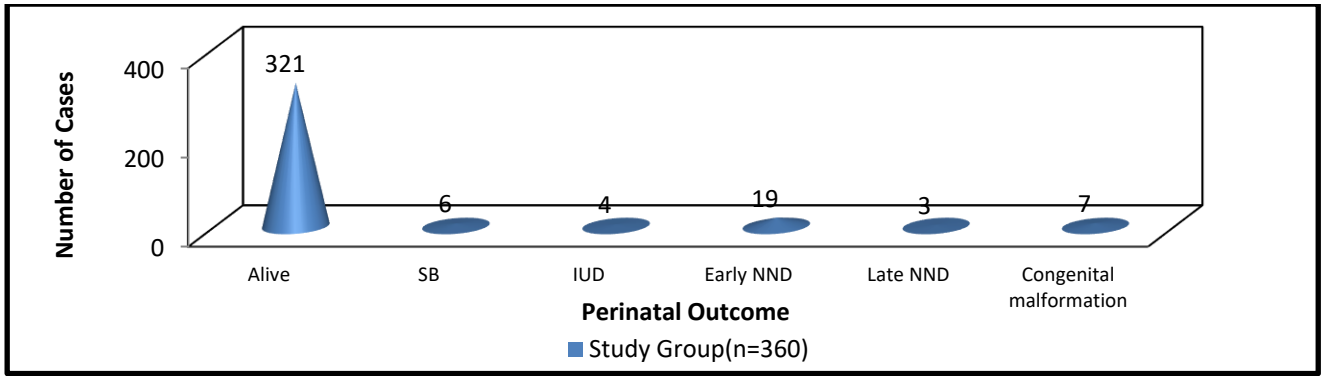


Figure 5: Distribution of cases according to perinatal outcome.

Table 1: Distribution of cases according to perinatal complications.

Perinatal complications	Study group (N=360)		Control group (N=360)	
	N	%	N	%
Respiratory distress syndrome	26	7.2	7	1.9
Meconium aspiration syndrome	8	2.2	2	0.5
Hypoglycemia	4	1.1	1	0.27
Hypothermia	3	0.83	1	0.27
Hyperbilirubinemia	7	1.9	2	0.5
Hypocalcaemia	2	0.5	0	0
Haematological complications	6	1.6	2	0.5
Necrotizing enterocolitis	3	0.83	1	0.27
Septicemia	2	0.5	1	0.27
No complication	299	83.05	343	95.27
Total	360	100	360	100

$\chi^2=28.466$, $p=0.0008$, significant

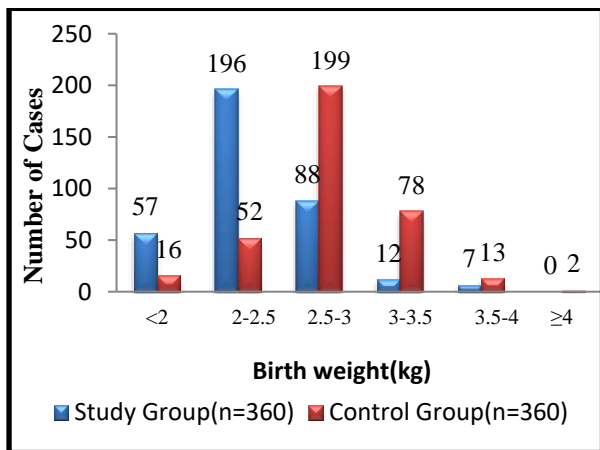


Figure 6: Distribution of cases according to birth weight.

HC/AC ratio was >1 in 64.7% of cases making most of the cases asymmetrical IUGR.

Among study group, 14.4% had amniotic fluid index (AFI) <5 suggesting oligohydramnios. In control group only 4.4% had AFI <5 . Incidence of IUGR in oligohydramnios is 76.47%.

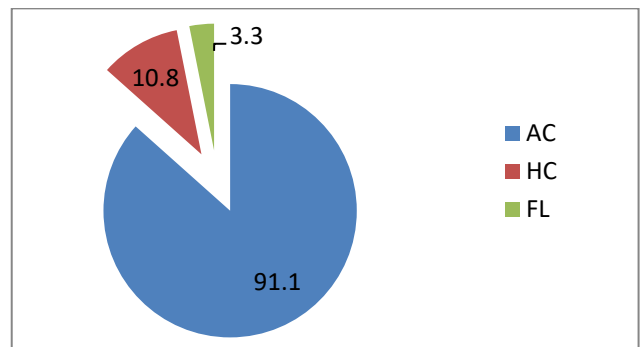


Figure 7: USG parameter below 10th centile.

Table 2: Distribution of cases according to 3rd trimester USG AFI.

AFI	Study group (N=360)		Control group (N=360)	
	N	%	N	%
<5 (oligo)	52	14.4	16	4.4
>5	303	84.1	341	94.7
>25 (poly)	5	1.3	3	0.8
Total	360	100	360	100

$\chi^2=21.801$, $p\leq 0.0001$, significant

Doppler indices

Table 3: Evaluation of umbilical artery PI in prediction of perinatal outcome.

UA PI	Admitted	Not admitted	Total
Abnormal PI (>95th percentile)	68	35	103
Normal PI	12	245	257
Total	80	280	360

Sensitivity of umbilical arterial pulsatility index (UA PI)-85.71%, specificity-87.6%, predictive value of a positive test-66.01%, predictive value of a negative test-95.3%

Table 4: Evaluation of MCA PI in prediction of perinatal outcome.

MCA PI	Admitted	Not admitted	Total
Abnormal PI (<5th percentile)	56	51	107
Normal PI	24	229	253
Total	80	280	360

Sensitivity of middle cerebral artery pulsatility index (MCA PI)-70%, specificity-81.8%, predictive value of a positive test-52.33%, predictive value of a negative test-90.51%

Table 5: Evaluation of cerebro-placental ratio in prediction of perinatal outcome.

CPR	Admitted	Not admitted	Total
Abnormal (<1 percentile)	72	30	102
Normal (>1)	8	250	258
Total	80	280	360

Sensitivity of cerebro-placental ratio (CPR)-90.1%, specificity-89.9%, predictive value of a positive test-70.6%, predictive value of a negative test-96.8%

DISCUSSION

The demographic factors in our study were similar to those in other studies like IUGR was common with extremes of age, women with lower socioeconomic status, who were unbooked, with poor literacy levels, belonging to rural areas and in women with heavy physical work. Similar results were found in the studies done by Lean et al, Ravikumar et al, Odibo et al and Kramer's meta-analysis.⁷⁻¹⁰

Incidence of IUGR was highest among women with body mass index (BMI) <18.5 i.e. 63.3% showing that IUGR is common among women with poor nutritional status. This is similar in the study done by Acharya et al and Kramer's meta-analysis.^{10,11}

Incidence of IUGR was very high with associated maternal complications such as PIH, GDM, severe anaemia and

oligohydramnios. The main reason is the compromised utero-placental circulation in these conditions. This was consistent with studies done by Bassetty et al and Morris et al.^{12,13}

Number of early and late pre-term deliveries was higher in the study group. The incidence of caesarean section was also higher in the IUGR cases (31.7%) as compared to the control group (11%). This was similar to the study done by Ryan et al.¹⁴

Perinatal outcome was poorer in the IUGR babies as evident by increased still births, IUDs, early and late neonatal deaths and congenital malformations. It was observed that respiratory distress was a major confounding factor in causing early neonatal deaths. Unterscheider et al conducted the prospective observational trial to optimise paediatric health in IUGR (PORTO) on 1,200 singleton pregnancies and found that fetal growth restriction is the single most important contributor to perinatal mortality in non-anomalous fetuses.¹⁵ The rate of NICU admission was also higher in the IUGR cases which is similar to result found by Sharma et al.¹⁶

On routine third trimester ultrasound 360 women ultrasound were found with IUGR. AC was the single most parameter abnormal in most of the cases i.e. in 91.1%. It is similar to the studies done by Larciprete et al and Baschat et al.^{17,18}

In our study, 150 cases were at more than 32 weeks of gestation. Out of these cases 64.7% had HC/AC ratio below one making them cases of asymmetrical IUGR. In a study by Vandenbosche et al. An HC/AC ratio of greater than one detects about 85 percent of growth-restricted fetuses.¹⁹ The percentage of IUGR in cases with oligohydramnios is very high indicating its close association with the condition similar to study done by Morris et al.¹³

All the cases diagnosed as IUGR on examination and ultrasound biometry were studied with color Doppler and followed for the perinatal outcome, which included NICU admissions, IUD, still births, early and late neonatal deaths.

The S/D ratio, PI and resistive index (RI) of UA and MCA were studied with respect to the perinatal outcome. We deduced that sensitivity, specificity, positive predictive and negative predictive value of UA PI were greater than MCA PI, making it a better diagnostic indicator. This was consistent with result of the study done by Khanduri et al on 60 antenatal women, where he found that the PI of the umbilical artery was more sensitive than the PI of the middle cerebral artery.²⁰ UA PI has the maximum overall diagnostic accuracy of 75%. Same result was obtained by a study done by Malik et al.²¹

The CPR is calculated by dividing the Doppler indices of the MCA by the UA and represents the interaction of

alterations in blood flow to the brain as manifest by increased diastolic flow as the result of cerebrovascular dilation resulting from hypoxia and increased placental resistance, resulting in decreased diastolic flow of the UA.

In our study sensitivity, specificity, positive and negative predictive value of CPR was the highest making it a very important diagnostic and prognostic indicator. Similar results were observed by Ray and Singh et al, Gandhi et al and DeVore.²²⁻²⁴

CONCLUSION

Majority of the cases of IUGR can be detected on an early routine third trimester ultrasound and growth of the foetus can be followed on serial ultrasound. Further if we study the placento-fetal circulation by the various Doppler indices, any stress on the foetus can be determined timely and we can plan the time and mode of delivery to give the best possible perinatal outcome.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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