Original Article
What is the necessity of cesarean section in the fetus with growth restriction or abnormal umbilical artery flow indices? A retrospective cohort study

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Abstract: Objective: To evaluate the necessity of cesarean section in the fetus with growth restriction or abnormal umbilical artery flow indices. Methods: An ultrasound database from a single hospital was reviewed for cases of intrauterine growth restriction and abnormal umbilical artery flow indices over a 7 year period (2007-2013). All identified cases were then searched in the electronic medical record for delivery details. The outcome of interest was need for cesarean delivery in the group of patients that attempted a vaginal delivery. Results: 38 women with singleton pregnancies with intrauterine growth restriction or abnormal umbilical artery Doppler velocities, or both, attempted vaginal delivery. Of these women 32 (84%) had a vaginal delivery. Conclusion: Patients with growth-restricted fetuses have a high rate of vaginal delivery when this is attempted. Information is limited on the feasibility of vaginal delivery in the setting of absent end-diastolic flow or reversed end-diastolic flow in the umbilical arteries. Though other factors should be taken into consideration, the presence of growth restriction or abnormal umbilical artery Doppler velocimetry alone should not prompt the physician to recommend a cesarean section.

Keywords: Intrauterine growth restriction, absent end-diastolic flow, reversed end-diastolic flow, increased systolic/diastolic ratio, cesarean

Introduction

Fetuses with intrauterine growth restriction (IUGR) are defined as those achieving growth <10\textsuperscript{th} percentile for gestational age. Possible etiologies of abnormal growth include insufficient placenta, a fetus affected by a genetic condition, exposures such as teratogens or infections or a constitutionally small fetus. Clinical adjuncts to help the physician assess for growth abnormalities include serial growth ultrasounds and Doppler assessment of the fetal umbilical arteries [1]. A fetus with IUGR or a fetus noted to have an increased systolic/diastolic (S/D) ratio, absent end-diastolic flow (AEDF) or reversed end-diastolic flow (REDF) may have abnormal placenta. These fetuses have been found to have poorer outcomes when compared to those of a similar gestational age without these findings.

When IUGR or abnormal umbilical artery Doppler flow velocities are detected, the question of which mode of delivery is appropriate arises. Fetuses with IUGR may be less likely to tolerate labor and may be best delivered by cesarean. We performed a retrospective cohort study of all cases identified at our hospital over a 7 year period. We reviewed delivery methods and neonatal outcomes.

Materials and methods

The ultrasound database at a single center was searched for all cases of IUGR fetuses between 2007 and 2013. Cases with the reported diagnosis of “intrauterine growth restriction (IUGR)”, “absent end-diastolic flow (AEDF)” and “reversed end-diastolic flow (REDF)” were included. IUGR was defined as fetal weight <10\textsuperscript{th} percentile or if the fetus had all four growth parameters (head circumference, abdominal circumference, biparietal diameter and femur length) less than the 10\textsuperscript{th} percentile but the formula applied calculated their weight to be ≥10\textsuperscript{th} percentile.
Inclusion criteria were a live fetus, growth abnormality or Doppler abnormality noted and available delivery data. Exclusion criteria were multiple pregnancies, pregnancies in which the fetus had a known lethal congenital abnormality, and pregnancies for which delivery data was not available. Included cases with IUGR but without AEDF/REDF were assessed for S/D ratio of the umbilical artery Doppler. Cases identified were then searched in the electronic medical record for clinical data inclusive of umbilical artery Doppler indices and non-lethal anomalies and delivery data inclusive of onset of labor (spontaneous or induced) and mode of delivery.

Cases were divided into groups: IUGR with normal umbilical artery Doppler indices, IUGR with an increased S/D ratio, defined as an S/D ratio $\geq 3.0$, IUGR with AEDF, IUGR with REDF, and normal fetal growth with abnormal Doppler findings. Following this, the delivery data was assessed per group.

The possible methods of delivery were cesarean delivery without an attempt at vaginal delivery, induced or spontaneous labor followed by vaginal delivery, or induced or spontaneous labor followed by cesarean delivery.

Cases were included in the ‘cesarean delivery without an attempt at vaginal delivery’ category if they had a cesarean for non-reassuring fetal assessment during the antenatal period (for example an outpatient NST) or if they went into spontaneous labor but were not allowed to labor (for example a patient with a history of a cesarean who did not desire a trial of labor after cesarean section). Cases were also included in this category if the patient elected to have a cesarean delivery.

Cases were included in the ‘spontaneous labor’ category if they presented with contractions or with rupture of membranes, whether or not they required augmentation of labor.

Cases were included in the ‘induced labor’ category if they presented without complaints of labor or rupture of membranes. Apgar scores were collected for each neonate.

**Results**

There were 77 singleton pregnancies identified. Two of these patients were found to have fetal losses on a subsequent visit after they received the diagnosis of IUGR; one was a 26 week 235 g fetus and the other a 24 week 195 g fetus. A third fetus was delivered after induction of labor 22 weeks of gestation. These three cases were excluded from analysis. Two additional pregnancies were excluded as they were coded on ultrasound records to have ‘IUGR’ or ‘abnormal Doppler indices’ but were on chart review found to have fetal growth at or above the 10th percentile and at least one of the four growth indices (abdominal circumference, head circumference, biparietal diameter and femur length) in the normal range, and normal Doppler indices. There were 7 patients included who had normal fetal growth overall but abnormal Doppler findings (increased S/D ratio, AEDF or REDF) noted on the ultrasound report. They remained in the analysis. There was one fetus with growth <10th percentile on an initial ultrasound. This growth abnormality was noted to be ‘resolved’ on a subsequent examination. Doppler indices were not reported on this patient. This patient was analyzed as ‘IUGR with normal Doppler indices’ and went on to deliver a small for gestational age fetus at 37 weeks. Thus after the exclusions, there remained 72 fetuses for analysis.

When divided into groups, there were 25 patients with singleton pregnancies who had the diagnosis of IUGR without umbilical artery Doppler abnormalities. Twenty attempted a vaginal delivery and 18 delivered vaginally. The two patients requiring cesarean during an attempt at vaginal birth underwent abdominal delivery for non-reassuring fetal assessment (Table 1).

There were 28 patients with IUGR and an S/D ratio of $\geq 3.0$. Sixteen attempted a vaginal delivery and 13 delivered vaginally. The indication for cesarean in the three unplanned abdominal deliveries was non-reassuring fetal assessment.

There were 5 patients with a singleton pregnancy complicated by IUGR and AEDF. All were delivered by cesarean section. However, four never attempted a vaginal delivery, with the fifth undergoing an induction of labor and then a cesarean for non-reassuring fetal assessment.

All patients with singleton pregnancies complicated by IUGR and REDF (n=7) were delivered by cesarean section without an attempt at vaginal delivery.
There were 7 pregnancies with weight at or above the 10th percentile (range 18th percentile to 32th percentile) without all four growth parameters being less than the 10th percentile (described above) in which Doppler indices were abnormal. Three had AEDF and 4 had REDF. After delivery, 4 of the neonates from this group did have a normal birth weight (13th, 18th, 19th and 38th percentile), whereas 3 had a birth weight less than the 10th percentile for their gender and gestational age (6th, 7th and 7th percentiles) [2]. Most of these patients did not attempt vaginal delivery with 6 having planned cesarean sections (one had a planned cesarean section after presenting in labor). One patient underwent an induction of labor with a fetus with normal growth and AEDF, and delivered vaginally.

There were 13 singleton gestations in which a neonate had an Apgar score of less than 7 at 5 minutes. These neonates are reported in Table 2. Ten of the neonates were in the ‘cesarean delivery without an attempt at vaginal delivery’ group and three were in the ‘attempt at vaginal delivery’ group. Twelve of the 13 infants were delivered by cesarean.

Additional fetal diagnoses were identified in the charts of 20 fetuses. These diagnoses included fetal arrhythmias and non-lethal structural and chromosomal abnormalities. Attempts at vaginal delivery were not precluded by the presence of a fetal anomaly with 8 of 12 patients attempting a vaginal delivery being successful.

Discussion

Our findings suggest that a vaginal delivery can be successful in women attempting this in the setting of IUGR and/or abnormal umbilical artery Doppler indices. There are several possible explanations as to why patients attempting vaginal delivery were successful in our cohort. One is that the chance of abnormal fetal heart rate tracing is low in the patient population studied. Another explanation may be a ‘high tolerance’ for Category II fetal tracings at the hospital at which this study was carried out, which has a cesarean section rate of 22%. This likely reflects a patient population desirous of vaginal delivery in combination with academic faculty committed to a low cesarean section rate. These results may not be reproducible in other centers. Apgar scores were used as a surrogate for fetal compromise and as shown above. Vaginal delivery was not associated with low Apgar scores.

Strengths of our study are the number of cases available for analysis. This was made possible by the electronic storage of a case list of eligible patients through the ultrasound department.

Weaknesses of this study include the retrospective nature of the work. There is the possibility that important clinical data was missed that would have been collected in a prospective series or in a randomized trial. Not all confounding factors were taken into consideration in our cohort. Perhaps the most important confounder - a patient who does not plan an attempt at vaginal delivery was considered, however other factors such as parity and comorbid conditions were not a part of the analysis. Additionally, there was no assessment of the fetal heart rate tracings as a part of this protocol, so no comment can be made as to the information available during the course of labor in these fetuses.

The researcher identified some charts with the descriptor ‘IUGR’ when the fetus was not in fact growth restricted using a definition of weight <10th percentile or of all four parameters for growth (head circumference, abdominal circumference, biparietal diameter and femur length) being <10th percentile with a ‘normal’ abstracted fetal weight. Seven of these fetuses were found to have abnormal Doppler velocity assessments in the umbilical artery and were hence left in the analysis. The reason for umbilical artery Doppler velocimetry being performed in these pregnancies seemed to be because of asymmetric (but technically normal) growth in several cases and without an easily identifiable

<table>
<thead>
<tr>
<th>Table 1. Route of delivery by category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Growth</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>IUGR</td>
</tr>
<tr>
<td>IUGR</td>
</tr>
<tr>
<td>IUGR</td>
</tr>
<tr>
<td>IUGR</td>
</tr>
<tr>
<td>Normal</td>
</tr>
</tbody>
</table>

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## Cesarean in growth restriction

<table>
<thead>
<tr>
<th>Patient category</th>
<th>Reason for cesarean</th>
<th>Indication for cesarean</th>
<th>Gestational Age (weeks)</th>
<th>Birth weight (grams)</th>
<th>Apgars (1, 5, 10 min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IUGR, Normal Dopplers</td>
<td>Induction, unplanned cesarean</td>
<td>NRFHT</td>
<td>32 weeks</td>
<td>Not listed</td>
</tr>
<tr>
<td>2</td>
<td>IUGR, Increased S/D ratio</td>
<td>Induction, epidural administered only</td>
<td>NRFHTs</td>
<td>32 weeks</td>
<td>555 g</td>
</tr>
<tr>
<td>3</td>
<td>IUGR, Increased S/D ratio</td>
<td>Spontaneous labor, vaginal delivery</td>
<td>N/A</td>
<td>26 weeks</td>
<td>610</td>
</tr>
<tr>
<td>4</td>
<td>IUGR, Increased S/D ratio</td>
<td>Spontaneous labor, no attempt at vaginal delivery</td>
<td>Transverse lie, NRFHTs</td>
<td>35 weeks</td>
<td>1710 g</td>
</tr>
<tr>
<td>5</td>
<td>IUGR, AEDF</td>
<td>Planned cesarean</td>
<td>History of cesarean</td>
<td>26 weeks</td>
<td>530 g</td>
</tr>
<tr>
<td>6</td>
<td>IUGR, AEDF</td>
<td>Planned cesarean</td>
<td>AEDF</td>
<td>26 weeks</td>
<td>600</td>
</tr>
<tr>
<td>7</td>
<td>IUGR, REDF</td>
<td>Planned cesarean</td>
<td>REDF</td>
<td>25 weeks</td>
<td>470 g</td>
</tr>
<tr>
<td>8</td>
<td>IUGR, REDF</td>
<td>Spontaneous labor, no attempt at vaginal delivery</td>
<td>REDF, Breech</td>
<td>31 weeks</td>
<td>520 g</td>
</tr>
<tr>
<td>9</td>
<td>IUGR, REDF</td>
<td>Planned cesarean, NRFHTs</td>
<td>REDF, Placenta previa</td>
<td>26 weeks</td>
<td>530 g</td>
</tr>
<tr>
<td>10</td>
<td>IUGR, REDF</td>
<td>Emergent cesarean (not in labor)</td>
<td>NRFHTs during antenatal testing</td>
<td>26 weeks</td>
<td>535 g</td>
</tr>
<tr>
<td>11</td>
<td>IUGR, REDF</td>
<td>Emergent cesarean (not in labor)</td>
<td>NRFHTs during antenatal testing</td>
<td>26 weeks</td>
<td>700 g</td>
</tr>
<tr>
<td>12</td>
<td>Normal growth, REDF</td>
<td>Planned cesarean</td>
<td>History of cesarean</td>
<td>25 weeks</td>
<td>540 g</td>
</tr>
<tr>
<td>13</td>
<td>Normal growth, REDF</td>
<td>Planned cesarean</td>
<td>REDF</td>
<td>28 weeks</td>
<td>1120 g</td>
</tr>
</tbody>
</table>

*N/A (Not applicable), NRFHTs (Non-reassuring fetal heart tones).*
Cesarean in growth restriction

reason in others. The identification of REDF in a large proportion of these fetuses may indicate that Doppler abnormalities precede growth restriction rather than occur concurrently with it and that Doppler may be useful in a wider range of clinical scenarios than growth restriction alone.

As the cases were identified from antenatal ultrasounds, there may be some ascertainment bias; fetuses that were not suspected to be growth-restricted before delivery but subsequently found to be <10th percentile for birth weight would not have been identified for study. In these cases, the clinician would not likely have altered their management of the pregnancy as they did not know about the eventual diagnosis.

A significant proportion of the pregnancies in this study were delivered by cesarean section without an attempt at vaginal delivery. This happened for a variety of reasons: previous cesarean section, patient or provider preference and malpresentation. In fact, there were 5 patients who underwent cesarean section after presenting in spontaneous labor. Four of these had a fetal presentation other than cephalic listed on their operative reports and one declined a trial of labor after cesarean section. For these reasons, we have included calculations based on the number attempting vaginal delivery after both spontaneous and induced labor. However, it is unknown how the patients in the planned cesarean group would have behaved clinically had they attempted vaginal deliveries.

IUGR has a known association with other fetal pathology as well as maternal medical conditions either predating or complicating pregnancy [3-5]. Selection bias was certainly possible in this cohort in relation to the patients chosen by providers to attempt a vaginal birth. Indeed, 100% of fetuses with REDF were delivered by cesarean section without an attempt at vaginal delivery. Additionally, several of the patients in the ‘emergent’ cesarean category underwent their deliveries after an abnormal antenatal fetal assessment, in effect removing them from those who could attempt labor as it was thought to be unsafe to administer uterotonic agents.

An additional weakness is the lack of outcome data for the fetuses in this cohort. Though we used the Apgar scores as the determinant of fetal wellbeing during labor, we do not have follow up data on the neonates delivered either via cesarean or vaginal delivery. Though cord blood gas assessment was recommended in this cohort of patients, so few were performed on the neonates we studied that meaningful assessments could not be undertaken in relation to cord gas parameters. Longer-term complications of either mode of delivery would not have been identified in this cohort as we did not assess neonatal outcomes other than those immediately after delivery. Previous work has shown an association between low Apgar scores and a decreased chance of survival in growth-restricted fetuses [6]. However, the use of Apgar scores alone is poorly predictive for long-term neonatal outcomes considering that many factors (gestational age, provider bias in assignment of scores) can affect their assignment. Interestingly, assessment of pregnancy management such as timing of delivery has not shown an association with cesarean section rate [7] or long term neonatal outcomes [8] in other studies.

Many of the patients with abnormal umbilical artery Doppler assessments underwent abdominal delivery without an attempt at labor. This creates a dilemma; would their fetuses have tolerated labor had it been attempted? Because of the small number of patients in our cohort that attempted labor from this category, the area requires additional study. We attempted to delineate which fetuses will tolerate labor by assessing fetuses with an increased S/D ratio, AEDF or REDF separately as we felt that this would allow delineation between ‘mild’, ‘moderate’ and ‘severe’ resistance in the placental vascular circuit. Our choice of an S/D ratio of 3.0 as the cutoff for ‘abnormal’ is similar to that used by other authors who have used a ratio of >3.0 [9-12]. However we acknowledge that this is an imperfect measure considering ‘normal’ S/D ratio values decrease as gestational age advances.

Lastly, though an attempt is made here to address a clinical problem in relation to the entire population at a single center, our center serves a mostly Caucasian and Hispanic patient population. The etiology of growth restriction may very well be different in other populations and our results may not apply in all ethnic groups.
Cesarean in growth restriction

Conclusion

Our research suggests that patients attempting a vaginal delivery in the setting of growth restriction is highly likely to be successful and that immediate fetal outcomes are equivalent to those delivered by cesarean. Allowing spontaneous or induced labor in these patients seems prudent. AEDF and REDF umbilical artery velocities may or may not be associated with fetal intolerance of labor as few patients with this finding attempted labor in this study. Future studies should focus on prospective cohorts to further address this area.

Disclosure of conflict of interest

None.

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References


