Sonographic Prenatal Diagnosis of Marginal Placental Cord Insertion

Clinical Importance

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Objective. To assess the impact of a sonographic diagnosis of marginal placental cord insertion on birth weight and duration of pregnancy. Methods. A retrospective chart review was performed for 100 singleton pregnancies with prospectively identified marginal placental cord insertion. Results. Birth weights below the 10th percentile occurred in 6.25% of pregnancies without preeclampsia. Spontaneous preterm delivery occurred in 7.3% of pregnancies without preeclampsia. Rates of birth weight below the 10th percentile and preterm delivery were not significantly different from those in the general population. Preeclampsia developed in 4 patients; all had elective preterm deliveries, and all gave birth to neonates with birth weights below the 10th percentile. Conclusions. A prenatal diagnosis of marginal placental cord insertion is not associated with increased risk of growth impairment or preterm delivery. Key words: sonography; cord; marginal; velamentous; growth restriction; preterm.

Abnormalities of placental cord insertion (PCI) have been linked to a variety of poor obstetric outcomes. Pathologic studies have shown velamentous PCI to be associated with increased rates of low birth weight, although this has been disputed by others. Increased rates of fetal malformation, preterm delivery, low Apgar scores, and intrapartum complications have also been noted with velamentous PCI. The link between vasa previa with its attendant poor outcomes and velamentous PCI is well established. Marginal PCI (variously described as a PCI 1–2 cm from the placental edge) has also been associated with fetal growth impairment and preterm delivery.

The use of color and power Doppler sonography together with gray scale sonography allows PCI to be identified with a high degree of specificity. Visualization of a PCI can be achieved in almost 100% of fetuses during the second trimester and has recently been extended into first-trimester imaging.
Although few would dispute the importance of antenatal detection of velamentous PCI, the importance of detection of marginal PCI is less clear. It has been suggested that a marginal PCI may evolve into a velamentous PCI\textsuperscript{10,11} with a corresponding increase in complications.

A PCI is routinely identified during obstetric sonography in our unit. This study was designed to evaluate the impact of prenatally diagnosed marginal PCI on birth weight and duration of pregnancy.

**Materials and Methods**

We performed a retrospective chart review of all patients imaged at the fetal diagnostic center at University of California, San Diego, between July 1998 and May 2000 in whom a diagnosis of marginal PCI was made. All patients were scanned as part of their routine care with an Elegra system (Siemens Medical Systems, Issaquah, WA). We defined marginal PCI as insertion of the umbilical cord within 2 cm from any placental edge. The PCI was localized as part of routine imaging as previously described.\textsuperscript{10} The following techniques were applied: (1) a 360° view of the PCI was obtained to assess the relationship of the PCI to all adjacent placental edges; (2) the cord vessels were identified entering placental parenchyma and not just lying adjacent to the placenta to avoid confusion with a free loop of cord; (3) the cord at the PCI was followed back into the amniotic cavity to avoid confusion with chorionic plate vessels; (4) color and power Doppler sonography were used freely as adjuncts to gray scale sonography; (5) maternal position was varied as required to facilitate imaging of the PCI; (6) if the PCI was not located readily, the entire placental surface was scanned to find it; and (7) all low-lying, bipartite or succinturiate lobed placentas were scanned with transvaginal color and power Doppler sonography to rule out vasa previa.

Patients with multiple gestations, velamentous PCI, or coexistent fetal anomalies were excluded from further study. The date of delivery, birth weight, and details of pregnancy and birth complications were obtained from chart review or telephone contact with the patient or her physician’s office.

Birth weights were plotted against gestational age at delivery and compared with previously published population data.\textsuperscript{14} Birth weights were converted into \( z \) scores with the use of the following formula:

\[
z = \frac{(a - b)}{c},
\]

where \( a \) was the actual birth weight (grams), \( b \) was the mean population birth weight at a specific gestational age of delivery (grams), and \( c \) was the SD of the mean population birth weight at that gestational age of delivery. We calculated mean birth weights for each specific gestational age \((b)\) using the formula:

\[
b = \frac{1}{9} x^3 + 28.47 x^2 - 456.6 x - 128.35,
\]

where \( x \) was the gestational age in weeks. We derived this formula from published population data\textsuperscript{14} by curve fitting \((R^2 = 0.9986)\). We calculated the 10th percentile \((d)\) for birth weight at each specific gestational age similarly by curve fitting the population data and deriving the formula:

\[
d = \frac{1}{9} x^3 + 116.94 x^2 - 3678.8 x + 37766
\]

\((R^2 = 0.9998)\). We calculated the SD \((c)\) of the birth weight at each specific gestational age using these values and the formula:

\[
c = \frac{(b - d)}{1.28}.
\]

Thus a \( z \) score of 0 would indicate that the neonate’s birth weight was equal to the average birth weight for that gestational age. A \( z \) score of +1 or −1 was equal to a birth weight 1 SD above or below the mean. We took a \( z \) score of −1.28 or less to indicate growth impairment, because birth weights yielding \( z \) scores at or less than this value fell below the 10th percentile for each gestational age.

We assessed curve fitting by regression analysis \((R^2)\). The \( z \) scores for the study subjects were compared with \( z \) scores calculated for the reference population by using analysis of variance; significance was accepted at \( P < .05 \).

The Institutional Review Board of University of California, San Diego, approved this study.

**Results**

Data from 100 women with a prenatal diagnosis of marginal PCI were available for review. The mean age of the women in the study \( \pm \) SD was...
34.1 ± 0.8 years; 82% were white, 15% were Asian, and 3% were black. The most common reason for referral was maternal age older than 35 years (66%). The mean gestational age at the time of diagnosis was 18.7 ± 2.7 weeks (range, 13.6–31.1 weeks).

The sonographic appearances of a typical marginal cord insertion are shown in Figure 1.

The birth weights of all 100 study neonates are shown plotted against gestational age in Figure 2. The curves shown are derived from published data for birth weight by gestational age obtained from 3,134,879 singleton live births in the United States in 1991.14 A total of 90 infants had birth weights above the 10th percentile for gestational age (open circles), and 10 infants had birth weights below the 10th percentile (closed circles); 7 of 10 had birth weights below the 5th percentile.

Four women had pregnancies complicated by preeclampsia. All gave birth to neonates with birth weights below the 10th percentile; 3 of 4 had birth weights below the 5th percentile.

The mean z score for all 100 neonates was –0.15 ± 0.96. This was not significantly different from that calculated for the mean population birth weight, \( z = 0 \pm 1.0 \) (\( P = .13 \), analysis of variance). If the 4 patients with preeclampsia were excluded from the analysis, the mean z score for the remaining 96 neonates was –0.09 ± 0.89. Again, this was not significantly different from that calculated for the mean population birth weight, \( z = 0 \pm 1.0 \) (\( P = .33 \), analysis of variance).

All 10 neonates whose birth weights fell below the 10th percentile had z scores of –1.28 or less (range, –2.68 to –1.29).

Preterm delivery at less than 37 weeks’ gestation occurred in 11 patients. The gestational age at delivery, birth weight, z score, and birth weight percentile are shown for these neonates in Table 1. Four patients had delivery induced before 37 weeks for preeclampsia. The remaining 7 patients gave birth between 32.4 and 36.6 weeks (mean, 35.2 weeks), for a preterm delivery rate of 7.3%.

**Discussion**

Marginal PCI was not associated with a significant increase in the rate of fetal growth impairment in this study. Furthermore, there was no increase in the rate of spontaneous preterm delivery in our patients.

Intrauterine growth restriction is commonly defined on the basis of a calculated fetal weight below the 10th percentile for gestational age. Similarly, small for gestational age is a term applied to neonates whose birth weight is below the 10th percentile for a given gestational age. Despite these definitions, the actual prevalence of intrauterine growth restriction is 4% to 7% after correction for low maternal weight, paternal phenotype, or residence at higher altitudes.15

Assessment of growth impairment is further complicated by the variety of standards of fetal growth used both clinically and in a research set-

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**Figure 1.** A, Gray scale image of marginal PCI at 20 weeks’ gestation. The umbilical cord is inserted 1.1 cm from the placental edge. B, Color Doppler image of a marginal PCI at 20 weeks’ gestation. The umbilical cord is inserted 1.35 cm from the placental edge.
In this study we used the data of Alexander et al.\textsuperscript{14} as our standard for comparison. That study collated birth weights from all live singleton births in the United States in 1991 and is the most current national reference data set available. Data from a similarly large number of deliveries in California between 1970 and 1976 are also available\textsuperscript{16} and could also be used as a reference data set for comparison. In our own nursery, birth weights are routinely plotted on a standard curve derived from data of Usher and McLean\textsuperscript{17} from Montreal between 1959 and 1963.

We compared our study data with all 3 of the above-mentioned reference data sets and found surprisingly similar results. On the basis of the data of Usher and McLean,\textsuperscript{17} there were 8 infants with birth weights below the 10th percentile. The California data set\textsuperscript{16} gave us 9 infants with birth weights below the 10th percentile, and the national data set gave us a total of 10 infants with growth impairment. We opted to use only the national data set for our comparisons in this paper, because we did not want to miss a potential effect of marginal PCI by lack of stringency in our choice of a reference data set. We acknowledge that any of the published databases could have been used with equal justification.

Four of our patients had elective delivery before term for preeclampsia. All of the neonates born to these mothers had growth impairment (3 had birth weights below the fifth percentile). Because there is a well-established association between preeclampsia and growth impairment, we would argue that these patients should not be included in the calculations of the effect of marginal PCI on fetal growth. When these patients were excluded from the analysis, only 6 infants had birth weights below the 10th percentile (6 [6.25\%] of 96); this is well within the expected rate of growth impairment seen in the general population without marginal PCI.

Some authorities have argued that only birth weights below the fifth percentile or less than 2 SD below the mean (2.5 percentile) should be used to define growth impairment. If we were to apply such a standard to the patients without preeclampsia in the present series, only 4 infants would have had birth weights below the fifth percentile.

Table 1. Gestational Age, Birth Weight, $z$ Score, and Birth Weight Percentile for 11 Patients With Marginal PCI Having Delivery Earlier Than 37 Weeks

<table>
<thead>
<tr>
<th>Gestational Age, wk</th>
<th>Birth Weight, g</th>
<th>$z$ score</th>
<th>Birth Weight Percentile</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.3</td>
<td>1000</td>
<td>-1.59</td>
<td>6th</td>
<td>Induced for preeclampsia</td>
</tr>
<tr>
<td>31.4</td>
<td>1615</td>
<td>-0.83</td>
<td>20th</td>
<td>Induced for preeclampsia</td>
</tr>
<tr>
<td>32.4</td>
<td>1861</td>
<td>-0.78</td>
<td>22nd</td>
<td>None</td>
</tr>
<tr>
<td>33.9</td>
<td>2778</td>
<td>0.33</td>
<td>63rd</td>
<td>None</td>
</tr>
<tr>
<td>34.9</td>
<td>1692</td>
<td>-2.13</td>
<td>2nd</td>
<td>None</td>
</tr>
<tr>
<td>35.4</td>
<td>2948</td>
<td>0.06</td>
<td>47th</td>
<td>Induced for preeclampsia</td>
</tr>
<tr>
<td>35.7</td>
<td>2750</td>
<td>-0.4</td>
<td>34th</td>
<td>None</td>
</tr>
<tr>
<td>36</td>
<td>2409</td>
<td>-1.18</td>
<td>12th</td>
<td>None</td>
</tr>
<tr>
<td>36.1</td>
<td>2381</td>
<td>-1.29</td>
<td>9th</td>
<td>None</td>
</tr>
<tr>
<td>36.6</td>
<td>2920</td>
<td>-0.36</td>
<td>36th</td>
<td>None</td>
</tr>
<tr>
<td>36.6</td>
<td>2041</td>
<td>-2.15</td>
<td>2nd</td>
<td>Induced for preeclampsia</td>
</tr>
</tbody>
</table>
We found no association between marginal PCI and the prevalence of preterm delivery in our study population. There were 11 deliveries before 37 weeks. Four patients had induced delivery for preeclampsia; the remaining 7 gave a spontaneous preterm delivery rate of 7.3% (7 of 96). The preterm delivery rate in the United States at present is between 9% and 11%. Rates are lowest in white women and highest in black women. Further increases are seen in women at the extremes of child-bearing age. The mean age in our study population was 34.1 years; expected rates of preterm delivery would be 7.5% for white women and 16.5% for black women in this age group. Thus no significant increase in the preterm delivery rate was observed in association with marginal PCI.

Here we report obstetric outcomes in women with marginal PCI identified prospectively on sonography. To our knowledge, prior studies of the effects of marginal PCI have been based on pathologic examination of placentas. We did not examine the placentas of our patients after delivery and therefore cannot confirm our prenatal diagnosis of marginal PCI. However, we contend that a finding of a marginal PCI based on placental examination after delivery is of little use in antenatal management. This study shows that an isolated sonographic finding of a marginal PCI in a singleton pregnancy carries no increased risk of growth impairment or preterm delivery and thus does not warrant any further imaging or fetal testing.

It has been suggested that a marginal PCI may progress to a velamentous PCI. We cannot address that issue in this study, because we did not examine the placentas after delivery. We used a 2-cm cutoff for PCI to the placental edge as our diagnostic criterion for marginal PCI. It is possible that this cutoff was too liberal. It would seem likely that the closer the PCI is to the placental edge, the more likely it would be to progress to a velamentous PCI. It would seem prudent to continue to follow growth in pregnancies in which the PCI is very marginal but not quite velamentous; we suggest 0.5 cm as a suitable cutoff but acknowledge that this is not based on any data.

This study was limited to singleton pregnancies. The implications for marginal and velamentous PCI in multiple gestations are beyond the scope of this article, and our conclusions do not apply to such pregnancies.

We conclude that antenatal detection of a marginal PCI is not associated with an increased risk of growth impairment or preterm delivery. We suggest that pregnancies with PCIs less than 0.5 cm from the placental edge continue to be followed sonographically for fetal growth.

References

11. Di Salvo DN, Benson CB, Laing FC, Brown DJ, Frates MC, Doubilet PM. Sonographic evaluation of the


