**OBSTETRICS**

**Maternal morbidity in patients with morbidly adherent placenta treated with and without a standardized multidisciplinary approach**

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**OBJECTIVE:** The purpose of this study was to test the hypothesis that a standardized multidisciplinary treatment approach in patients with morbidly adherent placenta, which includes accreta, increta, and percreta, is associated with less maternal morbidity than when such an approach is not used (nonmultidisciplinary approach).

**STUDY DESIGN:** A retrospective cohort study was conducted with patients from 3 tertiary care hospitals from July 2000 to September 2013. Patients with histologically confirmed placenta accreta, increta, and percreta were included in this study. A formal program that used a standardized multidisciplinary management approach was introduced in 2011. Before 2011, patients were treated on a case-by-case basis by individual physicians without a specific protocol (nonmultidisciplinary group). Estimated blood loss, transfusion of packed red blood cells, intraoperative complications (eg, vascular, bladder, ureteral, and bowel injury), neonatal outcome, and maternal postoperative length of hospital stay were compared between the 2 groups.

**RESULTS:** Of 90 patients with placenta accreta, 57 women (63%) were in the multidisciplinary group, and 33 women (37%) were in the nonmultidisciplinary group. The multidisciplinary group had more cases with percreta ($P = .008$) but experienced less estimated blood loss ($P = .025$), with a trend to fewer blood transfusions ($P = .06$), and were less likely to be delivered emergently ($P = .001$) compared with the nonmultidisciplinary group. Despite an approach of indicated preterm delivery at 34-35 weeks of gestation, neonatal outcomes were similar between the 2 groups.

**CONCLUSION:** The institution of a standardized approach for patients with morbidly adherent placenta by a specific multidisciplinary team was associated with improved maternal outcomes, particularly in cases with more aggressive placental invasion (increta or percreta), compared with a historic nonmultidisciplinary approach. Our standardized approach was associated with fewer emergency deliveries.

**Key words:** invasive placenta, maternal complication, placenta accreta, placenta increta, placenta percreta, standard treatment


**Placenta accreta** is a major cause of postpartum hemorrhage and not only is associated with a 40% chance of requiring massive transfusion (>10 units of packed red blood cells [PRBCs]) but also carries a maternal mortality rate that has been reported to be as high as 6-7%. Placenta accreta results from abnormal invasion of the myometrium by chorionic villi and attempts to separate a placenta accreta manually from the underlying uterine wall frequently...
precipitates significant hemorrhage.\textsuperscript{5}

Based on the depth of the invasion and the amount of morbidity adherent placenta, hysterectomy frequently is performed as a life-saving procedure.\textsuperscript{6,7}

Placenta accreta is associated strongly with the combination of placenta previa and previous cesarean delivery.\textsuperscript{1,2,6}

Placenta accreta is now the leading cause of cesarean hysterectomy in developed countries.\textsuperscript{8}

A defined management strategy has been shown previously to decrease the morbidity from placenta accreta.\textsuperscript{9,10}

Prenatal diagnosis, multidisciplinary consultation, and predelivery planning for cesarean hysterectomy are reported to be of benefit in the reduction of complication rates and maternal blood transfusion.\textsuperscript{5} Such an approach is recommended particularly in cases of more aggressive placental invasion, such as placenta increta or percreta.\textsuperscript{11,12}

Planned preterm delivery\textsuperscript{13} and a staged procedure with intraoperative arterial embolization\textsuperscript{14} are 2 strategies that have also been reported to improve outcomes.

The technique of cesarean hysterectomy used in the management of the morbidity adherent placenta is different from that generally used for intractable uterine atony or uterine rupture. In the case of invasive placenta, the anatomy frequently is distorted; tissues are more friable; neovascularization is present; tissue planes are less defined, and massive hemorrhage are more likely. These factors worsen progressively with deeper placental invasion, which makes surgery for placenta percreta 1 of the most challenging operations in obstetric practice. This study introduces a potentially effective intervention strategy for management of placenta accreta, although sufficient confirmatory studies are already lacking in the literature.

The aim of this study was to evaluate our outcomes after implementation of a formal multidisciplinary management program in which standardized preoperative, intraoperative, and postoperative approaches were used. Our primary outcome measures were estimated blood loss (EBL), need for transfusion, and perinatal complications. We hypothesized that our multidisciplinary approach would result in reduced blood loss, decreased transfusion, and a decrease in preoperative, intraoperative, and postoperative complications.

**Materials and Methods**

A retrospective cohort study included all pregnancies with a histopathologically confirmed diagnosis of placenta accreta, increta, or percreta treated in 1 of 3 tertiary teaching hospitals for Baylor College of Medicine, Houston, TX, between January 2000 and September 2013. This study was approved by the Baylor College of Medicine Institutional Review Board.

A formal multidisciplinary management program was introduced in 2011 for known and suspected cases of morbidity adherent placenta. We instituted a standardized protocol with a multidisciplinary strategy (Figure). Briefly, the protocol included admission at 33 to 34 weeks of gestation, planned preterm delivery between 34 and 35 weeks of gestation, preoperative consultation, and prospective planning for maternal and neonatal care by the multidisciplinary team. All patients were admitted to the maternal-fetal medicine (MFM) service under the “percreta team” protocol and treated by an MFM on the team. The MFM physician coordinated all care and planning. The team had a nursing coordinator who ensured that all preadmission and admission checklist items were completed. All patients had a standardized consultation scheduled after admission with pulmonary critical care (a 24/7 service on our labor and delivery unit), urology, blood bank, anesthesiology, nursing, and neonatal intensive care unit services. Other specialized services such as interventional radiology or vascular surgery were consulted on an as-needed basis in an individualized fashion. In some cases, patients began contracting or started bleeding before all consultations were completed; in a few cases, emergency surgery was required. In these cases, the multidisciplinary approach was still followed systematically to the extent that it was safe.

Whenever possible, patients underwent combined spinal-epidural anesthesia for bilateral ureteric stent placement and...
cesarean delivery. This minimized fetal exposure to general anesthesia and facilitated postoperative pain management. Before induction of general anesthesia, the large-bore venous lines, an arterial line, and a central venous line were placed to optimize monitoring and ensure adequate vascular access before onset of hemorrhage. Patients were positioned in lithotomy with low-Allen stirrups to allow visualization of vaginal bleeding, if necessary, and for a third co-surgeon to have access to the surgical field. Abdominal entry was through a periumbilical midline abdominal incision, and the pregnant uterus was exteriorized gently to allow fundal or posterior classic hysterotomy. The placenta was allowed to remain in situ without attempt at removal. A modified radical hysterectomy technique that included ureterolysis was standardized and included extensive use of a bipolar cautery device (Ligasure; Covidien, Mansfield, MA).

Given the distended and enhanced deep pelvic collateral vasculature that is usually present when there is morbidly attached placenta (regardless of whether it is an accreta, increta or percreta, and the importance of reducing blood supply to the uterus in a systematic manner), we have developed what we refer to as a modified radical hysterectomy technique. This technique is designed to ensure wide margins from the friable uterine wall such that fragile and unsupported vessels and/or thinned out myometrium is not inadvertently disrupted by the placement of clamps or by attempts to suture or ligate pedicles against the uterus itself. The retroperitoneum is accessed lateral to the round ligaments, and the ureters and iliac vessels are exposed and identified as a first step in the hysterectomy. The uterus is then separated from its support structures, which leaves as wide a margin of broad ligament as is possible. The ovaries are preserved, but the tubes are removed. This technique allows us the ability to identify the feeder arteries early in the case and ligate (uterine) or temporally clamp with a vascular clip (superior vesical) to reduce engorgement of the ballooned lower segment and bladder wall. Where necessary, a ureterolysis is carried out to protect the ureters and allow step-by-step devascularization of the lower segment. Even in cases of accreta and increta, in which the trophoblast has not invaded the bladder wall, there are still very distended and engorged blood vessels that traverse the interface between the bladder and uterine lower segment that can cause significant bleeding. By exposure of the lateral pelvic anatomy and performance of a ureterolysis in a systematic fashion, these vessels can be cauterized and closed down, and the bladder can be separated in a controlled manner with minimal blood loss.

Deliberate cystotomy and bladder excision was favored in cases with deep placental invasion over persistent attempts at bladder dissection. Intraoperative staged arterial embolization of the placental bed (after the cesarean delivery but before the hysterectomy) was performed for selected percreta cases that involved the lateral pelvic side walls. All patients received 500 mL albumin 5% before cesarean hysterectomy because acute volume expansion with colloid reduces intraoperative crystalloid requirement and facilitates hemodilution before hemorrhage. Early blood product replacement that used a massive transfusion protocol (transfusion of PRBCs and fresh frozen plasma in a 1:1 ratio) was encouraged, and electrolytes were measured frequently, particularly ionized calcium and potassium levels. During acute hemorrhage, we draw complete laboratory sets (arterial blood gas, K+, Ca++, H&H, prothrombin time, activated partial thromboplastin time, international normalized ratio, fibrinogen, platelets, D-dimer, glucose, Mg++) every 20 minutes. One jumbo dose (35-50 mL) of platelets was transfused after every 8 units of PRBCs. We tried to keep the platelet count ≥100,000/mL. Ureteric stents generally were put in with epidural anesthesia before the cesarean delivery. All patients received bodyder and overbody forced air warming plus warmed intravenous infusions to achieve perioperative normothermia. Patients were given standardized immediate recovery in the intensive care unit after the operation. After referral for treatment by our team, all patients underwent ultrasound examination by a team member (W.L.) to confirm the diagnosis. Several parameters were investigated during ultrasound scans that included the type of placenta previa, loss of normal hypoechogenic retroplacental zone, multiple vascular lacunae (irregular vascular spaces) within placenta, myometrial thickness <1 mm/loss of visualization of the myometrium, disruption of the placental-uterine wall interface and the presence of vessels that cross this area, blood vessels or placental tissue that bridge the uterine-placental margin, myometrial-bladder interface, or crossing uterine serosa. In cases with lateral or posterior placentaion, magnetic resonance imaging was considered for more accurate evaluation. In cases with lateral or posterior placentaion, magnetic resonance imaging was considered for more accurate evaluation. Before 2011, patients were treated on a case-by-case basis without a specific protocol and are included in the non-multidisciplinary group. Since the introduction of the multidisciplinary program at our center, the number of the referred patients was increased markedly.

Medical records were reviewed, and data were collected that pertained to maternal death, EBL, anesthesia type and duration, operative time, use of blood products, vital signs during surgery, intraoperative and postoperative complications (ie, vascular, ureteral, and bowel injury), cystotomy, ureteric reimplantation, need for reexploratory laparotomy, postoperative intensive care unit complications, length of stay, and readmission after discharge. Data for patients who came to the hospital in an emergent state and those who were hospitalized but required emergency surgery for obstetric complications (labor, bleeding, fetal concerns) were also analyzed. Neonatal data were collected for birthweight and postdelivery complications (respiratory distress syndrome, sepsis, infection, necrotizing enterocolitis, intracranial bleeds, hypoxemic ischemic encephalopathy, or neonatal death).

After referral for treatment by our team, all patients underwent ultrasound examination by a team member (W.L.) to confirm the diagnosis. Several parameters were investigated during ultrasound scans that included the type of placenta previa, loss of normal hypoechogenic retroplacental zone, multiple vascular lacunae (irregular vascular spaces) within placenta, myometrial thickness <1 mm/loss of visualization of the myometrium, disruption of the placental-uterine wall interface and the presence of vessels that cross this area, blood vessels or placental tissue that bridge the uterine-placental margin, myometrial-bladder interface, or crossing uterine serosa. In cases with lateral or posterior placentaion, magnetic resonance imaging was considered for more accurate evaluation. Before 2011, patients were treated on a case-by-case basis without a specific protocol and are included in the non-multidisciplinary group. Since the introduction of the multidisciplinary program at our center, the number of the referred patients was increased markedly.

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Patient characteristics were compared with the use of descriptive statistics. The
Mann-Whitney U test was used to compare continuous variables when
appropriate. Categoric outcomes were compared with the use of χ² analysis and
the Fisher exact test as appropriate. Multivariate logistic regression was per-
formed to investigate the effect of several variables on the outcomes. A probability
value of < .05 was considered significant.

We used SPSS statistical software
(version 17.0; SPSS Inc, Chicago, IL).

**Results**

Ninety cases of histopathologically confirmed placenta accreta, increta, or
percreta were identified from 2000-2013. Of the 90 patients, 57 women (63%)
were in the multidisciplinary group (March 2011 to September 2013), and
33 women (37%) were in nonmultidisciplinary group (January 2000
to March 2011). Maternal demographics are presented in Table 1. There was no
statistically significant difference in maternal characteristics or the number of
previous cesarean deliveries between the 2 groups. The multidisciplinary
group had a higher percentage of cases
with placenta percreta (P = .008) and
placenta previa (P = .047).

Maternal outcomes of the 2 groups are shown in Table 2. Patients in the multi-
disciplinary group had longer anesthesia
time (because this included the time for
stent and line placement in many cases),
greater use of bipolar diathermy, and
fewer attempts to remove the placenta
manually (P < .001 for all). There were
significantly more cystotomies (P = .008) in the multidisciplinary group
(explained by deliberate per protocol
cystotomy and excision of involved
bladder dome rather than extensive
dissection of bladder off the lower
segment in percreta cases).

Overall, patients in the multidisci-
plinary group had significantly lower
EBLs (P = .025) when compared with
that seen in the nonmultidisciplinary
group, with a median of 2.1 L (range,
0.5–18 L) vs 3 L (range, 0.8–14 L). The
median of PRBC units transfused was
not statistically different (multidis-
ciplinary group, 4 units [range, 0–24
units]; nonmultidisciplinary group, 4.5
units [range, 1–25 units]; P = .114).
Postoperative hospital length of stay was
no different (P = .52). Table 3 shows a
comparison of the multidisciplinary and
nonmultidisciplinary groups with
respect to their antenatal diagnosis. The
number of patients with antenatal diag-
nosis was significantly higher (P < .001)
in the multidisciplinary group compared
with nonmultidisciplinary group (44
[79%] vs 12 [37%], respectively).

Table 4 shows the maternal outcomes
specifically in cases of deeper placental
invasion (increta or percreta). EBL was
significantly lower in the multidisci-
plinary group than in the non-
multidisciplinary group (2.1 L [range,
0.9–18 L] vs 3.5 L [range, 0.8–14 L];
P = .031). There was not a statistically
significant trend to fewer transfused
units of PRBCs (median, 3.5 units per
case [range, 0–24 units] vs 6 units per
case [range, 2–18 units]; P = .058),
respectively. There was no significant
difference in maternal outcomes be-
tween the multidisciplinary and non-
multidisciplinary groups when only
accreta cases were compared (excluding
increta and percreta). The length of
hospital stay in the 2 groups was not
different.

The need for emergency surgery in
the multidisciplinary group was sig-
nificantly lower than in the nonmul-
tidisciplinary group (23% vs 64%; P = .001). In the multidisciplinary group,
46% of patients had only general
anesthesia; 44% of patients had
epidural and general anesthesia, and
10% of patients had epidural anesthesia
only, compared with 53%, 22%, and
25%, respectively, in the nonmul-
tidisciplinary group (P = .057). There
was no case of vesicovaginal fistula
reported up to 6 weeks after delivery in
either group. There was 1 case of
intraoperative iatrogenic internal iliac
vein injury that was repaired in the
multidisciplinary group. There was 1
case of maternal death reported in
the multidisciplinary group. This pa-
tient underwent an emergency cesarean
hysterectomy after she started bleeding
vaginally at 33 weeks of gestation.
During the hysterectomy, which was
progressing without complication,
there was sudden onset of massive
hemorrhage that emanated from the
retroperitoneum. Despite massive

**Table 1**

Patient characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multidisciplinary group (n = 57)</th>
<th>Nonmultidisciplinary group (n = 33)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median maternal age, y (range)</td>
<td>33 (24–45)</td>
<td>33 (20–43)</td>
<td>.71</td>
</tr>
<tr>
<td>Median body mass index at delivery, kg/m² (range)</td>
<td>32.1 (17.7–53.7)</td>
<td>28.9 (20.0–44.3)</td>
<td>.12</td>
</tr>
<tr>
<td>Median gestational age at delivery, wk (range)</td>
<td>34 (16–39)</td>
<td>34 (19–40)</td>
<td>.50</td>
</tr>
<tr>
<td>Median parity, n (range)</td>
<td>3 (0–12)</td>
<td>2 (1–8)</td>
<td>.66</td>
</tr>
<tr>
<td>Median gravidity, n (range)</td>
<td>4 (1–14)</td>
<td>4 (2–11)</td>
<td>.46</td>
</tr>
<tr>
<td>History of cesarean delivery, n (%)</td>
<td>51 (93)</td>
<td>28 (87)</td>
<td>.46</td>
</tr>
<tr>
<td>Previous cesarean delivery, n (%)</td>
<td></td>
<td></td>
<td>.23</td>
</tr>
<tr>
<td>0</td>
<td>4 (7)</td>
<td>4 (12)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>12 (21)</td>
<td>11 (33)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>24 (42)</td>
<td>13 (40)</td>
<td></td>
</tr>
<tr>
<td>≥3</td>
<td>17 (30)</td>
<td>5 (15)</td>
<td></td>
</tr>
<tr>
<td>Median time since last cesarean delivery, mo (range)</td>
<td>41.5 (11–144)</td>
<td>42 (12–216)</td>
<td>.31</td>
</tr>
</tbody>
</table>

transfusion and aortic pressure, the patient died. At autopsy, a previously unknown retroperitoneal aneurysm was found in the right renal fossa. This aneurysm ruptured during the surgery, which led to uncontrollable hemorrhage and death.

A greater percentage of pregnancies in the multidisciplinary group received antenatal steroid administration (60% in multidisciplinary group vs 39% in non-multidisciplinary group; \( P = .064 \)). Twelve neonates (21%) in the multidisciplinary group experienced respiratory distress syndrome vs 8 neonates (24%) in the nonmultidisciplinary group (\( P = .72 \)), but no babies experienced sepsis, infection, necrotizing enterocolitis, intracranial bleeds, hypoxic ischemic encephalopathy, or neonatal death during their hospital stay in either group (overall, 6 neonates were delivered at \( \leq 23 \) weeks of gestation who were nonviable).

Multivariate logistic regression did not reveal any significant contribution for any of the variables that included antenatal diagnosis, emergency surgery, antenatal steroid administration, and deeper invasion of placenta (increta/percreta) in the prediction of the outcomes. There was a trend for antenatal diagnosis to predict the need for transfusion of \( > 4 \) units of PRBC with control for all other potential confounders (adjusted odds ratio, 3.532; \( P = .066; 95\% \text{ CI}, 0.920—13.559 \)).

**COMMENT**

This study introduces a comprehensive systematic multidisciplinary approach for the treatment of patients with morbidly adherent placenta and shows a reduction in the need for emergency surgery and a reduction in the EBL during and after surgery. The rising incidence of morbidly adherent placenta has focused attention on the cause, treatment, and outcomes of patients with this condition. The incidence of placenta accreta has increased from 1 in 10,000 deliveries in the 1960s to 3 in 1000 deliveries during the past decade \(^1\) and has been linked consistently to the increasing rate of cesarean deliveries. A multidisciplinary approach to cases of suspected placenta accreta has been recommended by the American Congress of Obstetricians and Gynecologists, \(^16\) and our data supports this. Although blood loss was less and blood transfused was not significantly different between the 2 groups, this is somewhat misleading because the multidisciplinary group included significantly more patients with deeper placental invasion, bladder involvement, and the need for more extensive (ureterolysis) and complex (bladder dissection and excision) surgery (\( P = .008 \)). The similar volume of blood transfusion reflects a different strategy of earlier and more aggressive transfusion than before. The reduction in emergency surgery for placenta increta/percreta cases is important because, given the increased risk of this type of emergency surgery, any reduction could be regarded as a reduction of

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multidisciplinary group (n = 57)</th>
<th>Nonmultidisciplinary group (n = 33)</th>
<th>( P ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median estimated blood loss, L (range)</td>
<td>2.1 (0.5—18)</td>
<td>3 (0.8—14)</td>
<td>.025</td>
</tr>
<tr>
<td>Median packed red blood cell transfusion units, n (range)</td>
<td>4 (0—24)</td>
<td>4.5 (1—25)</td>
<td>.114</td>
</tr>
<tr>
<td>Packed red blood cell transfusion of ( \geq 4 ) units, n (%)</td>
<td>37 (65)</td>
<td>26 (79)</td>
<td>.166</td>
</tr>
<tr>
<td>Median hemoglobin decrease, mg/dL (range)</td>
<td>1.1 (−4.6 to 5.5)</td>
<td>1 (−3 to 5.1)</td>
<td>.760</td>
</tr>
<tr>
<td>Median crystalloid transfusion, mL (range)</td>
<td>4300 (1000—16,200)</td>
<td>5250 (2000—17,000)</td>
<td>.166</td>
</tr>
<tr>
<td>Median length of hospital stay, d (range)</td>
<td>4 (2—12)</td>
<td>4 (2—14)</td>
<td>.523</td>
</tr>
<tr>
<td>Use of bipolar diathermy device, n (%)</td>
<td>40 (70)</td>
<td>0</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>No attempt to remove placenta, n (%)</td>
<td>45 (80)</td>
<td>7 (22)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Median anesthesia time, min (range)</td>
<td>287 (74—608)</td>
<td>180 (62—398)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>General anesthesia after epidural, n (%)</td>
<td>25 (44)</td>
<td>7 (22)</td>
<td>.057</td>
</tr>
<tr>
<td>Median neonatal birthweight, g (range)</td>
<td>2400 (800—3900)</td>
<td>2300 (300—3900)</td>
<td>.460</td>
</tr>
<tr>
<td>Cystotomy and bladder repair, n (%)</td>
<td>17 (30)</td>
<td>2 (6)</td>
<td>.008</td>
</tr>
<tr>
<td>Bowel injury, n (%)</td>
<td>1 (2)</td>
<td>1 (3)</td>
<td>.999</td>
</tr>
<tr>
<td>Ureteral injury, n (%)</td>
<td>1 (2)</td>
<td>2 (6)</td>
<td>.550</td>
</tr>
<tr>
<td>Reoperation, n (%)</td>
<td>3 (5)</td>
<td>1 (3)</td>
<td>.999</td>
</tr>
<tr>
<td>Readmission, n (%)</td>
<td>2 (3)</td>
<td>1 (3)</td>
<td>.999</td>
</tr>
</tbody>
</table>

**TABLE 2**

Comparison of maternal complications, operative variables, and complications

potential morbidity and mortality rates in a near-miss situation.

In the present era of obstetric management, the diagnosis of placenta accreta is made initially by ultrasound examination in an early prenatal visit. Patients with a history of a previous cesarean delivery and placenta previa in the index pregnancy should be considered to be at significantly increased risk and be evaluated specifically for invasive placentation. Several studies have reported improved clinical outcome if placenta accreta is managed with a planned cesarean hysterectomy, in contrast to emergency surgery at the time of the procedure is too high to justify being unprepared for massive hemorrhage and extensive resuscitation when the unexpected occurs (Table 3). Prenatal diagnosis is helpful in the management of placenta accreta, and it could be an important component of any multidisciplinary approach. We did, however, show a significant improvement in the outcome when a known antenatal diagnosis is combined with a multidisciplinary approach, particularly in patients with deeper placental invasion (increta or percreta). However, there was a trend of benefit even though the whole cases included patients with simple accreta.

Eller et al have reported better outcomes in placenta accreta cases using a multidisciplinary approach in a multicenter study. Patients who were included in their control group were from several different centers, each of which had somewhat different management protocols. They included patients without histopathologic confirmation of the diagnosis (29% in multidisciplinary group and 18% in the control group), which may bias their results towards a more favorable outcome in the multidisciplinary group. In our study, only cases from a single faculty group were included, and all cases had a confirmed histopathologic diagnosis of placenta accreta, increta, or percreta. This minimizes the potential for bias because of different management techniques within each group.

Our approach uses a rather aggressive strategy that includes the standard use of hysterotomy with ureterolysis, identification and ligation of the superior vesical arteries (which are sometimes larger than the uterine vessels), intentional cystotomy (and excision of bladder wall) to help with a more expedited separation of bladder from lower uterine segment (rather than extensive bladder dissection) when there is percreta into the dome of the bladder. We believe that this prevents the initiation of severe bleeding that results from

### Table 3
Comparison of maternal complications, operational settings, and complications in the groups who had antenatal diagnosis

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multidisciplinary group (n = 43)</th>
<th>Nonmultidisciplinary group (n = 12)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median estimated blood loss, L (range)</td>
<td>2 (0.5–18)</td>
<td>2.3 (1.2–5.5)</td>
<td>.236</td>
</tr>
<tr>
<td>Median packed red blood cell transfusion units, n (range)</td>
<td>3 (0–24)</td>
<td>4.5 (1–13)</td>
<td>.536</td>
</tr>
<tr>
<td>≥4 packed red blood cell transfusion units, n (%)</td>
<td>27 (61)</td>
<td>8 (67)</td>
<td>.999</td>
</tr>
<tr>
<td>Median hemoglobin decrease, mg/dL (range)</td>
<td>1.1 (–4.6 to 5.5)</td>
<td>0.2 (–1.3 to 5.1)</td>
<td>.507</td>
</tr>
<tr>
<td>Median crystalloid transfusion, mL (range)</td>
<td>4450 (1000–16,200)</td>
<td>3900 (2800–10,000)</td>
<td>.753</td>
</tr>
<tr>
<td>Median length of hospital stay, d (range)</td>
<td>4 (2–12)</td>
<td>4.5 (3–14)</td>
<td>.793</td>
</tr>
<tr>
<td>Use of bipolar diathermy device, n (%)</td>
<td>35 (79)</td>
<td>0 (0)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>No attempt to remove placenta, n (%)</td>
<td>42 (98)</td>
<td>6 (50)</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Median anesthesia time, min (range)</td>
<td>300 (74–608)</td>
<td>185 (116–316)</td>
<td>.036</td>
</tr>
<tr>
<td>Median neonatal birthweight, kg (range)</td>
<td>2.3 (1.5–3.5)</td>
<td>2.6 (0.5–3.3)</td>
<td>.787</td>
</tr>
<tr>
<td>Cystotomy and bladder repair, n (%)</td>
<td>16 (36)</td>
<td>1 (8)</td>
<td>.080</td>
</tr>
<tr>
<td>Bowel injury, n (%)</td>
<td>1 (2)</td>
<td>0</td>
<td>.999</td>
</tr>
<tr>
<td>Ureteral injury, n (%)</td>
<td>1 (2)</td>
<td>1 (8)</td>
<td>.386</td>
</tr>
<tr>
<td>Reoperation, n (%)</td>
<td>1 (2)</td>
<td>1 (8)</td>
<td>.386</td>
</tr>
<tr>
<td>Readmission, n (%)</td>
<td>0</td>
<td>1 (8)</td>
<td>.214</td>
</tr>
</tbody>
</table>

protracted, and often fruitless, attempts to dissect the bladder off the lower segment of the uterus. A reasonable concern about our multidisciplinary approach is that it may expose patients to an unnecessarily invasive procedure if instituted in women in whom accreta is suspected but subsequently shown not to be present. All of our cases who were treated with the multidisciplinary approach had histologically confirmed morbidly adherent placentation. Thus, we are unable to comment on whether this approach may increase morbidity for patients who do not have accreta. Clearly, expertise in antenatal diagnosis and a level of comfort with the diagnosis of accreta are essential parts of such a program.

We did not see any postoperative complications from this approach and specifically did not encounter any vesicovaginal fistulae or postoperative micturition or bladder capacity issues. We used a massive transfusion protocol that was activated as soon as significant bleeding was encountered to avoid coagulopathy. This lower threshold for aggressive transfusion of blood, rather than crystalloid, may be the reason that there is no difference in the use of blood products between the 2 groups, despite the lower EBL in the multidisciplinary group. Another reason is that the multidisciplinary group included many more patients with more significant degrees of invasion and consequently more blood loss. Preoperative ureteral stent placement was used whenever possible to help prevent ureteral injury. We regard the optimum time for delivery to be 34-35 weeks of gestation to balance the risk of neonatal complications with the risk of an unplanned, emergent surgery.20

Most groups who described a multidisciplinary approach to the management of placenta accreta have included a gynecologic oncologist as the core members of their team, along with an urologist, an interventional radiologist, and vascular surgeon providers.5,11,12,14 In our protocol, an interventional radiologist was always made aware of the case but was not necessarily present in the operating room, unless a procedure was requested. Preoperative intravascular balloon catheters are not a standard part of our protocol, given the current controversy regarding this intervention.21 General and/or thoracic surgeons were consulted only when needed. With the use of our current multidisciplinary protocol, anesthesia time is notably longer than in the nonmultidisciplinary groups. This is attributable mostly to the additional time required for stent and line placement before the start of surgery but may also reflect the additional operative time for ureterolysis, bladder dissection, bladder excision, and cystotomy repair.

Our study had several limitations. A retrospective design inevitably leads to missing data and an inability to collect all required information. The significantly increased number of patients with a diagnosis of accreta in the multidisciplinary group may raise a concern for ascertainment bias. Given that all cases were histologically confirmed, we are

<table>
<thead>
<tr>
<th>Variable</th>
<th>Multidisciplinary group (n = 42)</th>
<th>Nonmultidisciplinary group (n = 15)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median estimated blood loss, L (range)</td>
<td>2.1 (0.9–18)</td>
<td>3.5 (0.8–14)</td>
<td>.031</td>
</tr>
<tr>
<td>Median packed red blood cell transfusion units, n (range)</td>
<td>3.5 (0–24)</td>
<td>6 (2–18)</td>
<td>.058</td>
</tr>
<tr>
<td>≥4 packed red blood cell transfusion units, n (%)</td>
<td>25 (60)</td>
<td>13 (87)</td>
<td>.056</td>
</tr>
<tr>
<td>Median hemoglobin decrease, mg/dL (range)</td>
<td>1.4 (–4.6 to 4.4)</td>
<td>1.8 (–0.7 to 5.1)</td>
<td>.262</td>
</tr>
<tr>
<td>Median crystalloid transfusion, mL (range)</td>
<td>4500 (1000–16,200)</td>
<td>4500 (2000–11,000)</td>
<td>.843</td>
</tr>
<tr>
<td>Median length of hospital stay, d (range)</td>
<td>4 (2–12)</td>
<td>4 (2–8)</td>
<td>.219</td>
</tr>
<tr>
<td>Use of bipolar diathermy device, n (%)</td>
<td>35 (83)</td>
<td>0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>No attempt to remove placenta, n (%)</td>
<td>40 (98)</td>
<td>4 (27)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Median anesthesia time, min (range)</td>
<td>300 (74–608)</td>
<td>180 (62–326)</td>
<td>.002</td>
</tr>
<tr>
<td>Median neonatal birthweight, kg, (range)</td>
<td>2.3 (1.5–3.9)</td>
<td>2.3 (0.6–3.3)</td>
<td>.511</td>
</tr>
<tr>
<td>Cystotomy and bladder repair, n (%)</td>
<td>15 (36)</td>
<td>1 (7)</td>
<td>.044</td>
</tr>
<tr>
<td>Bowel injury, n (%)</td>
<td>1 (2)</td>
<td>1 (7)</td>
<td>.461</td>
</tr>
<tr>
<td>Ureteral injury, n (%)</td>
<td>1 (2)</td>
<td>2 (13)</td>
<td>.166</td>
</tr>
<tr>
<td>Reoperation, n (%)</td>
<td>3 (7)</td>
<td>0</td>
<td>.599</td>
</tr>
<tr>
<td>Readmission, n (%)</td>
<td>1 (2)</td>
<td>0</td>
<td>.999</td>
</tr>
</tbody>
</table>

confident that there is no bias with respect to inclusion of cases. However, since 2011, all cases have been recorded contemporaneously in a database; before 2011, cases had to be recovered from medical records. Although the increasing incidence of accreta over time and failure to recover all of the cases before 2011 may be partially responsible, a more plausible explanation for the numeric difference between the groups is that our department rapidly grew in size and became a referral center since we instituted a new systematic multidisciplinary approach with a defined “percreta team.” A heightened awareness of the risk factors for accreta in our referral base, a widened network of MFM practices that performed ultrasound surveillance, and an increased comfort with and desire to refer their cases into our tertiary care center by our referring physicians all contributed to better antenatal identification of the accreta cases. The potential for treatment bias frequently exists when a new technique is introduced. In our case, we are confident that no such bias was present with respect to the increased incidence of more severe degrees of placental invasion because all cases had objective pathologic evaluation, and no diagnosis was based on the type of intervention that was used.

Given that our intervention consisted of a number of bundled interventions, it is possible that ≥1 elements may be primarily responsible for the observed differences. Earlier and more accurate diagnosis with the use of ultrasound scanning and magnetic resonance imaging, referral to our team for prenatal management, and the assumption of care, admission at 33 weeks of gestation, and delivery at 34-35 weeks of gestation, and our multidisciplinary approach may all be important and difficult to tease apart in determining the outcome.

As a part of our multidisciplinary protocol, placental removal was not attempted after cesarean delivery, and we believe that this approach contributed to the decreased incidence of massive bleeding. A change in strategy regarding early initiation and liberal use of blood products at the first sign of significant bleeding made comparison of the quantity of blood transfused in the 2 groups less meaningful. Although our multidisciplinary protocol was applied in as standardized a manner as possible, in some cases we had to operate without all preparations being made. Obviously, although protocol-based care is optimal, the heterogeneity of this condition is such that all the cases could not be treated without some variation. Another potential weakness in our study is the subjectivity of EBL in our primary outcome, which may have biased the study.22 Countering this concern is the fact that, with the introduction of our multidisciplinary approach, the rigor of blood loss estimation was increased significantly, and the threshold for transfusion and institution of a massive transfusion protocol was reduced greatly in an effort to stay ahead of hemodynamic instability. If anything, patients in the multidisciplinary group were more likely to have their blood loss overestimated and to receive more blood than the patients who were treated without this approach.

Since we began our multidisciplinary program, we have seen a significant increase in the number of increta and percreta cases. It is important to note that, in the current study, despite there being a significantly higher proportion of increta/percreta cases in the multidisciplinary group, the outcomes were similar in most cases and better in some than in the nonmultidisciplinary group. This is significant given the much higher risk of intraoperative bleeding, the more technically challenging surgery, and the greater risk of postoperative complications that are associated with placenta percreta than with placenta accreta. We believe that this highlights the importance of the multidisciplinary approach.

In summary, although the current literature lacks confirmatory evidence for the potential benefit of using a multidisciplinary intervention strategy for the management of placenta accreta, our data suggest that protocol-based prospective management with a team of specialists and peripartum procedural guidelines is associated with improved maternal outcomes in patients with placenta accreta, increta, and percreta. Such an approach should be considered in those centers that routinely treat these cases.

REFERENCES