CLINICAL ARTICLE

**Outcomes of the first 50 patients with abnormally invasive placenta managed using the “Triple P Procedure” conservative surgical approach**

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**KEYWORDS:** Abnormally invasive placenta; Intentional retention of the placenta; Myometrial excision; Peripartum hysterectomy; Triple P Procedure; Visceral injury

**SYNOPSIS:** The Triple P Procedure should be considered as a safer, conservative alternative to peripartum hysterectomy during counselling prior to surgery for women with abnormally invasive placenta.

**ABSTRACT**

**Objective**: To determine maternal outcomes for women with abnormally invasive placenta (AIP) managed using the Triple P Procedure and establish its safety as a conservative surgical management option.

**Methods**: A retrospective study of the outcomes of the first 50 patients who underwent the Triple P Procedure for AIP from September 2010 to May 2017 at St George’s Maternity Unit. Maternity case notes and the database were reviewed to determine the volume of bleeding, procedure-related complications, hysterectomy rate, and postoperative hospitalization.

**Results:** Mean operative blood loss was 2318 mL (range, 400–7300 mL and the incidence of bladder and ureteric injuries was 2% (n=1) and 0%, respectively. Median length of hospital stay was 4 days (range, 2–8 days)**.** Three women (6.0%) developed arterial thrombosis without any long-term complications and none of the patients required peripartum hysterectomy.

**Conclusion:** The Triple P Procedure should be considered as a conservative, less risky alternative to a peripartum hysterectomy during counselling prior to surgery for women with AIP.

**1 INTRODUCTION**

Abnormally invasive placenta (AIP), previously referred to as morbidly adherent placenta (MAP), is a rare but potentially life-threatening condition. It is defined as the abnormal invasion of trophoblastic tissue beyond the decidua basalis into the myometrium, sometimes extending to the uterine serosa or even beyond it to infiltrate adjacent pelvic organs. It is classified depending on the degree of trophoblastic invasion into accreta (placenta invading the superficial myometrium), increta (invasion of the deeper myometrium), and percreta (the placenta perforates the uterine serosa and may infiltrate other pelvic organs) [1].

The presence of a previous uterine scar, usually due to one or more previous cesarean deliveries, is the most important risk factor. A combination of previous cesarean delivery and placenta previa significantly increases the risk for AIP. However, other risk factors that damage the decidua basalis, such as previous myomectomy, evacuation of retained products of conception secondary to a spontaneous abortion, manual removal of the placenta after vaginal delivery, previous termination of pregnancy, infection such as endometritis, and fertility treatment, may also predispose to AIP.

Worldwide, the incidence of AIP has increased significantly over the last 15 years, from 1 in 2500 pregnancies to about 1 in 533, which is considered to be secondary to the rising cesarean delivery rate [2]. A national case–control study using the UK Obstetric Surveillance System (UKOSS)[3] suggested that the odds of having AIP increased in women who had had a previous cesarean delivery (adjusted odds ratio [aOR] 14.41; 95% CI, 5.63–36.85) and that the a OR was 65 in women with placenta previa.

Traditional management approaches to AIP have been to perform peripartum hysterectomy with or without resection and repair of other pelvic organs involved, or to recommend expectant management leaving the placenta in situ and waiting for spontaneous resorption, which carries the subsequent risk of secondary hemorrhage and infection[4,5].

Due to the morbidity and mortality associated with peripartum hysterectomy [6], various conservative approaches have been attempted [7,8]. It has been reported that intentional retention of the entire placenta may be associated with serious maternal complications, such as secondary hemorrhage, sepsis, coagulopathy, and delayed peripartum hysterectomy [9],as well as utero-cutaneous fistula [10].

The Triple P Procedure was developed as a conservative surgical alternative to peripartum hysterectomy at St George’s Hospital London in 2010 to reduce serious maternal morbidity [11]. St George’s University Hospitals NHS Foundation Trust is a regional referral center for AIP.

The aim of the present study was to determine maternal outcomes for the first 50 patients managed using the Triple P Procedure to establish whether it is a safe and conservative surgical management option for AIP.

**2 MATERIALS AND METHODS**

A retrospective study of patient outcomes using maternity case notes and the database was conducted. The Triple P Procedure was offered as the recommended surgical option for all women with anterior or posterior AIP after counselling regarding other options (i.e. peripartum hysterectomy and intentional retention of the placenta). Women with placental invasion into the broad ligament were offered peripartum hysterectomy or intentional retention of the placenta, based on individual risk factors. Informed patient consent was obtained prior to surgery. Approval for the study was obtained from St George’s Research and Enterprise Office.

The Triple P procedure is a three-step surgical approach that includes perioperative localization of the placental edge and delivery of the fetus above the upper border of the placenta, pelvic devascularization, and placental nonseparation with myometrial excision (Box 1).  **Figure 3 & 4 have been supplied as Supplementary Figures 1&2**

The rationale for this technique is based on the clinical observation that a retained placenta after childbirth does not bleed profusely if there is no partial separation prior to manual removal of the placenta. Therefore, forcible separation of the adherent placenta from its highly vascular myometrial bed is avoided to minimize bleeding; the entire placenta with its adherent myometrial bed is excised and the myometrial defect is repaired. In cases of placenta percreta invading the urinary bladder, approximately 3–4 cm of invading placental tissue is left in situ after the application of PerClot (CryoLife Inc, Kennesaw, GA, USA) to achieve hemostasis. Intrauterine balloon tamponade is used, when necessary, in cases of abnormal invasion of the placenta into the cervix (i.e. “j”-shaped placentae extending from the anterior to posterior wall) to achieve hemostasis.

An individualized, perioperative, multidisciplinary care plan is used in every case. When a woman is referred to the unit an ultrasound scan with color Doppler is undertaken by a dedicated team who specialize in AIP to confirm the findings. MRI is not performed routinely, except in cases of invasion into the broad ligament (i.e. lateral placenta) or in cases of posterior placenta where it is difficult to assess the degree of posterior invasion on ultrasound due to the presence of the fetal head.

Cesarean delivery is scheduled between 34 and 36 weeks unless there is a maternal or fetal indication or if there is active vaginal bleeding requiring earlier delivery.

Figure 1 illustrates the “St George’s Boat” incision used to gain access to the myometrium above the upper border of the placenta. Once the myometrial excision is performed, PerClot (Cryolife Inc) is applied to arrest bleeding from exposed placenta venous sinuses (Figure 2) at the site of invasion into the urinary bladder. Women were managed in the obstetric High Dependency Unit (HDU) in the labor ward and, in the absence of massive obstetric hemorrhage or any surgical complications, were discharged after 3 days on average.

**3 RESULTS**

From September 2010 to May 2017 50 patients were managed with the Triple P Procedure. Patients’ characteristics are presented in Table 1. The median number of previous cesarean deliveries was 2 (range, 0–6). Four women (8.0%) had not had a previous cesarean delivery but had a history of sepsis following spontaneous abortion (n=1), termination of pregnancy (n=1), manual removal of placenta (n=1), or normal vaginal delivery (n=1).

The most common placental localization was anterior previa in 29 cases (58.0%). Seven women (14.0%) had posterior previa, 7 (14.0%) had both anterior and posterior previa (i.e. central), and 6 (12.0%) had an anterior placenta (not previa). There was only one case of cornual placenta.

All 50 women had the standard preoperative preparation and standard surgery using the Triple P procedure with the exception of one patient who did not have preoperative internal iliac artery balloon placement. This patient presented with significant bleeding that necessitated an urgent operation to control ongoing bleeding.

Median blood loss was 2318 mL (range, 400–7300 mL). Intraoperative blood loss was less than 1500 mL in 22 (44%) women. Additional intraoperative details are given in Box 2.

A total of 12 (24.0%) procedures were performed under general anesthesia, 8 (16.0%) of which were conversion from regional anesthesia owing to massive obstetric hemorrhage. Box 3 describes the postoperative management of internal iliac artery occlusive balloon catheters.

Median postoperative hospital stay was 4 days (range, 2–8 days). Mean hemoglobin level on discharge was 98 g/L (range, 80–124 g/L). Box 4 highlights the intra- and postoperative complications of the Triple P Procedure.

All women were followed up in the outpatient clinic 8 weeks after delivery. Transvaginal ultrasound at this appointment showed complete remodeling of the uterus. For 47 (94.0%) women, the findings were very similar to those of women who have undergone standard cesarean deliveries; the remaining three women had placenta percreta invading the urinary bladder. Complete placental resorption took up to 10 weeks in these women, with no case of secondary hemorrhage or sepsis.

The histopathology report confirmed AIP in 28 patients (56.0%), histopathological visualization was inconclusive in 2 (4.0%) patients, pathology could not confirm AIP in the resected specimen in 10 patients (20.0%), and 10 cases (20%) were not reported. This was because in cases of placenta percreta invading the urinary bladder, to avoid bladder injury, the area of invading placenta was left in-situ with the application of the local haemostat (PerClot). Therefore, histopathological confirmation was not possible in such cases.

**4 DISCUSSION**

None of the women who underwent the Triple P Procedure needed a peripartum hysterectomy and 42.0% did not require any blood products. Complete resorption of the placenta and uterine remodeling was noted in 94.0% of women during transvaginal ultrasonography 8 weeks after the procedure.

Compared with the published evidence on morbidity associated with peripartum hysterectomy [12], our series of 50 patients suggests that the Triple P Procedure is a safer conservative alternative to a peripartum hysterectomy without the complications associated with intentional retention of the entire placenta. Mean operative blood loss was 2318 mL, which is lower than the reported mean estimated blood loss during a peripartum hysterectomy of 5300 mL (range, 2000–1000 mL) [13]. This reflects a higher need for blood products, with a mean of five units reported for peripartum hysterectomy compared with three units for the Triple P Procedure. It has been reported that separation of the placenta increases the risk of bleeding[14]and we strongly believe that placental nonseparation and myometrial excision is a crucial step of the Triple P Procedure that avoids excessive bleeding.

Regarding complications, ureteric injuries are reported in 7% of women who undergo peripartum hysterectomy [15]; however, there were no ureteric injuries among our patients. Similarly, injuries to the urinary bladder are reported in 15% of peripartum hysterectomy cases[15], which is much higher than the single case (2.0%) reported in the present study. Through the “St George’s Boat Incision” we were able to gain access to the upper border of the placenta in all cases without the need for a midline skin incision.

Median hospital stay in our series was 4 days, which is shorter than the 8.7 days reported for peripartum hysterectomy [16]. It has been reported recently that anterior placenta previa with abnormal invasion increases the risk of prolonged postoperative hospitalization in women who underwent the Triple P Procedure [17].

Confirmation of AIP on histopathological examination was not possible for some of our patients. This may be due to retention of the invading placental tissue into the urinary bladder during the Triple P Procedure, which renders histological confirmation impossible. This was intentional because if attempts were made to remove the invading placental tissue then a cystotomy would have been needed. We avoided injury to the bladder in 49 out of 50 patients by not attempting to remove the placental tissue invading the urinary bladder.

Application of two vertical compression sutures above the uterine tamponade balloons to prevent balloon migration to the upper segment and to maintain tamponade to the areas of placental invasion in the cervix may be useful for patients with AIP invading the cervix (supplementary information S1). The reconstructed myometrium is shown in supplementary information S2.

We have previously reported good outcomes with prophylactic placement of balloon catheters for patients with AIP [18]. Although, 3 (6.0%) of our patients had documented arterial thrombosis, none required surgical intervention. Early detection of developing thrombosis using a pulse oximeter on each big toe and early referral to interventional radiology may account for this.

The limitations of the present study include its retrospective nature and the smaller numbers. We also appreciate that we cannot make a direct comparison with the outcomes of the Triple P Procedure and other alternatives available (i.e. peripartum hysterectomy and other conservative surgical measures) because no randomized controlled trials have been carried out. However, our complication rates are lower than the reported complications for a peripartum hysterectomy.

In settings with low resources or in emergency cases, “uterine strangulation” (application of saline tubing or Foley catheter tubing around the lower uterine segment) or occlusion of the uterine arteries can be usedto reduce the risk of massive hemorrhage [19]. However, it may be insufficient for AIP invading the bladder because the blood supply comes partially from lower collaterals arising from the vaginal, vesical, and pudendal arteries. A case series of 22 from Russia using a “modified Triple P Procedure” involved temporary clamping of the internal iliac arteries instead of insertion of occlusive balloon catheters[19]. The authors reported good outcomes and this modified procedure may be useful in centers with no access to interventional radiology[19]. The same authors have subsequently performed 35 surgeries using this procedure and have reported good long-term outcomes at 24 months after surgery[20].

More recently, a Chinese case series of 45 patients managed using the modified Triple P Procedure applied uterine strangulation instead of pelvic arterial balloon occlusion, with good outcomes[21] with comparable of mean blood loss of 2423 mL [21] and 1078 mL [19], respectively. This suggests that in centres where access to interventional radiology procedures are not available, alternative measures such as uterine ‘strangulation’ or temporary clamping of the internal iliac artery may be used to achieve pelvic devasculariation. It has also been shown that introduction of the Triple P Procedure was associated with reduced incidence of postpartum hemorrhage, postoperative hospitalization, and elimination of peripartum hysterectomy [22]

The Triple P Procedure was developed to minimize maternal morbidity and mortality associated with peripartum hysterectomy. It is recognized that there may be concerns surrounding the integrity of the uterine scar during a subsequent pregnancy after myometrial excision and uterine reconstruction. However, in 2017 the first case of pregnancy after the Triple P Procedure was reported with excellent maternal and perinatal outcomes[23]. The Triple P Procedure may be considered for women who desire future pregnancies, after appropriate counseling on the possible risks of recurrence and complications, including uterine scar rupture.

AIP is associated with significant maternal morbidity and mortality worldwide[25]. To mitigate the complications of peripartum hysterectomy, several conservative measures have been proposed[26,27]. However, a high hysterectomy rate of approximately 20% has been reported, with complications such as uterine infection, hemorrhage, retention of iatrogenic foreign bodies, coagulopathy, and low urethral ligations [26].

In conclusion, analysis of our first 50 patients managed using the Triple P Procedure for AIP suggests that it is a safer, conservative surgical alternative to peripartum hysterectomy with no cases of ureteric injuries and with significantly reduced likelihood of intraoperative bleeding, need for blood transfusion, and reduced hospital stay. While peripartum hysterectomy remains a lifesaving procedure for women with massive obstetric hemorrhage, our results show that for most women with AIP, peripartum hysterectomy and its associated morbidity can be avoided using the Triple P Procedure. Considering the serious complications of peripartum hysterectomy highlighted in a recent systematic review [28], we recommend that the Triple P Procedure is considered as a conservative treatment option to minimize complications during counseling women with AIP prior to surgery.

**AUTHOR CONTRIBUTIONS**

SA, EC, and AB conceptualized the Triple P Procedure. EC and AP designed the manuscript. BT, AB, RH, and JM acquired and interpreted the data. AP maintained the database and performed the data analysis with EC. All co-authors, who are members of the Regional Referral Service for AIP, contributed to sections pertaining to their relevant clinical area and interpreted the data and reviewed, edited, and revised the manuscript.

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**CONFLICTS OF INTEREST**

The authors declare no conflicts of interest.

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**FIGURE LEGENDS**

**Figure 1.** “St George’s Boat Incision” – note the rectus sheath has been reflected upward like an inverted boat to gain access to the myometrium above the upper border of the placenta.

**Figure 2.** The myometrial defect after performing myometrial excision and application of the local hemostat, Perclot (CryoLife Inc), to arrest bleeding from exposed placenta venous sinuses.

**Supplementary information S1.** Application of two vertical compression sutures above the uterine tamponade balloons to prevent balloon migration to the upper segment and to maintain tamponade to the areas of placental invasion in the cervix.

**Supplementary information S2.** Reconstructed uterus after myometrial excision.

**Box 1.**

Peri- and intraoperative aspects of the Triple P Procedure.

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| **Immediately prior to surgery**On the day of surgery, women attend the Interventional Radiology Suite for the placement of temporary occlusive balloon catheters in the anterior division of the internal iliac arteries, after the insertion of the epidural catheter by the anesthetist. The correct placement of the balloons is then rechecked in the obstetric theatre immediately prior to commencing surgery using a portable image intensifier.**Opening the anterior abdominal wall**The skin incision is performed through the previous suprapubic scar and the skin with subcutaneous tissue is reflected upward to expose the rectus sheath to allow access to the myometrium above the upper border of the placenta (Figure 1). A “St George’s Boat” incision is made on the rectus sheath (Figure 1). This incision converts a suprapubic skin incision to a “boat-shaped” incision in the rectus, which allows the lateral angles of the incision to be extended upward to enable access to the myometrium above the upper border of the placenta.**Delivery of the fetus and myometrial excision**A transverse uterine incision is performed above the upper border of the placenta to avoid cutting through the placenta prior to delivering the fetus. Once delivery has been accomplished, the uterus is exteriorized and the prophylactic occlusive balloons are inflated. The placenta and the underlying myometrium below the implantation site are then excised together without attempting to separate the placenta.**Repair of the myometrial defect**An approximately 2-cm margin of myometrium (even if there is some invading placental tissue) in the lower uterine lip is preserved to facilitate the repair of the myometrial defect (Figure 2). In cases of placenta percreta, which invades the urinary bladder, the bleeding of the retained remaining placenta is controlled by the application of local hemostatic agents, such as PerClot (CryoLife) (Figure 2). In cases of central placenta percreta invading the anterior and posterior uterine walls with invasion into the cervical canal, a uterine tamponade balloon is inflated within the cervix with two vertical compression sutures inserted just above the balloon to prevent balloon migration into the upper segment (Figure 3). Once hemostasis is achieved, the myometrial defect is repaired in two layers, the first one with three interrupted “box” sutures using a 110-mm needle to appose the myometrial edges. This is followed by the second continuous suture (Figure 4).  |

**Table 1.**

Patients’ characteristics, intraoperative results, and results at discharge (n=50).

|  |  |
| --- | --- |
| Characteristics | No. (%) |
| Maternal age, y |  |
|  25–30 | 10 (20.0) |
|  31–35 | 13 (26.0) |
|  36–40 | 18 (36.0) |
|  >40 | 9 (18.0) |
| Body mass index |  |
|  <20 | 4 (8.0) |
|  21–25 | 18 (36.0) |
|  26–30 | 16 (32.0) |
|  >30 | 12 (24.0) |
| Previous caesarean deliveries |  |
|  0 | 4 (8.0) |
|  1 | 20 (40.0) |
|  2 | 10 (20.0) |
|  3 | 10 (20.0) |
|  4–6 | 6 (12.0) |
| Gestational age at delivery, wk |  |
|  <24 | 1 (2.0) |
|  24–27+6 | 2 (4.0) |
|  28–33+6 | 9 (18.0) |
|  34–36+6 | 22 (44.0) |
|  >37 | 16 (32.0) |
| Placental localization |  |
|  Anterior previa | 29 (58.0) |
|  Posterior previa | 7 (14.0) |
|  Anterior and posterior | 7 (14.0) |
|  Anterior | 6 (12.0) |
|  Cornual | 1 (2.0)  |
| Estimated blood loss, mL |  |
|  <1000 | 9 (18.0) |
|  1000–1500 | 13 (26.0) |
|  1500–2000 | 13 (26.0) |
|  >2000 | 15 (30.0) |
| Blood transfusion (red cells), Units |  |
|  0 | 21 (42.0) |
|  1–2 | 9 (18.0) |
|  3–4 | 11 (22.0) |
|  >4 | 9 (18.0) |
| Blood transfusion (fresh frozen plasma), Units  |  |
|  0 | 31 (62.0) |
|  1–2 | 2 (4.0) |
|  >2 | 17 (34.0) |
| Hospital stay, d |  |
|  2 | 3 (6.0) |
|  3 | 17 (34.0) |
|  4 | 16 (32.0) |
|  5–6 | 13 (26.0) |
|  >6 | 1 (2.0) |
| Hemoglobin on discharge, g/dL |  |
|  8–9 | 8 (16) |
|  9.1–10 | 20 (40) |
|  10.1–11 | 14 (28) |
|  >11 | 8 (16) |

**Box 2**.

Intraoperative details of the 50 patients who underwent the Triple P procedure.

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| * Mean surgical time from knife to skin to closure was 70 minutes (range, 40–110 min).
* Median blood loss was 2318 mL (range, 400–7300 mL). Intraoperative blood loss was <1500 mL in 42% of the women. Of note, the woman with the greatest blood loss (7300 mL) did not have preoperative internal iliac artery balloon placement.
* Additional hemostatic sutures, modified B-Lynch or vertical compression sutures, or figure of 8 sutures were applied in 20 out of the 50 cases. This was more common among the first 30 procedures performed in our unit, reflecting an evolution in the management of these complex cases with experience.
* The use of PerClot (CryoLife; Figure 2) as an adjuvant hemostatic agent was used in almost all patients, except in the first three.
* Additional intrauterine balloon placement was needed in 4 (8.0%) women with central placenta previa with increta or percreta infiltrating the cervical canal.
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**Box 3.**

Postoperative management of internal iliac artery occlusive balloon catheters.

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| * In addition to clinical examination to assess blood flow to the limbs, a pulse oximeter is applied to both big toes to ensure adequate oxygenation and normal saline (10 mL/hour) is infused through the balloon catheter to avoid the formation of blood clots.
* In addition, a pulse oximeter is attached to both big toes to continuously monitor oxygen saturation of the lower limbs to help diagnose ischemia of the lower limbs secondary to balloon migration or arterial thrombosis.
* The occlusion balloons are deflated after 2 or 4 hours, depending on the degree of intraoperative hemorrhage but the catheters are left in situ until the next morning so that they can be rapidly inflated in case of delayed hemorrhage. In addition, an emergency embolization could be carried out, if indicated.
* The occlusive balloon catheters are removed the following morning (after approximately 24 hours) and the arterial puncture sites are sealed with an arterial closure device.
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**Box 4.**

Intra- and postoperative complications of the Triple P Procedure.

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| * Four women had a postpartum hemorrhage in the first 24 hours of <1500 mL and three of these (i.e. 6.0%) had a uterine artery embolization as a consequence. No other women needed uterine artery embolization.
* Three women (6.0%) had thrombosis secondary to the internal iliac artery balloon placement. They received treatment and were discharged with no further complications. Following these complications, use of the pulse oximeter to both toes and infusion of saline were introduced to minimize these complications.
* Three women (6.0%) required ITU admission owing to massive obstetric hemorrhage.
* Only one patient (2.0%) had a bladder injury that was immediately repaired and recovered with no further complications. None of the women had any ureteric injury or other visceral injury.
* Another woman with antero-lateral placenta, extending partially into the broad ligament on the right side, required a re-laparotomy 8 hours after the intervention owing to internal bleeding from one of the small collateral arteries arising from the bladder. The bleeding vessel was ligated and she did not require embolization or ITU admission and recovered well.
* None of the 50 patients required an immediate or delayed hysterectomy.
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