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REVIEW ARTICLE

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Effectiveness of the Triple P Procedure and its modifications on reducing the blood loss and peripartum hysterectomy rates in women with Placenta Accreta Spectrum (PAS): a review of published literature

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ABSTRACT

Background: Placenta Accreta Spectrum (PAS) disorders has been reported to be associated with a maternal mortality rate of 7–10%, worldwide, and many women who survive, experience life changing morbidity. Triple P procedure (**p**- perioperative placental localization and incision on the myometrium above the upper border of the placenta; **p**- pelvic devascularisation; and **p**-placental non-separation and myometrial excision) was developed in 2010 as a novel conservative alternative to peripartum hysterectomy to avoid severe maternal morbidity and mortality). There have been several modifications to the original Triple P Procedure to achieve "pelvic devascularisation" based on locally available resources.

Objective: To determine the effectiveness of the Triple P Procedure and its modifications on reducing the blood loss and the rate of peripartum hysterectomy in women who were diagnosed to have placental accreta spectrum (PAS) by reviewing the published literature.

Materials and methods: PubMed, Embase and Google Scholar Search searches were made using "Triple P" and "Modified Triple P." Papers selected were assessed independently for content, data extraction and analysis. The following parameters were included for the analysis: total number of cases, total EBL, need for blood transfusion, injury to adjacent pelvic organs (urinary bladder, ureter, bowel), need for embolization, admission to intensive care unit (ICU), post-operative in-patient hospital stay, peripartum Hysterectomy, for "Modified" Triple P Procedure, the nature of the modification.Study characteristics were extracted using a predesigned data extraction table.

Results: The literature search identified 6 articles on the Triple P Procedure and 8 articles on the modified Triple P Procedure which were deemed eligible for analysis and comparison, based on the inclusion criteria. 75 patients had the Triple P procedure with an estimated mean blood loss of 2.31 L and a blood transfusion rate of 52%. The bladder injury rate was only 1.3%. None of the patients had a peripartum hysterectomy. Overall, 654 patients had the Modified Triple P procedure with an estimated mean blood loss of 1.4 L and a blood transfusion rate of 64.5%. The mean hospital stay was 3.86 days and 6.1% had a peripartum hysterectomy.

Conclusion: The Triple P Procedure and the Modified Triple P procedure are associated with lower estimated blood loss as compared to the reported rates with a peripartum hysterectomy. The Triple P Procedure was associated with lower rates of inadvertent injuries to the bladder and ureters as compared to the Modified Triple P Procedure and reported rates with peripartum hysterectomy. Both the Triple P and the Modified Triple P Procedure are associated with very low rates of peripartum hysterectomy (0% and 6.1%, respectively).

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Triple P Procedure; Modified Triple P Procedure; pelvic devascularisation; placenta accreta spectrum; peripartum hysterectomy; massive postpartum hemorrhage

Introduction

Placenta Accreta Spectrum (PAS) disorders (earlier referred to as "morbidly adherent placenta" or "abnormal invasion of the placenta") is a complex spectrum, ranging from mild to moderate adherence to the superficial (<50%) of the myometrium (placenta accreta), to deeper invasion (>50%) of the myometrium (placenta increta), culminating in a full thickness of the myometrium and extending beyond the uterine serosa (placenta percreta). The latter may invade

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adjacent tissues and organs such as the urinary bladder, ureters, the parametrium or the bowel increasing the risk of severe maternal morbidity and mortality due to extensive neovascularisation with increased risk of hemorrhage and/or due to mechanical effects of invasion. Although, destruction of the decidua basalis due to previous uterine trauma has been postulated to be the major predisposing factor for the abnormal trophoblastic invasion into the myometrium, other molecular mechanisms such as reduced expression of Micro mRNA 34a, Ecadherin (E-CAD), epidermal growth factor EGF c-(erbB-2), transforming growth factor beta (TGFb), vascular endothelial growth factor receptor 2 (VEGFR-2) and endothelial cell receptor tyrosine kinase (RTK) Tie-2 also contribute to PAS [1]. Large population-based studies have shown a linear association between the number of cesarean sections and placenta accreta spectrum [2–4], and in the presence of placenta praevia and the 4 previous cesarean section, the risk of placenta accreta spectrum has been shown to increase to 67% [2].

Peripartum hysterectomy has been the cornerstone for treatment for many years with several national societies and professional bodies recommending this radical surgical approach [5] despite reported serious maternal morbidity and mortality [6]. A large systematic review of one hundred and twenty-eight studies (7858 women) on emergency obstetric hysterectomy found that placental pathology was the leading cause, and the average blood loss was 3.7 L [7]. Moreover, the maternal mortality was 5.7 per 100 emergency hysterectomies, and it was higher (11.9 per 100 hysterectomies) in low resource settings [7]. In the United Kingdom, peripartum hysterectomy was recommended as the standard of care for women with PAS, despite the development of the novel conservative surgical procedure, the "Triple P Procedure" in 2010 [8], and a recommendation for a conservative approach to reduce severe maternal morbidity and mortality [9]. Unfortunately, it was only after the publication of Confidential Enquiries into Maternal Deaths Report (MBRRACE-UK: Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK) in 2018 which highlighted doubling of the maternal deaths, almost all of this increase was due to placental accreta spectrum [10], the Royal College of Obstetricians & Gynecologists (RCOG) revised their guideline on PAS [11]. This guideline finally recommended "delivery of the fetus without disturbing the placenta, followed by partial excision of the uterine wall (placental implantation site) and repair of the uterus" (i.e. the Triple Procedure) only in 2019 [11], despite the Triple P Procedure having been developed in the UK in 2010 with publications recommending a conservative approach in 2012 [8,9]. The UK Confidential Enquiries into Maternal Deaths Report in 2018 had concluded that "improvements in care may have made a difference to the outcome for 38% of women who died and 74% of women with major obstetric haemorrhage who survived" [10]. Therefore, earlier adoption of conservative approaches may have contributed to improved outcomes for women diagnosed with PAS. It is indeed very regrettable that a more recent population based comparative study between the UK (154 cases) and France (219 cases) reported that a larger proportion of women with PAS (43%) continue to have peripartum hysterectomy as compared to France (23%) which was statistically significant ($p < 0.001$), and a larger proportion of women in France received a uterus-sparing conservative surgery (36%) as compared to only 19% in the UK, which was also statistically significant ($p < 0.001$) [12]. This study also concluded that the total median blood loss in the UK was 3 L (IQR 1.7–6.5 L), compared with 1 L (IQR 0.5–2.5 L) in France, and more women with PAS had a severe postpartum hemorrhage (PPH) in the UK compared with women with PAS in France (58% vs 21%, $p < 0.001$) [12]. Continuing low rate of uterus-sparing surgery in the UK (19%), despite scientific publications highlighting the risks of severe maternal morbidity and mortality associated with peripartum hysterectomy [6,7,9] despite the International Consensus Guidelines produced by the International Federation of Gynecology and Obstetrics (FIGO) including the Triple P Procedure as a conservative management option in 2018 [13] highlights the challenges in changing the historical obstetric practices. Moreover, it is regrettable that despite the publication of the good maternal and perinatal outcomes following the first 50 cases of Triple P Procedure from a center in the UK in 2019 [14], 43% of women with PAS have been subjected to a peripartum hysterectomy, and they have had more than double the rate of severe postpartum hemorrhage as compared with women diagnosed with PAS in France [12]. Although, some have attempted to justify the increased poor outcomes observed in the UK based on the "disappointingly low at <50% prenatal diagnosis in both the UK and France" and that that "these data are 7–12 years old" [15], scientific evidence suggests that peripartum hysterectomy is associated with significantly increased risks of severe maternal morbidity [6,7]. In fact, the recent PACCRETA prospective study has also concluded that conservative management of PAS was associated with reduced rates of total estimated blood loss exceeding 3000 ml, blood transfusion, adjacent organ injury, and non-postpartum

hemorrhage-related severe maternal morbidity as compared to peripartum hysterectomy [16].

What is the Triple P Procedure?

The Triple P Procedure is a novel conservative surgical alternative to a peripartum hysterectomy, which aims to avoid the serious morbidity and mortality associated with peripartum hysterectomy as well as the drawbacks of intentional retention of the placenta (IRP). It has been shown that although leaving the entire placenta in in-situ within the uterine cavity may lead to a spontaneous resorption rate of 75% and therefore, would help avoid peripartum massive postpartum hemorrhage associated with a peripartum hysterectomy, it has been associated with secondary postpartum hemorrhage and sepsis [17]. In addition, a delayed hysterectomy rate of 10.8% and a severe maternal morbidity rate of 6% have also been reported [17]. A multicenter observational study by the by the International Society of Placenta Accreta Spectrum (PAS-IS) has also reported 41.7% delayed hysterectomy rate [18]. However, this study also reported a 57% hysterectomy rate and an associated 7.9% re-laparotomy rate [19]. Intentional retention of the placenta (IRP), in addition to the risks of delayed peripartum hysterectomy and sepsis [20], was also reported to be associated with risks of utero-cutaneous fistula [21,22] and a recent systematic review has highlighted increased risk of coagulopathy [23]. Despite these drawbacks, several authors have recently recommended a conservative surgical approach for PAS to minimize the risks of severe maternal morbidity and mortality associated with a peripartum hysterectomy, even in countries where PAS was traditionally managed with a peripartum hysterectomy [24–28]. In addition to the increased risk of massive postpartum hemorrhage, additional morbidity due to surgical complications such as urinary tract, bowel and pelvic nerve injury, and the loss of fertility and its accompanying psychological trauma that occur following a peripartum hysterectomy have made several experts to advocate a more conservative approach [9,25,26].

The Triple P Procedure was developed to avoid the serious maternal morbidity associated with a peripartum hysterectomy whilst avoiding the complications of IRP such as delayed hysterectomy and sepsis in 2010 [8,29,30]. One of the authors (EC) was urgently summoned to the operating theater by two obstetric consultants who were struggling to control the ongoing massive postpartum hemorrhage with an estimated blood loss (EBL) of 6.5 L in 2010. It was an undiagnosed case of placental percreta invading the bladder and the parametrium, and unfortunately, several attempts had been made to separate the placenta by the obstetricians, which had resulted in a torrential blood loss as well as injury to the urinary bladder. The author (EC) had no option but to perform a peripartum hysterectomy to save the life of the woman, and haemostasis was achieved with difficulty as the woman had also developed a coagulopathy. There was postoperative admission in the intensive care unit (ICU) and a prolonged recovery. This "near-miss" forced the author (EC) to think "outside the box" based on his previous experience as a trainee/resident whilst managing women with retained placentae who did not bleed if the placenta had remained attached to the myometrium. This gave birth to the Triple P Procedure where the key concept is "placental non-separation and excision of the placenta along with the underlaying (invaded) myometrial tissue, *en masse*, without any attempts to remove it. This avoided the serious maternal morbidity associated with peripartum hysterectomy due to inevitable bleeding abnormal neovascularisation, as well as the complications due to retaining the whole placenta with increased risks of secondary postpartum hemorrhage, delayed hysterectomy and coagulopathy.

The Triple P Procedure is comprised of three essential steps, starting with placental localization and the delivery of the fetus incision through the myometrial incision placed above the upper border of the placenta. This is crucial to minimize the blood loss during birth because performing a perioperative ultrasound scan immediately prior to commencing surgery to determine the upper border of the placenta enables the surgeon to avoid inadvertently cutting through the vascular abnormal placental venous sinuses, and the resultant hemorrhage. A transverse skin incision and cranially reflecting the subcutaneous tissue from the rectus sheath enables the access of the myometrium above the upper border of the placenta through the "St George's Boat" incision on the rectus sheath (Figure 1). This crucial step enables the surgeon to avoid any injury to the urinary bladder as well as massive hemorrhage by incising the "uninvaded" myometrium at a higher level on the uterus (Figure 2). The second step is pelvic devascularisation which is carried out immediately after the delivery of the neonate by inflating the pre-positioned occlusive balloon catheter placed into the anterior division of the internal iliac artery by the interventional radiology team, immediately prior to epidural anesthesia. This is crucial because the abnormally invading trophoblastic tissues and resultant neovascularisation receive their blood supply from the branches of uterine, vesical and pudendal arteries. Therefore, placement and the inflation of the occlusive balloons inside

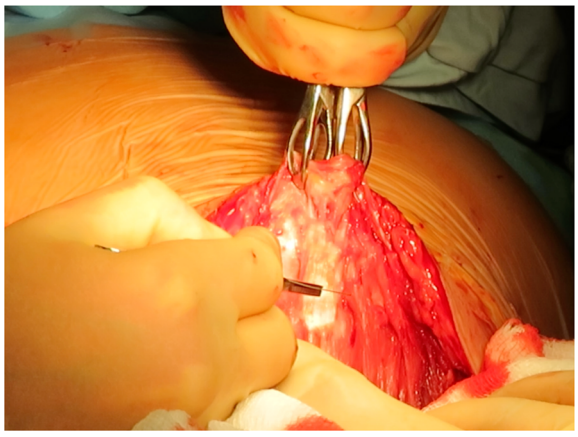

Figure 1. Conversion of a transverse skin incision into a midline incision through the "St George's Boat" incision, and creation of a rectus sheath flap to gain access to the myometrium at a higher level.

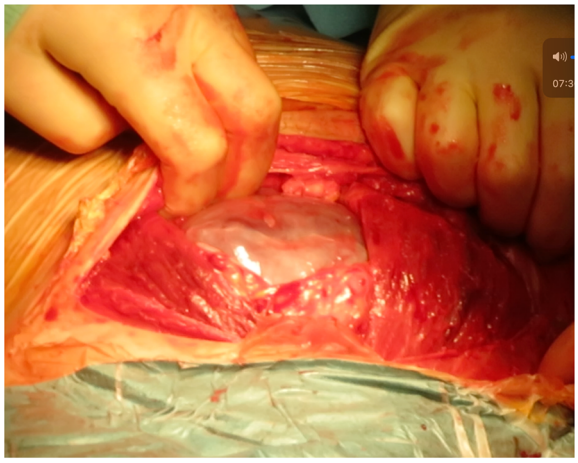

Figure 2. Placenta Percreta invading the urinary bladder and the lower uterine wall. St George's Boat Incision on the rectus sheath enables the surgeon to make an incision on the uterine myometrium above the upper border of the invading placenta.

the anterior division of the internal iliac artery would help reduce the pulse pressure of all its branches, significantly reducing the risk of bleeding prior to myometrial excision. In the absence massive obstetric hemorrhage and/or coagulopathy, the occlusive balloons are deflated after 2 h by the interventional radiology team, and the intravascular catheters are removed after 24 h. This approach minimizes the risk of arterial thrombosis secondary to prolonged occasion by balloons whilst enabling a rapid re-inflation of the intra-arterial occlusive balloons and embolization if there is excessive bleeding within the first 24 h of surgery [31]. The third step involves placental non-separation and myometrial excision after the blood supply to the myometrium have been reduced by pelvic devascularisation. A careful and systematic examination of the anterior surface of the uterus to determine the extent of abnormal invasion of the placenta and associated neovascularization both on the vertical and transverse planes is mandatory prior to myometrial excision. Parametrial invasion are not suitable for myometrial incision due to the increased risk of damage to the ureters and great vessels. However, focal myometrial excision is relatively easier in cases of abnormal invasion of the placenta on the posterior wall or around the cornua because normally adjacent pelvic organs are not invaded in these situations.

In contrast, abnormal invasion of the placenta in the lower anterior uterine wall may be associated with the invasion of the trophoblastic tissue into the urinary bladder. Therefore, it is important to ensure approximately 2 cm (at least one finger breadth) of myometrial/invaded bladder tissue is retained above the upper border of the urinary bladder during myometrial excision to facilitate the closure of the myometrial defect after the excision of the adherent placenta with the underlying myometrium [9,14,29–31]. If there is evidence of invasion into the urinary bladder, approximately 2–3 cm of the placental tissue at the site of this invasion is left behind after excising the rest of the placenta. Bleeding from the placental venous sinuses of this 2–3 cm of retained placental tissue can be easily controlled by the application of a local hemostat, such as the PerClot (Figure) and application of constant pressure with a warm saline pack for approximately 5–6 min. It has been reported that the mean blood loss was lower than for hysterectomy, and PerClot was also safe to be used with a cell saver [32]. Therapeutic broad-spectrum antibiotics should be continued for 5 days to reduce the risks of infection. This approach of leaving 2–3 cm of placental tissue attached to the urinary bladder undisturbed avoids an inadvertent injury to the urinary bladder which normally occurs when attempts are made to separate the adherent placental tissue from the posterior bladder wall. Therefore, an intentional or accidental cystotomy and resultant prolonged catheterization of the urinary bladder can be easily avoided. In cases of cervical trophoblastic invasion due to a central placenta praevia with accreta invading both anterior and posterior walls of the uterus, the use of the Bakri balloon inflated with approximately 150 ml of warm saline, and retained by two vertical compression sutures (vertical sandwich technique or the VST) is recommended [33,34]. This approach prevents the Bakri balloon inadvertently migrating to the upper uterine segment and ensures continuous pressure on the neovascularised cervical venous sinuses until blood clots are formed [33]. The balloon can be deflated and removed transvaginal

after 12 h of insertion. It has been shown that even if 2–3 cm of placental tissue invading the urinary bladder is left in-situ, 84% had complete resorption within 4 weeks, and no abnormal vascularity was seen on Doppler examination performed at 8 weeks after birth [35]. In addition, no remnant placental tissue was observed at 10 weeks post Triple P Procedure [35].

Reconstruction of the myometrial defect involves the assistant compressing the uterus to minimize the size of the defect after the administration of oxytocin infusion to contract and retract the uterus. After securing the branches of uterine arteries at both angles of the uterine incision, the application of three, interrupted "Box Stiches," two at the angles and one at the center enables the approximation of the upper and lower margins of the myometrial defect without undue tension [9,14,29–31]. This is followed by a continuous suture applied to the edges of the myometrial incision to achieve haemostasis from the edges (Figure). The size of the myometrial excision and resultant "defect" during the Triple P Procedure has been found to have no correlation with uterine biometry (total lengths of the anterior and posterior uterine wall and the endometrial cavity) after 8 weeks of surgery [35].

The reported mean length of stay after the Triple P procedure was 4.2 days, however, in the presence of co-morbidities such as diabetes mellitus and paralytic ileus, this was reported to be increased to 5.5 days [36]. The main objective of developing the Triple P Procedure was to avoid serious maternal morbidity and mortality and not preserve fertility. However, the first pregnancy following the Triple P Procedure was reported in 2017, with no recurrence in the subsequent pregnancy [37].

"Modified" Triple P Procedure

One of the limitations of the Triple P Procedure which was developed at St George's University Hospital in London in 2010 is its applicability in "low resource" healthcare settings due to the unavailability of interventional radiology service for pelvic devascularisation 24 h a day. However, it is laudable that clinicians from several countries have developed innovative, and cost-effective approaches to carry out "pelvic devascularisation" prior to the placental separation and myometrial excision. These include temporary clamping of the internal iliac arteries [38], ligation of internal iliac arteries [39], and the application of a tourniquet around the lower uterine segment to reduce the vascularity prior to myometrial excision [40]. These novel, innovative approaches to modify the second 'p' (pelvic devascularisation) has enabled the advantages of the original Triple P Procedure to be made available for women in healthcare settings where there is limited or no access to interventional radiology services (Figure 3). These studies using the "Modified" Triple P Procedure have reported both short term and long term maternal and perinatal outcomes [38–43].

Objective

To determine the effectiveness of the Triple P Procedure and its modifications on reducing the blood loss and the rate of peripartum hysterectomy in women who were diagnosed to have placental accreta spectrum (PAS) by reviewing the published literature.

Materials & methods

Medline, Embase, and Google Scholar were searched electronically utilizing combinations of the relevant medical subject heading (MeSH) terms, key words, and word variants for "Triple P Procedure," and "Modified Triple P Procedure." The search and selection criteria were restricted to the English language. Reference lists of relevant articles and reviews were hand-searched for additional reports.

The following parameters were included for the analysis:

1. Total number of cases
2. Total EBL
3. Need for blood transfusion
4. Injury to adjacent pelvic organs (urinary bladder, ureter, bowel)
5. Need for embolization
6. Admission to intensive care unit (ICU)
7. Post-operative in-patient hospital stay
8. Peripartum Hysterectomy
9. For "Modified" Triple P Procedure, the nature of the modification.

The abstracts of all potentially relevant papers were examined individually for suitability by IM, and scientific articles were excluded at this stage only if they did not meet the inclusion criteria. The remaining papers were obtained in full text and were assessed independently for content, data extraction and analysis. Study characteristics were extracted using a predesigned data extraction table. Studies which did not report the occurrence of the observed outcomes were excluded.

Results

The literature search identified 6 articles on the Triple P Procedure (Table 1), and 8 articles on the modified Triple P Procedure (Table 2), which were deemed

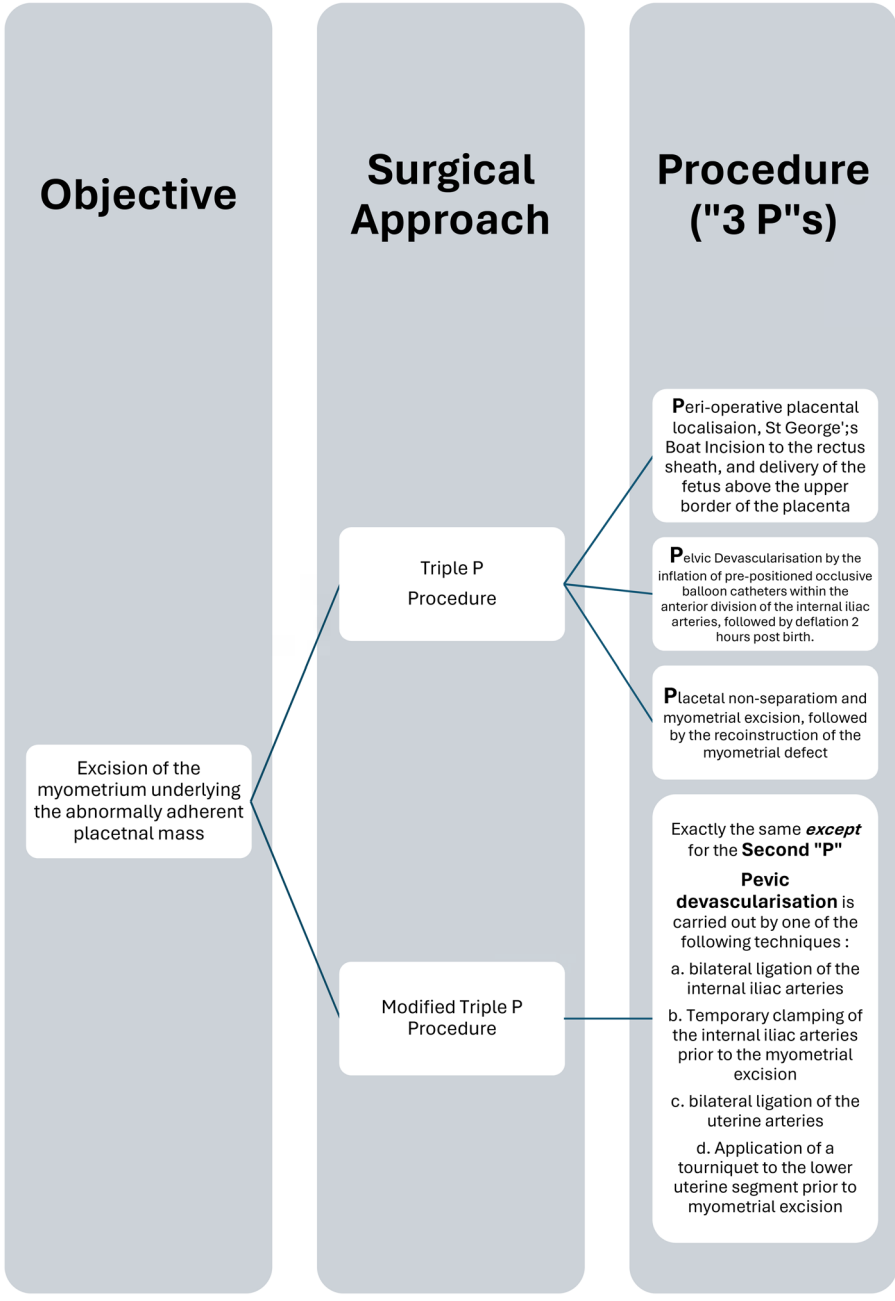

Figure 3. Comparison of the surgical steps involved in the Triple P and the modified Triple P procedures.

eligible for analysis and comparison, based on the inclusion criteria.

Outcomes following the Triple P Procedure

Overall, 75 patients had the Triple P procedure with an estimated mean blood loss (EBL) of 2.31 L and a blood transfusion rate (BTR) of 52%. Bladder injuries occurred in 1.3% with no cases of ureteric injuries (Table 1). No patients underwent ureteric catheterization either prior to or during the procedure. Only 8% required post-operative embolization following the inflation of intra-vascular occlusive balloons into the anterior division of the internal iliac arteries. 4% required admission into the intensive care unit (ICU) following massive obstetric hemorrhage. The mean hospital stay was 4.5 days and none of the patients (0%) had a delayed peripartum hysterectomy.

Outcomes following the Modified Triple P Procedure

Overall, 654 patients had the *Modified* Triple P procedure with an estimated mean blood loss (EBL) of 1.4 L and a blood transfusion rate (BTR) of 64.5%. Bladder injuries occurred in 15.9% s (Table 2). Only 0.3%

Table 1. Triple P.

Year of Publications & authors	No of cases	Total EBL	Need for transfusions	Injury to adjacent organs	Need for embolization	Admission to ICU	Post-op inpatient stay	Hysterectomy
Teixidor Vinas M 2015	19	2.31 ± 1.38	9	0	3	0 (managed in obstetric HDU within the labor ward)	4.75 ± 2.02	0
Benko M 2020	1	nr	1	0	0	0 (managed in obstetric HDU within the labor ward)	5	0
Chandraharan E 2011	4	nr	nr	0	0	0 (managed in obstetric HDU within the labor ward)	nr	0
Carrillo AP 2017	50	2.318 (0.400–7.3)	29	1	3	3 (47 were managed in obstetric HDU within the labor ward)	4 (2–8)	0
Cauldwell M 2017	1	nr	nr	0	0	0	nr	0
Total / Average	75	Mean = 2.31 L	52%	1.3%	8%	4%	4.5 days (based on reported cases)	0

required post-operative embolization following the inflation of intravascular occlusive balloons into the anterior division of the internal iliac arteries. 4% required admission into the intensive care unit (ICU) following massive obstetric hemorrhage. The mean hospital stay was 3.86 days and 6.1% of patients had a peripartum hysterectomy.

Discussion

To our best knowledge, this is the first scientific; paper which analyzed the outcomes of published cases of both the Triple P and the Modified Triple P Procedure. We believe that the findings of our study will provide useful information for frontline clinicians working in both well-resourced, and under-resourced healthcare settings to counsel their patients regarding the surgical options which are now available for the management of placental accreta spectrum disorders (PAS). Our results show that the Triple P Procedure has reduced rate of complications as compared with those reported with the peripartum hysterectomy (Table 3). In fact, our findings are compatible with the recent publications which have concluded that local resection of the myometrium may avoid a peripartum hysterectomy in approximately 80% of women [44] and had a lower complication rate.

Our analysis shows that both the Triple P Procedure and the Modified Triple P Procedure are associated with a lower estimated blood loss (EBL), blood transfusion rate and injury to adjacent structures as compared with the published outcomes with a peripartum hysterectomy. These differences in the complication rates can be explained by the meticulous surgical techniques employed during the myometrial resection which avoids extension of the incision and/or the application of any clamps outside the margins of the invaded myometrium. This approach avoids inadvertent injuries to the urinary bladder and the ureters and does not require any ureteric catheterization prior to or during the procedure.

Our results show that as compared to the Triple P Procedure, the Modified Triple P Procedure is associated with greater blood loss (52% vs 64.5%), increased rate of bladder injuries (1.3% vs 15.9%) and peripartum hysterectomy rate (0% vs 6.1%). These differences can be explained by the fact that application of a uterine tourniquet will not be effective in all cases because if the placental invades the urinary bladder and/or the cervix, the tourniquet may not be able to achieve adequate haemostasias. In addition, the tourniquet may "cut-through" the bladder resulting in an inadvertent bladder injury. Similarly, the application of uterine artery ligatures may not be able to arrest the blood supply arising from the collateral blood vessels (i.e. vesical, rectal and the branches of the internal pudendal blood vessels). In contrast, the use of interventional radiology techniques immediately prior to the Triple P Procedure to ensure the placement of the occlusive balloon catheters within the anterior division of the internal iliac arteries ensures reduced blood flow through the collaterals. It is very likely that this approach reduced the likelihood of blood transfusions as well as the subsequent need for a peripartum hysterectomy.

Nevertheless, the Modified Triple P Procedure offers an important surgical alternative to reduce severe maternal morbidity in under-resourced and resource-poor healthcare settings. Although, compared to the Triple P Procedure, the likelihood of a peripartum hysterectomy was found to be greater in our study (0% vs 6.1%), it is important to appreciate that approximately 94% of women had avoided a peripartum hysterectomy in these under-resourced healthcare settings with challenging health economy. Compared to a routine gynaecological hysterectomy, a peripartum hysterectomy is associated with serious morbidity and mortality [6], in addition to the loss of fertility and the detrimental effects of surgical menopause in a young woman. In

Table 2. Modified TripleP.

Year of Publications & authors	No of cases	What is the modification?	Reason for modification	Total EBL	Need for transfusion	Injury to adjacent organs	Need for embolization	Admission to ICU	Post-op inpatient stay	Hysterec-tomy
Wei Y 2017	45	Vertical incision. Creating a bladder flap and pushing the bladder caudally to the cervical internal os level. Foley catheter to bundle the lower uterine segment instead of interventional occlusion of iliac artery by balloon catheters. Removing the placenta manually except that invaded into the myometrium.	Unavailable interventional radiology	nr	40	0	0	4	4.295 ± 0.587	0
Vuong ADB 2023	217	Vesicouterine dissection along with hemostatic neo vascular sutures before performing the uterine incision. A tourniquet is first put into the para-cervical area (using a Foley 12-F catheter), and bilateral uterine artery ligation (using Chromic 1/0) is performed, followed by manual placen tal removal (without forcibly extracting the whole placenta in the case of failed placental separation). Suture of both edges of the uterine incision and hemostatic sutures of the placental bed surface (using chromic suture 1/0) are performed. Finally, the tourniquet is released and a transverse B-Lynch com pression suture is made.	nr	1.518 ± 1.275	151	9	0	nr	7.18 ± 2.14	22
Mousa A 2023	20	Sub umbilical midline skin incision is performed. Devascularisation of the newly formed vessels between the anterior surface of the uterus and the posterior bladder wall is done by either direct cauterization or ligation with 2.0 polyglactin. Devascularization of the placental bed is achieved by ligating the uterine arteries on both sides just below the area of PAS. These sutures enter from the anterior uterine wall (passing through the entire thickness of the anterior and posterior uterine walls at the lateral side of the uterus) and exit from the posterior uterine wall. The same type of suture is applied using the same technique, at two centimeters above the incision line. Anterior and posterior cervical wall vascular control sutures are then placed. Trans verse interrupted compression sutures are then applied to the placental bed in the posterior or the remaining anterior uterine wall	Devascularize the uterus without the need for inter ventional radiology or the complex surgical skills required for safe access to the retroperitoneal space	1.431 ± 360	20	1	0	0	1.3 ± 0.73	2
Mohammad AA 2019	57	Ligate the anterior division of the internal iliac ar tery bilaterally. If the placenta separates partially, extract it and back the lower uterine segment by gauze. Dissec the bladder down to the cervico-vaginal junction. Avoid dissection of adherent bladder at the midline. Approach the bladder from the lateral aspect of the vesico-cervical space.	nr	nr	57	5	0	11	1.6 ± 0.6	0
Tskhay VB 2017	35	Devascularization of the uterus with clamping procedure instead of performing balloon occlusion of internal iliac arteries	balloon occlusion of internal iliac arteries is still not available	nr	nr	1	0	0	8.2 ± 1.9	0
Zhao H 2022	142	Prophylactic abdominal aorta balloon occlusion and/or tourniquet, single continuous suture was performed on the lower lip of the uterine incision before the incision was closed	nr	nr	77	3	2	6	4 (4–7)	0
Mumtaz S 2022	56	Devascularization of the uterus by ligation of both internal iliac arteries instead of performing balloon occlusion of internal iliac arteries	nr	nr	nr	nr	0	nr	nr	3
Ghaleb MM 2021	62	Dissection of the visceral peritoneum reflected over the urinary bladder. Devascularization of the uterus by ligation of both internal iliac arteries instead of performing balloon occlusion of internal iliac arteries. Manual placental separation Grasping the cervix from inside the uterine cavity	nr	nr	62	3	0	nr	nr	12
Abd-Elmoneim Abo-Elroose A 2019	20	Bilateral uterine artery ligation. Re-suturing of the remaining healthy uterine tissue in a T-shaped manner	to have a better anatomical tissue cooptation	1.480	16	1	0	nr	3.8 ± 1.4	1
Total / Average	654			1.47 L	64.6%	15.9%	0.3%		3.86	6.1%

Table 3. Comparison of reported outcomes between the Triple P Procedure & peripartum hysterectomy.

Complication	Triple P Procedure (50 cases) [14]	Peripartum Hysterectomy (reported rates in the FIGO Guideline) [13]
Cystotomy	2 %	7% – 48%
Ureteric Injuries	0%	0–18%
Mean Blood Loss	2.3 L	2.0–3.0 L
ITU Admission	4%	15%–66%
Venous Thromboembolism	0%	4%
Return to Theater	2.5%	4–18%
Maternal Mortality	0%	1–7%

addition to the avoidance of increased healthcare costs, avoidance of a peripartum hysterectomy may also reduce the need for blood transfusions and admission to the intensive care units which may pose challenges for a resource-restrained healthcare system.

The findings of our study suggest that compared with the traditional obstetric approach of universal peripartum hysterectomy and subsequent attempts of leaving the entire placenta in-situ (intentional retention of the placental or IRP), with their respective serious maternal morbidity, local resection of the myometrium using the Triple P or the Modified Triple P Procedure appears to be viable alternative. The aim of obstetric practice has always been to have a live, healthy and undamaged mother and her baby at the end of pregnancy and birth. Our analysis shows that the Triple P Procedure and the Modified Triple P Procedure are both associated with reduced estimated blood loss, reduced blood transfusion rate, reduced injury to adjacent organs and peripartum hysterectomy rate. Therefore, it is vital that frontline clinicians consider these novel, conservative surgical options in both well-resourced and resource poor healthcare settings,

The main strength of the study is a robust analysis of the published cases of both the Triple P and the Modified Triple P Procedures. We considered the parameters which would be clinically relevant to practicing frontline clinicians. We acknowledge that our study has limitations. Firstly, it is a retrospective study and therefore, it is exposed to the drawbacks of conducting any retrospective study. Secondly, we acknowledge that in the absence of a stratification of the severity of PAS, it is difficult to evaluate the outcomes in patients undergoing classic and modified Triple P procedures. Thirdly, it may be argued that the numbers are small. However, the placental accreta spectrum is relatively a rare clinical condition, and both Triple P Procedure and its various modifications are relatively newer techniques, compared to a peripartum hysterectomy or an IRP. We strongly believe that, although the numbers are small, the findings of our study may have a positive clinical impact both in well-resourced, and resource restrained healthcare systems. Consideration of a viable alternative to a peripartum hysterectomy by frontline clinicians may help avoid serious short term and long term maternal morbidly including negative psychological sequalae associated with loss of the uterus. We acknowledge that further evidence from prospective multicenter studies is needed to demonstrate that the Triple P (or the Modified Triple P) Procedure is a safer option than the one step conservative surgery or leaving the entire placenta *in situ*. Furthermore, currently there is no robust evidence confirming that the Triple P is feasible and safe in all cases of PAS, especially in cases with parametrial involvement. However, the vast majority of cases of PAS involve the abnormal invasion of the placenta through the previous uterine scar (i.e. anterior uterine wall), and therefore, the Triple P Procedure (or its' modifications) is likely to be very effective in such cases of anterior placental invasion. Although, the Triple P Procedure is a conservative surgical alternative to a peripartum hysterectomy, it requires advanced expertise which includes the use of interventional radiology procedures to support surgery to ensure improvement in clinical outcomes. The modifications to the Triple P Procedure enable this conservative surgical technique to be used in resource-limited healthcare settings.

Implications for clinical practice

We hope that the findings of the study will help ensure a paradigm shift in the management of placenta accreta spectrum disorders, which is due to the abnormal invasion of the trophoblasts and not the uterus. Therefore, resection of the invaded myometrium should be considered as the first line treatment, and a peripartum hysterectomy should be considered as a life-saving radical option in the obstetrician's armamentarium. This was similar to performing a routine total abdominal hysterectomy for perimenopausal bleeding 30 years ago, and subsequently using endometrial ablation and hormonal treatments after the realization by the gynecologists, albeit very late, that the abnormal, perimenopausal bleeding was mostly due to an endometrial pathology and not the myometrial pathology. Similarly, once obstetricians realize that placenta accreta spectrum disorders are due to the abnormal invasion of the placental and not the uterus, it is hoped that a paradigm shift to a conservative local resection of the invading placenta and the underlying myometrium will occur. This is essential to avoid severe morbidity, including adverse psychological sequalae associated with a peripartum hysterectomy in young women of reproductive age. Although recently it has been reported that local resection of the

myometrium may avoid hysterectomy in up to 80% of cases [44], our analysis shows that a peripartum hysterectomy can be avoided by 100% and 93. 9% by the Triple P Procedure and the Modified Triple P Procedure, respectively. However, obstetricians who perform the Triple P Procedure and Modified Triple P Procedure must have the necessary surgical skills, expertise, clinical acumen, and competency to perform an immediate peripartum hysterectomy, if required to optimize maternal outcomes. If these procedures are performed by obstetricians who lack a sound knowledge of pelvic anatomy and pathogenesis of placenta accreta spectrum, serious patient safety incidents may occur. Therefore, surgery for PAS must be performed by obstetricians and gynecologists with the required surgical skills, knowledge, competencies and expertise, irrespective of the chosen modality of treatment: Triple P, Modified Triple P, local resection or a peripartum hysterectomy.

Conclusion

The Triple P Procedure and the Modified Triple P procedure are associated with lower estimated blood loss reported with a peripartum hysterectomy. They are also associated with lower rates of inadvertent injuries to the bladder and ureters. Both the Triple P and the modified Triple P Procedure are associated with very low rates of peripartum hysterectomy (0% and 6.1%, respectively).

Disclosure statement

EC pioneered the development of the Triple P Procedure in 2010. IM, SE, FA and EC, have no conflicts of interests relating this invited review.

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References

[1] Ali H, Chandraharan E. Etiopathogenesis and risk factors for placental accreta spectrum disorders. Best Pract Res Clin Obstet Gynaecol. 2021;72:4–12. doi: 10.1016/j.bpobgyn.2020.07.006.

[2] Clark SL, Koonings PP, Phelan JP. Placenta previa/accreta and prior cesarean section. Obstet Gynecol. 1985;66(1):89–92.

[3] Fitzpatrick KE, Sellers S, Spark P, et al. Incidence and risk factors for placenta accreta/increta/percreta in the UK: a national case-control study. PLoS One. 2012;7(12):e52893. doi: 10.1371/journal.pone.0052893.

[4] Fitzpatrick K, Sellers S, Spark P, et al. The management and outcomes of placenta accreta, increta, and percreta in the UK: a population-based descriptive study. BJOG. 2014;121(1):62–71. doi: 10.1111/1471-0528.12405.

[5] American College of Obstetricians and Gynecologists; Society for Maternal-Fetal Medicine. Obstetric Care Consensus No. 7: Placenta Accreta Spectrum. Obstet Gynecol. 2018;132(6):e259–e275.

[6] Wright JD, Devine P, Shah M, et al. Morbidity and mortality of peripartum hysterectomy. Obstet Gynecol. 2010;115(6):1187–1193. doi: 10.1097/AOG.0b013e3181df94fb.

[7] van den Akker T, Brobbel C, Dekkers OM, et al. Prevalence, indications, risk indicators, and outcomes of emergency peripartum hysterectomy worldwide: a systematic review and meta-analysis. Obstet Gynecol. 2016;128(6):1281–1294. doi: 10.1097/AOG.0000000000001736.

[8] Chandraharan E, Rao S, Belli AM, et al. The Triple-P procedure as a conservative surgical alternative to peripartum hysterectomy for placenta percreta. Int J Gynaecol Obstet. 2012;117(2):191–194. May doi: 10.1016/j.ijgo.2011.12.005.

[9] Chandraharan E. Should the Triple-P procedure be used as an alternative to peripartum hysterectomy in the surgical treatment of placenta percreta? Womens Health. 2012;8(4):351–353. doi: 10.2217/whe.12.24.

[10] Knight M, Bunch K, Tuffnell D, Jayakody H, Shakespeare J, Kotnis R, Kenyon S, Kurinczuk JJ, on behalf of MBRRACE-UK, (Eds.). Saving lives, improving mothers' care – lessons learned to inform maternity care from the UK and Ireland Confidential Enquiries into Maternal Deaths and Morbidity 2014-16. Oxford: National Perinatal Epidemiology Unit, University of Oxford, 2018. https://www.npeu.ox.ac.uk/assets/downloads/mbrrace-uk/reports/MBRRACE-UK%20Maternal%20Report%202018%20-%20Web%20Version.pdf.

[11] Jauniaux E, Alfirevic Z, Bhide AG, et al. Placenta praevia and placenta accreta: diagnosis and management. Green-top Guideline No. 27a. BJOG. 2019;126(1):e1–e48. doi: 10.1111/1471-0528.15306.

[12] McCall SJ, Deneux-Tharaux C, Sentilhes L, et al. Placenta accreta spectrum – variations in clinical practice and maternal morbidity between the UK and France: a population-based comparative study. BJOG. 2022;129(10):1676–1685. doi: 10.1111/1471-0528.17169.

[13] Sentilhes L, Kayem G, Chandraharan E, et al. FIGO consensus guidelines on placenta accreta spectrum disorders: conservative management. Int J Gynaecol Obstet. 2018;140(3):291–298. Mar doi: 10.1002/ijgo.12410.

[14] Pinas-Carrillo A, Bhide A, Moore J, et al. Outcomes of the first 50 patients with abnormally invasive placenta managed using the "Triple P Procedure" conservative surgical approach. Int J Gynaecol Obstet. 2020;148(1):65–71. doi: 10.1002/ijgo.12990.

[15] Bhide A. BJOG mini commentary on Placenta accreta spectrum – variations in clinical practice and maternal morbidity between UK and France: a population-based comparative study. BJOG. 2022;129(10):1686–1686. doi: 10.1111/1471-0528.17170.

[16] Sentilhes L, Seco A, Azria E, et al. Conservative management or cesarean hysterectomy for placenta accreta spectrum: the PACCRETA prospective study. Am J Obstet Gynecol. 2022;226(6):839.e1–839-e24. doi: 10.1016/j.ajog.2021.12.013.

[17] Sentilhes L, Ambroselli C, Kayem G, et al. Maternal outcome after conservative treatment of placenta accreta. Obstet Gynecol. 2010;115(3):526–534. Mar doi: 10.1097/AOG.0b013e3181d066d4.

[18] van Beekhuizen HJ, Stefanovic V, Schwickert A, et al. A multicenter observational survey of management strategies in 442 pregnancies with suspected placenta accreta spectrum. Acta Obstet Gynecol Scand. 2021;100(Suppl 1):12–20. doi: 10.1111/aogs.14096.

[19] Shainker SA, Coleman B, Timor-Tritsch IE, et al. Special Report of the Society for Maternal-Fetal Medicine Placenta Accreta Spectrum Ultrasound Marker Task Force: consensus on definition of markers and approach to the ultrasound examination in pregnancies at risk for placenta accreta spectrum. Am J Obstet Gynecol. 2021;224(1):B2–B14. doi: 10.1016/j.ajog.2020.09.001.

[20] Sentilhes L, Kayem G, Mattuizzi A. Conservative approach: intentional retention of the placenta. Best Pract Res Clin Obstet Gynaecol. 2021;72:52–66. doi: 10.1016/j.bpobgyn.2020.07.010.

[21] Meyer NP, Ward GH, Chandraharan E. Conservative approach to the management of morbidly adherent placentae. Ceylon Med J. 2012;57(1):36–39. doi: 10.4038/cmj.v57i1.4199.

[22] Athanasias P, Krishna A, Karoshi M, et al. Uterocutaneous fistula following classical caesarean delivery for placenta percreta with intentional retention of the placenta. J Obstet Gynaecol. 2013;33(8):906–907. doi: 10.3109/01443615.2013.825583.

[23] Abi Habib P, Goetzinger K, Turan OM. Placenta accreta spectrum conservative management and coagulopathy: case series and systematic review. Ultrasound Obstet Gynecol. 2024;63(6):731–737. doi: 10.1002/uog.27547.

[24] Einerson BD. Conservative management for placenta accreta spectrum: questions and barriers remain but are surmountable. Am J Obstet Gynecol MFM. 2023;5(3):100859. doi: 10.1016/j.ajogmf.2023.100859.

[25] Sichitiu J, El-Tani Z, Mathevet P, et al. Conservative surgical management of placenta accreta spectrum: a pragmatic approach. J Invest Surg. 2021;34(2):172–180. Feb doi: 10.1080/08941939.2019.1623956.

[26] Chandraharan E. Need for an urgent paradigms shift in thinking to avoid serious maternal morbidity and mortality associated with PAS. Best Pract Res Clin Obstet Gynaecol. 2021;72:1–3. doi: 10.1016/j.bpobgyn.2021.04.001.

[27] Sentilhes L, Kayem G, Silver RM. Conservative management of placenta accreta spectrum. Clin Obstet Gynecol. 2018;61(4):783–794. doi: 10.1097/GRF.0000000000000395.

[28] Pineles BL, Sibai BM, Sentilhes L. Is conservative management of placenta accreta spectrum disorders practical in the United States? Am J Obstet Gynecol MFM. 2023;5(3):100749. doi: 10.1016/j.ajogmf.2022.100749.

[29] Pinas-Carrillo A, Chandraharan E. Management of morbidly adherent placenta. Obstetrics, Gynaecol Reproduct Med. 2016;26(10):283–290. doi: 10.1016/j.ogrm.2016.07.006.

[30] Piñas Carrillo A, Chandraharan E. Placenta accreta spectrum: risk factors, diagnosis and management with special reference to the Triple P procedure. Womens Health. 2019;15:1745506519878081.

[31] Piñas-Carrillo A, Chandraharan E. Conservative surgical approach: the Triple P procedure. Best Pract Res Clin Obstet Gynaecol. 2021;72:67–74. doi: 10.1016/j.bpobgyn.2020.07.009.

[32] Chandraharan E, Pinas A, Hartopp R, et al. Effectiveness of the local haemostat "PerClot" as an adjuvant for Triple P Procedure for the management of placenta percreta. Book of Abstracts. World Congress of the Royal College of Obstetricians and Gynaecologists (RCOG), Liverpool. June 2016.

[33] Benko M, Crespo Rodriguez M, Chandraharan E. Conservative surgical management with Triple P procedure for the Placenta Accreta with Cervical Invasion: case report. Estudi De Casos. 2020. doi: 10.3306/MEDICINABALEAR.35.03.39.file:///Users/edwin/Downloads/Dialnet-ConservativeSurgicalManagementWithTriplePProcedure-7582998-1.pdf.

[34] Chandraharan E, Commare A, Pinas A, et al. The role of the "Vertical Sandwich Technique" (VST) for abnormal invasion of the placenta of the cervix in reducing postpartum haemorrhage and peripartum hysterectomy. Book of Abstracts. European Congress of Intrapartum Care (ECIC). Turin, March. 2019; [cited 2024 Oct 30]. Available from: https://www.researchgate.net/publication/333034348_THE_ROLE_OF_THE_VERTICAL_SANDWICH_TECHNIQUE_VST_FOR_ABNORMAL_INVASION_OF_THE_PLACENTA_OF_THE_CERVIX_IN_REDUCING_POSTPARTUM_HAEMORRHAGE_AND_PERIPARTUM_HYSTERECTOMY.

[35] Chandraharan E, Moore J, Hartopp R, et al. Does the size of the myometrial excision during the Triple P Procedure for the management of placenta percreta matter? Analysis of the first 25 cases. Book of Abstracts. World Congress of the Royal College of Obstetricians and Gynaecologists (RCOG), Liverpool. June 2016.

[36] El Tahan M, Carrillo AP, Moore J, et al. Predictors of postoperative hospitalisation in women who underwent the Triple-P Procedure for abnormal invasion of the placenta. J Obstet Gynaecol. 2018;38(1):71–73. doi: 10.1080/01443615.2017.1334141.

[37] Cauldwell M, Chandraharan E, Pinas Carillo A, et al. Successful pregnancy outcome in woman with history of Triple-P procedure for placenta percreta. Ultrasound Obstet Gynecol. 2018;51(5):696–697. doi: 10.1002/uog.17566.

[38] Tskhay VB, Yametov PK, Yametova NM. Efficiency of modified method "Triple-P" as a conservative surgical alternative to hysterectomy in cases of placenta previa accreta/percreta. In: Presented at BIT's 4th International Congress of Obstetrics and Gynaecology. Spain: Barcelona; 2016.

[39] Zhao R, Zheng Y, Ruyue M, et al. Experience of diagnosis and treatment of 16 cases of placenta accreta spectrum at different degrees: a case report. J Surgery. 2023;3(2):1119.

[40] Abo-Elroose AA, Ahmed MR, Shaaban MM, et al. Triple P with T-shaped lower segment suture; an effective novel alternative to hysterectomy in morbidly adherent anterior placenta previa. J Matern Fetal Neonatal Med. 2021;34(19):3187–3191.

[41] Wei Y, Cao Y, Yu Y, et al. Evaluation of a modified "Triple-P" procedure in women with morbidly adherent placenta after previous caesarean section. Arch Gynecol Obstet. 2017;296(4):737–743. doi: 10.1007/s00404-017-4447-0.

[42] Tskhay VB, Yametov PK, Yametova NM. The use of modified Triple-P method with adherent placenta long-term results. MOJ Womens Health. 2017;4:e00079.

[43] Zhao H, Zhao X, Chen C, et al. Effects and long-term outcomes of a modified triple-P procedure in patients with severe PAS: a retrospective cohort study. Front Med. 2022;9:839716. doi: 10.3389/fmed.2022.839716.

[44] Palacios-Jaraquemada JM, Fiorillo A, Hamer J, et al. Placenta accreta spectrum: a hysterectomy can be prevented in almost 80% of cases using a resective-reconstructive technique. J Matern Fetal Neonatal Med. 2022;35(2):275–282.