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RESEARCH

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Uterovesical tourniquet for conservative management of placenta accreta spectrum: a prospective cohort study in a low-resource setting

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Abstract

Background Placenta accreta spectrum (PAS) is a condition affecting the placental detachment during labour and could be associated with life-threatening haemorrhage. We evaluated a novel uterovesical tourniquet technique to reduce blood loss during uterine sparing surgery.

Methods This is a prospective cohort study that was conducted between 01/10/2023 and 01/04/2024, at Cairo University Hospital. Pregnant women with confirmed intra operative diagnosis of PAS were recruited to this study. The study included the application of a tourniquet around the lower part of the uterus and bladder before the delivery of the fetus to control blood loss during the operation. The primary outcomes were the operative procedure performed (Uterine sparing surgery Vs Caesarean Hysterectomy) and the measurement of the intraoperative blood loss.

Results Twelve patients were included in this study. The average gestational age at deliver was 35.17 weeks ± 0.72. The uterine sparing surgery was successful in 11 out of the 12 patients (91.7%). The mean intraoperative blood loss was 950 mL ± 233.55 and the average operative time was 84.58 min ± 41.64. The mean number of packed RBCs units' transfused was 1.58 units ± 1.38. One bladder injury occurred.

Conclusion The uterovesical tourniquet may reduce haemorrhage in PAS, offering a feasible option for resource-limited settings.

Trial registration This trial has been registered on clinicaltrials.gov with the identifier NCT06185894.

Keywords Placenta Accreta Spectrum, Uterine sparing treatment, Uterovesical Tourniquet

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Background

Placenta accreta spectrum (PAS) is a group of placental disorders affecting the placental detachment from the myometrium during birth, often requiring surgical interventions [1]. The most significant risk factors for PAS are placenta previa and having a previous caesarean delivery (CD). Caesarean scar pregnancy can contribute towards the development of PAS as the pregnancy advances" [2, 3]. The challenging aspect of managing this condition is limiting the maternal morbidities such as massive obstetric hemorrhage, massive blood transfusion, and disseminated intravascular coagulation [4].

There is no standardized treatment for PAS [5]. To optimize the surgical outcomes, interventions have been developed to limit the blood loss. However, in situations where the placenta is attached to the lower uterine wall, a caesarean hysterectomy would be the ideal treatment. [2, 6, 7]. Various techniques of caesarean hysterectomy for PAS have been published, such as the Soleymani-Alazzam-Collins (SAC) technique, which involves performing a radical hysterectomy for the removal of the uterus with the placenta in situ. [8].

Depending on the extent and grade of PAS, uterine sparing surgery could be successful in providing hemostasis while preserving the fertility. [9] Intentional placental retention with long term follow-up has been recognized as an approach. However, the longer postoperative hospital stays, higher risk of infection and compromised future fertility might limit the use of this option. [10] Alternative approaches include uterine artery embolization and the use of abdominal aortic balloons, which can significantly limit the blood loss during. [11, 12] Kasr Alainy simplified uterine sparing surgery technique offers a conservative surgical approach for the management of PAS, suitable for application in the low- and middle-income countries (LMICs) [13].

In this study, we introduce a novel application of an established surgical technique for hemostasis during the uterine sparing surgery of PAS. We placed a uterovesical tourniquet pre-delivery to occlude placental perfusion, hypothesizing that this low-cost, technically simple method could improve the surgical outcomes in uterine sparing surgery for the management of PAS. This study evaluates its feasibility and safety in a prospective cohort.

Methods

This is a prospective cohort study that was conducted between 01/10/2023 and 01/04/2024, at the University Department of Obstetrics and Gynecology, Faculty of Medicine, Cairo University. The study was approved by the Research Ethics Committee (REC), Faculty of Medicine, Cairo University, with the registration number MS-105–2023. It was additionally registered on clinicaltrials.gov with the identifier NCT06185894. The registration date is on the 15th of December, 2023. The first patient was enrolled on this study on the 17th of December 2023. Except for the availability of an interventional radiologist and cell salvage devices, our center meets the recommended criteria of the International Society for Placenta Accreta Spectrum (IS-PAS: previously IS-AIP) for an accredited specialist PAS center [14].

Women presenting to our unit with the high suspicion of the diagnosis of PAS, based on ultrasound evaluation, were given the option to participate in this study after an extensive counseling. This included a discussion about the potential benefits, risks, and alternatives to this modified technique for the management of PAS. Those who agreed to participate signed an informed consent with the option to opt out at any stage of the study.

The included patients in this study were pregnant women with sonographic diagnosis of PAS, confirmed by intra operative inspection and post-operative histopathological examination. Additionally, the women would have had at least one previous caesarean section and desire fertility preservation. The exclusion criteria included women not desiring future fertility, chronic medical disorders, and those requiring an emergency delivery due to antepartum hemorrhage of labor pains.

Women who met the criteria, and consented to participating in the study underwent an ultrasound scan to confirm the gestational age, assess the placenta, and confirm PAS and its topography. The ultrasound was performed by a fetal medicine specialist using a 4–8 MHZ transabdominal curvilinear probe (Voluson P8, GE, Zipf, Austria). Preoperative laboratory tests were done, including a full blood count, prothrombin time and concentration, liver, and kidney function tests, and two valid blood group and antibody screen samples. A crossmatch for the initial four units of blood was requested on the morning of the surgery.

The patients were offered an admission into the hospital at 34 weeks of gestation and received two intramuscular injections of 12 mg of dexamethasone (Epidrone, Epico, Egypt), 24 h apart. The delivery was performed at 36 weeks of gestation on an elective basis [14]. The operative data (operative procedure performed, operative time, blood loss, intraoperative complications, need for internal iliac artery ligation, or blood transfusion) were recorded. All our patients were followed during the first twenty-four hours for (1) postpartum hemorrhage, (2) surgical interventions including return to theatres, (3) blood transfusion, and (4) ICU admission. To assess the impact of blood loss on the c levels, the patient's Hct and Hb were measured again six hours after delivery.

The primary outcomes were the operative procedure performed (Uterine sparing surgery Vs Caesarean Hysterectomy) and the measurement of the intraoperative blood loss. The later was achieved by measuring the

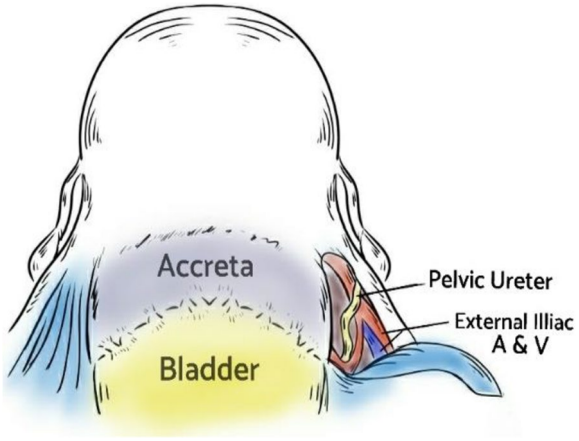

Fig. 1 Dissecting the anterior leaflet of the broad ligament

blood volume in the suction machine reservoir and calculating the weight difference of the surgical swabs. The difference of the surgical swabs (in grams) was translated to ml by using a blood density formula [15]. The secondary outcomes were the operative time, perioperative drop in HB, intraoperative complications, ITU admission, and the number of units of blood transfused.

All the women received a general anesthetic during the surgical procedure. The operative steps are described below and demonstrated in the attached video.

1) The positioning of the patient in the dorsal supine position is done before being prepared and draped.
2) A Maylard incision or a vertical midline incision is performed.
3) Sharp dissection of the abdominal wall is done in layers via electrocautery surgical device.
4) Step 1: The dissection and separation of the adherent bladder from the anterior uterine wall. The bladder is reflected to the level of the internal cervical os. In the case of cervical invasion, the bladder is reflected caudally to the level of the anterior vaginal fornix. The aim of this step is to disconnect the newly developed vessels linking the placenta to the urinary bladder.

    o Special note: If the bladder dome is adherent to the uterus and an unintentional cystotomy is feared, the uterovesical pouch dissection is delayed after the fetal extraction. This is to be completed after the uterovesical tourniquet is placed to reduce the hemorrhagic complications and bladder injury.

5) **Step 2:** Insertion of a Foley's catheter from a right broad ligament aperture and advancing it posterior to the uterus towards the left broad ligament,

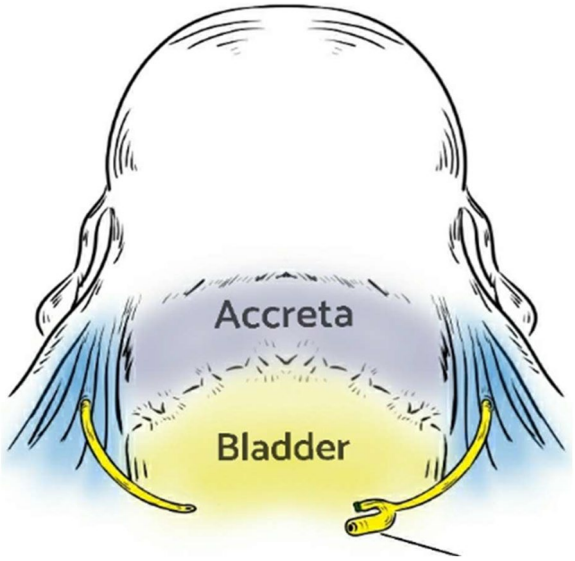

Fig. 2 The lower uterine segment and the bladder encircled by the Foley's catheter

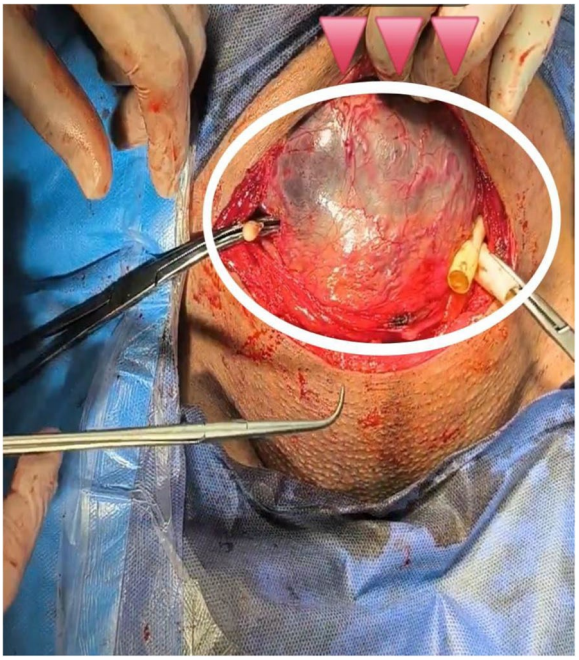

Fig. 3 Tourniquet encircling the gravid uterus

making a tourniquet around the lower part of the uterus. (Figs. 1), (Fig. 2), and (Fig. 3).
6) **Step 3:** Uterine incision at the placental upper border immediately after tightening the tourniquet, followed by the delivery of the foetus and immediate cord clamping. (Figs. 4), (Fig. 5), and (Fig. 6).
7) **Step 4:** Placental bed devascularization:

    o 4a: Ligation of the uterine arteries at two levels. The lower level is 5 mm under the lower edge of

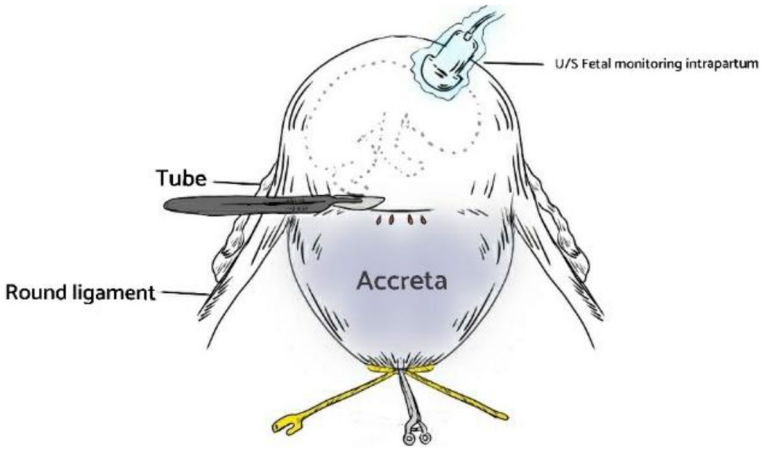

Fig. 4 Uterine incision above the upper edge of the placenta

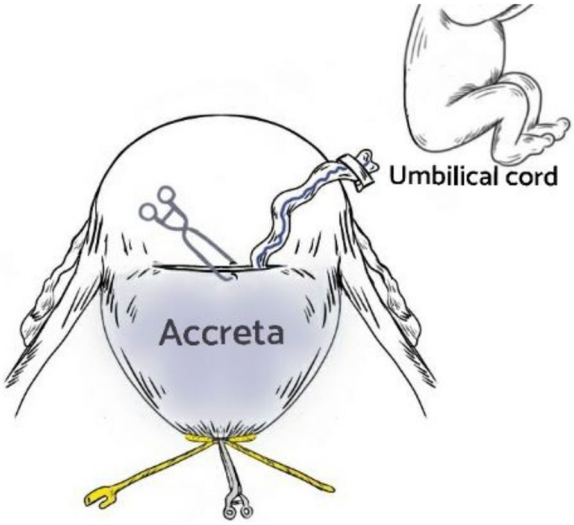

Fig. 5 Cord clamping following the delivery of the fetus

the placenta. The upper level is 5 mm above the upper edge of the adherent part of the placenta. (Figs. 7) and (Fig. 8).

- Special note: Ureteric exploration is done prior to the low uterine artery ligation in the case of a total pelvic placenta accreta. This is to avoid an injury to the ureters within the ureteric tunnels.
- 4b: Cervical control sutures: Transverse sutures are placed in the lower segment, 5 mm below the lower border of the placenta. Similarly, a suture is placed in the posterior uterine wall just above the attachment of the uterosacral ligaments.

8) **Step 5:** Untightening the tourniquet gradually to check for any obscured bleeding. It is normal to experience some oozing of dark brown blood from the cut placental surface, representing the backflow from a devascularized placenta. If heavy and bright red bleeding occurs, this reflects incomplete devascularization of the placental bed and the tourniquet should be retightened, and the devascularization completed appropriately.

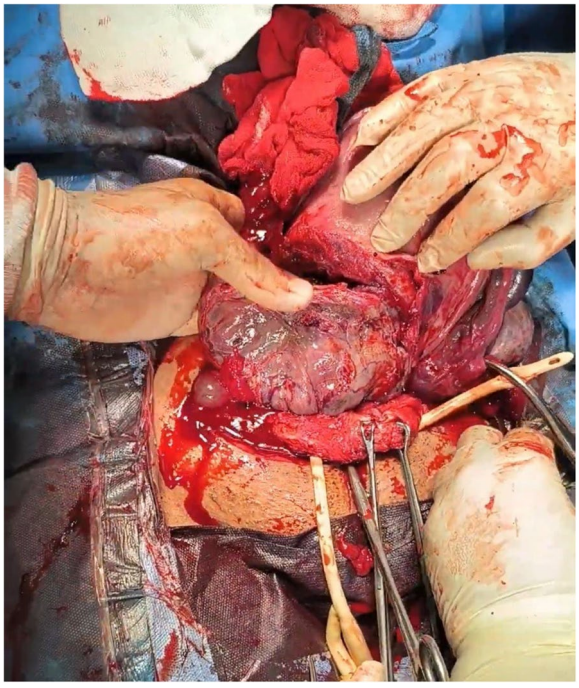

Fig. 6 Assessment of the extent and depth of invasion of the placenta to the lower uterine segment

9) **Step 6:** Manual separation of the adherent placenta, with the piecemeal removal of the firmly adherent placental cotyledons. The thin lower segment is resected, and care is given to avoid an unnecessary excision of the lower uterine segment myometrium. We only resected areas of paper-thin lower uterine segment with adherent placenta as they were unsuitable for repair (selective resection). Where myometrium remained thick and viable, the adherent placenta was removed piecemeal and the uterine wall

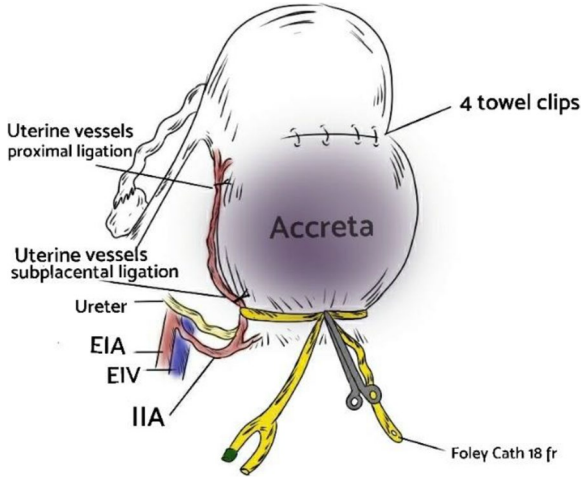

Fig. 7 Proximal and distal uterine artery ligation

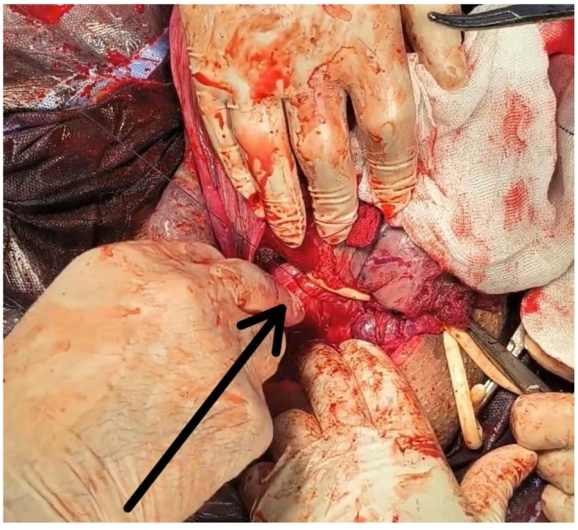

Fig. 8 Ligation of the uterine artery below the lower edge of the placenta

preserved. This selective resection was performed with the intent of Maximizing the preservation of uterine muscle for future fertility, while ensuring adequate haemostasis. (Figs. 9) and (Fig. 10).

10) **Step 7:** Direct haemostatic sutures are placed through the placental bed to stop any residual bleeding. This is followed by the removal of the tourniquet once the haemostasis is satisfactory. (Fig. 11).
11) **Step 8:** The reconstruction of the hysterotomy is performed by two layers of continuous running sutures, using an absorbable suture.1 If the haemorrhage is not adequately controlled with the above steps, a peripartum hysterectomy should be performed sooner rather than later. (Fig. 12).
12) The bladder and the ureters are finally inspected for their integrity and to ensure the absence of urological injuries.

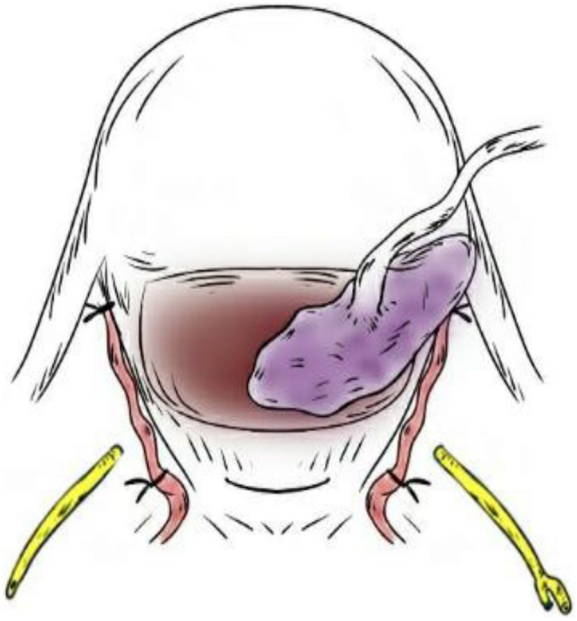

Fig. 9 Placing haemostatic sutures in the placenta bed

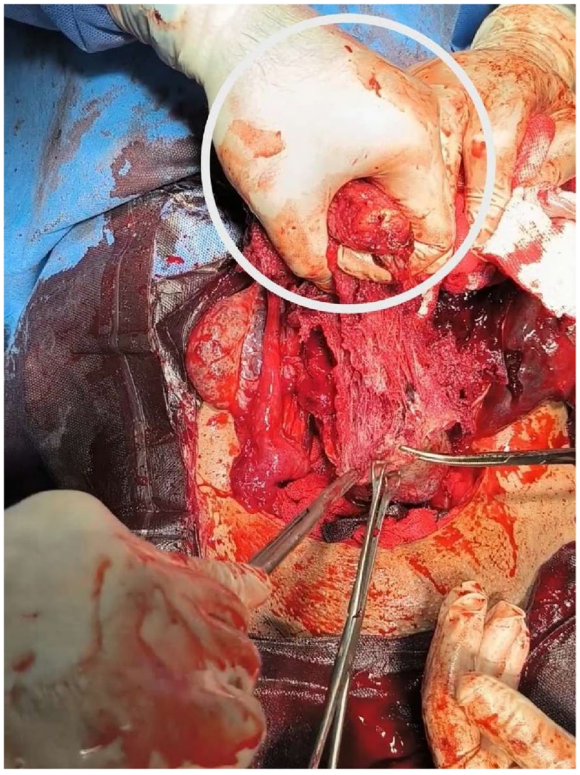

Fig. 10 Forcible removal of the adherent placenta

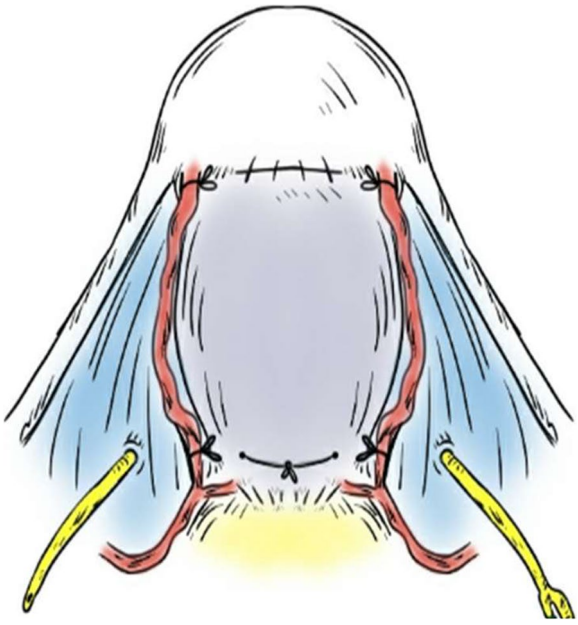

Fig. 11 Untying the tourniquet

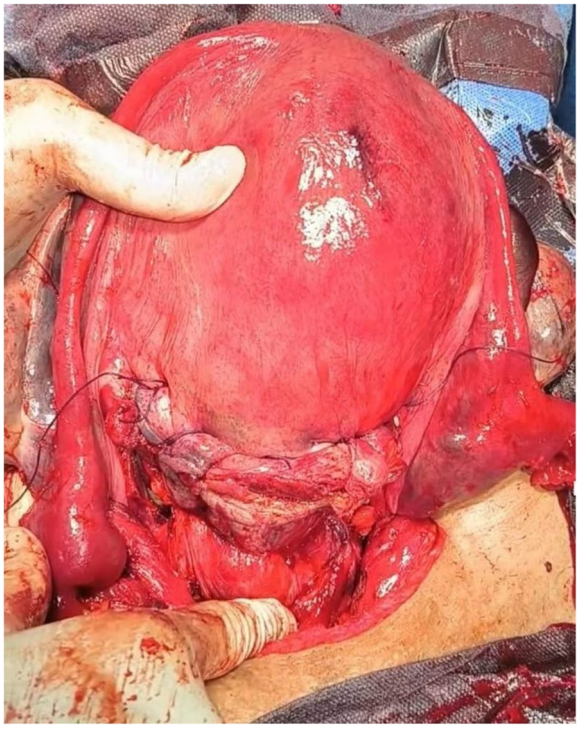

Fig. 12 Repaired uterus

13) Peritoneal lavage is performed, and the abdominal wall is closed in layers. A wide bore drain is left in the peritoneal cavity for 24 h.

Statistical methods

The data was analysed by the statistical package for the Social Sciences (SPSS) version 25 "IBM Corp., Armonk, NY, USA". Numerical data were presented in mean ± standard deviation or median and range. Categorical data were presented in frequencies and percentages.

Table 1 Demographic characteristics

Age (years)	**31.83 ± 4.41**
	32 (22–38)
BMI (kg/m^2)	**26.45 ± 2.46**
	26.61 (22.81–30.84)
Parity (number)	**2.42 ± 1.24**
	2 (1–5)
Previous caesarean sections (number)	**2.17 ± 0.94**
	2 (1–4)
Gestational age at delivery (weeks)	**35.17 ± 0.72**
• ≥ 36 weeks	**4/12 (33.33%)**
• < 36 weeks	**8/12 (66.67%)**
Medical Conditions	
• Nil	**7/12 (58.33%)**
• Anaemia in pregnancy	**3/12 (25.00%)**
• Gestational hypertension	**1/12 (8.33%)**
• Gestational diabetes	**1/12 (8.33%)**
Previous Uterine Surgery	**No cases**

Results

This study included 12 pregnant women who were diagnosed in the antenatal period with PAS. Initially, sixteen patients were recruited to the study. One patient decided to withdraw as she requested an elective caesarean hysterectomy. Two patients were excluded from the study after they presented with labour pains and underwent an emergency procedure. One patient was excluded from the study due to spontaneous placental separation during the caesarean delivery, hence excluding PAS.

The demographic data analysis showed that the age of the participants ranged between 22 and 38 years; their BMI ranged between 22.81 and 30.84; the parity ranged between 1 and 5; and the number of previous CD was between 1 and 4. The average Gestational age at delivery was 35.17 ± 0.72. One-third of the cases (four patients) underwent an elective CD after 36 weeks of gestation, while two-thirds of the cases (eight patients) underwent a CD between 34 and 36 weeks. Although all the patients included in this study did not suffer from chronic medical illness, three of them developed anaemia during the current pregnancy. One patient developed gestational hypertension, and another woman developed gestational diabetes mellitus (Table 1).

There were two patients with placenta previa, while Ten patients had a low-lying Placenta. The intraoperative visual assessment revealed that six patients had a low-grade PAS and that six patients had a high-grade PAS. The postoperative histopathological diagnosis confirmed that seven cases were placenta accreta, and four patients

had partial placenta increta. Only one patient had a partial placenta Percreta (Table 2).

The intra- and postoperative outcomes of the conservative management using a tourniquet were promising. The drop-in haemoglobin level (the difference between the pre and postoperative haemoglobin) was minimal (0.96 ± 0.44 gm/dL), and the median number of packed RBCs units' transfusion was 2. The intraoperative blood loss ranged from 500 to 1200 cc, and the drain output ranged from 100 to 400 cc. The operative time varied from 40 to 185 min. Apart from one case that had a bladder injury and underwent a caesarean hysterectomy, no cases had any complications or needed ICU admission. Overall, eleven out of the twelve cases successfully had a conservative surgical management of PAS without surgical complications (Table 3).

Table 2 Summary of placental classification

Type of Placenta Previa	
• Low Lying Placenta	**10/12 (83.33%)**
• Placenta Previa	**2/12 (16.67%)**
Intraoperative Clinical Diagnosis	
• Low-grade PAS	**6/12 (50.00%)**
• High-grade PAS	**6/12 (50.00%)**
Postoperative Histopathological Diagnosis	
• Placenta Accreta	**7/12 (58.33%)**
• Placenta Increta (partial)	**4/12 (33.33%)**
• Partial Percreta (partial)	**1/12 (8.33%)**

Table 3 Operative findings and outcomes

Preoperative Hemoglobin (gm/dL)	**10.80 ± 0.79**
	11 (9.6–12)
Postoperative Hemoglobin (gm/dL)	**9.84 ± 0.66**
	9.9 (9–11)
Drop in Hemoglobin (gm/dL)	**0.96 ± 0.44**
	1 (0–1.5)
Intraoperative Blood Loss (cc)	**950.00 ± 233.55**
	1100 (500–1200)
Drain Output (cc)	**212.50 ± 77.24**
	200 (100–400)
Operation Duration (minutes)	**84.58 ± 41.64**
	60 (40—185)
Blood Transfusion (packed RBCs units)	**1.58 ± 1.38**
	2 (0—4)
Hospital Stay (days)	**1.17 ± 0.39**
	1 (1—2)
ICU admission	**No cases**
Outcomes of uterine sparing surgery	
• Succeeded	**11/12 (91.67%)**
• Failed (Hysterectomy was done)	**1/12 (8.33%)**

Discussion

Principal Findings

This study assessed the efficacy and safety of using a tourniquet for uterine sparing surgery of PAS. It included 12 pregnant women with a confirmed diagnosis of PAS. In the current study, the drop of haemoglobin level was minimal (0.96 ± 0.44 gm/dL), and the intraoperative blood loss ranged from 500 to 1200 cc. In addition, 11 out of the 12 cases (91.67%) had successful uterine sparing surgery without complications. The low volume of average and median blood loss combined with high success rate, makes this technique a practical solution for the management of PAS. This technique could also be applied when performing an emergency caesarean section for PAS or when it has not been diagnosed antenatally and incidentally discovered during Caesarean section. The Tourniquet can provide the Obstetrician with the opportunity to reduce the rate and volume of blood loss while waiting for the PAS surgeons and, or the Interventional radiologist to arrive to the operating theatres.

The single case requiring caesarean hysterectomy was due to the continuous vaginal bleeding despite tourniquet application and applying all haemostatic sutures described our study. On further assessment of the cervical canal, a placental lobe was found situated below the tourniquet level; within the cervical canal. The decision for hysterectomy was made to ensure patient safety and to achieve definitive haemostasis.

We reported a single case of discrepancy of between intraoperative clinical PAS grading and histopathological examination of the selectively resected myometrium. In this case, the operating team diagnosed a high-grade placenta and decided to selectively resect the affected area. This was confirmed to be Accreta) on histology. The explanation is an area of hypervascularity on the surface was misinterpreted by the operating team as a placenta lobe. Another discordance in our study was the number of packed RBCs transfused relative to the volume of blood loss. The average blood loss in our study was 950 ml (S 233.55), yet the median transfusion rate was two units of packed red blood cells. This was due to our institutional anaesthetic protocol adopting conservative transfusion thresholds in PAS cases; owing to the unpredictable nature of the bleeding and the potential for rapid rate of Haemorrhage. Additionally, some patients had pre-existing anaemia (3/12 patients), which encouraged pre emptive transfusion.

Results in the context of what is known

Maternal morbidity and mortality are commonly associated with PAS worldwide and represent a challenge when managing pregnant women with such abnormal placentation [16]. According to the published case studies and case series, the incidence of PAS is cited at 1:1000 births worldwide [17]. However, with the growing rates of CD and interventional uterine operations such as myomectomy, this figure is likely to rise further [18].

The source of bleeding is mainly the placental blood supply [19, 20]. The variation in the placental site and degree of penetration triggers the need for different techniques to limit the intraoperative blood loss. The idea of using the tourniquets to minimize the intraoperative blood loss in pregnant women with PAS depends on reducing the blood flow to the placenta [21, 22].

In support of our findings, two case reports by Staniczek et al. (2023) revealed that using a Foley's catheter as a tourniquet was a safe and efficient way to stop the bleeding in a patient with PAS [23]. Furthermore, Altal et al. (2022) evaluated a modified surgical technique in 11 patients with PAS via using a cervical tourniquet during caesarean deliveries, with the aim of reducing blood loss and preserving fertility. They found that the mean blood loss was 1688.8 ml in those patients [24]. Huang et al. (2021) evaluated the use of a lower uterine tourniquet as well as a higher uterine tourniquet in cases of PAS. They reported that applying a tourniquet around the lower or upper part of the uterus effectively reduces blood loss during the CD [25].

The Placement of the tourniquet around the uterus without the dissection and incision of the broad ligament has been previously described by Staniczek and Altal [23, 24]. However, in both studies, the broad ligament was not dissected and the Tourniquet has been placed to encircle both the cervix and both suspensory ligaments of the ovaries. The advantages of this technique of applying the tourniquet without opening of the broad ligament are: (1) easier application as it does not require advanced surgical skills, (2) Quicker to apply, and (3) complete devascularization of the uterus with the occlusion of its 4 main blood supply vessels. However, the disadvantages would be (1) exposing the ovaries to ischaemia which can compromise the ovarian functions, (2) the need to wait until the delivery of the fetus and exteriorization of the uterus which increases the duration and volume of bleeding and (3) congestion of the veins in the broad ligament with further risk of development of a broad ligament haematoma. On the other hand, our Technique avoids subjecting the ovaries to ischaemia and defers the risk of venous congestion and development of broad ligament haematoma. Additionally, it enables us to apply and even tie the tourniquet prior to the uterine incision, further minimizing the blood loss.

Huijgen et al. (2013) presented a case report of a 38-year-old woman with PAS who had a CD and experienced postpartum bleeding. Despite using a Bakri balloon and placing a B-Lynch suture, the blood loss was not reduced until a Penrose drain was wrapped around the cervix and used as a tourniquet. They concluded that the cervical tourniquet could effectively reduce blood loss after CD, as well as preserve fertility by avoiding an emergency hysterectomy [26]. Additionally, when Ikeda et al. (2005) used a tourniquet in two out of four pregnant women with PAS, this resulted in a considerably lower blood loss volume. [27].

In two case reports by Staniczek et al. (2023), the estimated blood loss was 500 ml in the first patient, while the second patient had an estimated blood loss of 3000 ml [23]. In addition, Envain and Garabedian. (2020) used the tourniquet method on a 35-year-old patient with prenatally suspected PAS and had a desire to retain her uterus. The total blood loss was 3000 ml [22]. In a study of 21 pregnant women with PAS, Shmakov et al. (2019) employed bilateral tourniquets placed on the upper uterine pedicles and the cervico-isthmic part, which resulted in blood loss volume of 1295 ± 520.3 ml. Therefore, they hypothesized that tourniquets might limit the blood flow to the placenta during surgery, resulting in less intraoperative blood loss until the haemostasis and repair sutures are placed [28].

Meng et al. (2017) referred to using two tourniquets in 23 pregnant women with PAS to control intraoperative blood loss. The first tourniquet was wrapped around the upper portion of the lower uterine segment and the suspensory ligaments, and the second tourniquet was introduced below the round ligaments through the avascular area of the broad ligament and below the lower border of the placenta. Following the removal of the first tourniquet, a bilateral uterine artery ligation using a circular suture, or a compression square suture was performed. This was followed by the removal of the second tourniquet. According to their findings, the intraoperative blood loss was 1286 ± 175 ml, and 90% of women had a successful CD [21].

Strengths and limitations

The strength of this study is the ability of this technique to reduce the blood loss and enable fertility preservation in the low-income clinical setup; where more expensive interventions might not be available. Additionally, it can provide a temporary control of bleeding in cases of unanticipated or undiagnosed PAS, until an experienced gynaecological surgeon attends and takes over the surgery. The limitations of this study are (1) a small sample size, (2) lacking a control group, and a small number of high-grade PAS cases.

Research implications

More prospective studies on larger scales are required to further assess the efficacy, safety, and reproducibility of using a tourniquet while performing uterine sparing surgery for PAS and comparing it to the placebo group.

Conclusion

The uterovesical tourniquet may reduce haemorrhage in PAS, offering a feasible innovative option for resource-limited settings. It can also provide temporary control of bleeding in unanticipated or undiagnosed PAS until an experienced surgeon is available. This feasibility study proves its safety and reproducibility.

Abbreviations

CD	Caesarean Delivery
PAS	Placenta Accreta Spectrum
LMICs	Low- and middle-income countries
Hct	Hematocrit
HB	Hemoglobin
ICU	Intensive care unit

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12884-025-08381-7.

Supplementary Material 1.

Authors' contributions

A Mousa: Protocol development and Surgeon.—H M Gaafar: Protocol development and foetal medicine scanning.—M Abdullah: Data collection—M Elsherbini: Protocol development and Surgeon.—M A Rasheed: Data analysis—D Rida: Media development.—A Sayasneh: Editing and review.—S Collins: Project management and review.—A Abdelbar: Protocol development, Manuscript writing, editing, and review.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Research Ethics Committee (REC), Faculty of Medicine, Cairo University, in accordance with the Declaration of Helsinki. The registration number is MS-105–2023.

Consent for publication

Informed consent for publication was obtained from all the participating patients.

Competing interests

The authors declare no competing interests.

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