The Journal of Maternal-Fetal & Neonatal Medicine

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/ijmf20

Efficacy of distal haemostasis during caesarean delivery in women with placenta accreta spectrum disorders

S. V. Barinov, R. G. Shmakov, I. V. Medyannikova, Yu. I. Tirskaya, T. V. Kadtsyna, O. V. Lazareva, I. N. Razdobedina, T. N. Neustroyeva & S. S. Stepanov

To cite this article: S. V. Barinov, R. G. Shmakov, I. V. Medyannikova, Yu. I. Tirskaya, T. V. Kadtsyna, O. V. Lazareva, I. N. Razdobedina, T. N. Neustroyeva & S. S. Stepanov (2021): Efficacy of distal haemostasis during caesarean delivery in women with placenta accreta spectrum disorders, The Journal of Maternal-Fetal & Neonatal Medicine, DOI: 10.1080/14767058.2021.2005019

To link to this article: https://doi.org/10.1080/14767058.2021.2005019

Published online: 18 Nov 2021.

THE JOURNAL OF MATERNAL-FETAL & NEONATAL MEDICINE
https://doi.org/10.1080/14767058.2021.2005019

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

Efficacy of distal haemostasis during caesarean delivery in women with placenta accreta spectrum disorders

S. V. Barinov[a], R. G. Shmakov[b], I. V. Medyannikova[a], Yu. I. Tirskaya[a], T. V. Kadtsyna[a], O. V. Lazareva[a], I. N. Razdobedina[c], T. N. Neustroyeva[d] and S. S. Stepanov[a]

[a]Federal State Budget Institution of Higher Education "Omsk State Medical University" of the Russian Ministry of Health, Omsk, Russia; [b]Federal State Budget Institution National Medical Research Center for Obstetrics, Gynecology and Perinatology named after Academician V.I.Kulakov of the Ministry of Healthcare of Russian Federation, Moscow, Russia; [c]Perinatal Centre of Omsk Regional Clinical Hospital, Omsk, Russia; [d]Perinatal Center of the State Autonomous Institution of the Republic of Sakha (Yakutia) Republican Hospital No. 1, Yakutsk, Russia

ABSTRACT

Pregnancies complicated by the placenta praevia are associated with an increased risk of massive obstetric bleeding and high rates of hysterectomy which are often caused by the placenta accreta. *The aim of our study* was to identify the risk factors for placenta praevia associated with PAS disorders and the efficacy of distal haemostasis during Cesarean delivery.

Methods: This was a cohort study carried out between 2014 and 2020 in 532 women with abnormal placental localization and attachment. The placental attachment spectrum (PAS) disorder diagnosis was confirmed during the surgery and by the histology results in 164/532 participants. Depending on the surgical approach during the Cesarean delivery, patients were divided into three groups. In Group 1 ($n = 52$), patients underwent bilateral uterine artery ligation. In Group 2 ($n = 33$), we used the combined compression haemostasis approach including the placement of tourniquets and insertion of an intrauterine balloon for controlled tamponade. In Group 3 ($n = 79$), we used the combination of surgical haemostasis with the controlled intrauterine tamponade using the vaginal and intrauterine Zhukovsky balloon.

Results: PAS was observed in 30.8% of the placenta praevia cases, and in 93.3% was associated with the presence of a uterine scar. Women with the placenta praevia and PAS had a significantly higher number of past deliveries ($p = .001$). According to the FIGO classification, 53.8% of women with placenta praevia observed during the Cesarean had PA1 and 46.2% PA2. With regards to the PAS disorders observed in 30.8% of patients, 38.4% had PAS3, 34.7% PAS4, 18.3% PAS5 and 8.5% PAS6. The histology analysis showed normal placental attachment in 42.9% of the total number of study participants, placenta accreta in 28.2%, placenta increta in 16.7%, and placenta percreta in 12.2%. In Group 1, we performed the resection of uterine wall with the attached portion of the placenta in 13.5% of women, in Group 2 in 30.3% women, and in Group 3 in 50.6% women. There was a significant 4.8-fold reduction in the number of hysterectomies in Group 3 versus Group 2 ($p = .043$) and a 4.4-fold reduction in Group 2 versus Group 1 ($p = .003$). In Group 2, the volume of blood loss was 1.3-fold lower and in Group 3 1.5-fold lower than in Group 1. *Conclusion*: The techniques of compression distal haemostasis evaluated in this study in women with PAS are efficacious in the reduction of adverse maternal outcomes and should be used more widely in clinical practice.

ARTICLE HISTORY
Received 17 July 2021
Revised 5 November 2021
Accepted 8 November 2021

KEYWORDS
placenta praevia; PAS; uterine scar; Cesarean delivery; obstetric bleeding; uterine artery ligation; tourniquets; Zhukovski balloon catheter

1. Introduction

Postpartum obstetric bleeding remains one of the major challenges in modern obstetrics due to its potentially devastating effect on the future reproductive potential of those patients who have to undergo the hysterectomy and its overall contribution to maternal morbidity and mortality. Only 62–65% of vaginal deliveries are believed to be accompanied by physiological blood loss. A third of the patients lose between 500 and 1000 ml of blood, and in 3–8% of cases, massive bleeding is observed, with the volume of blood loss exceeding 1.5%[1,2]. Within this category, the most severe bleeding cases are associated with placental accreta spectrum (PAS) disorders, especially in term pregnancies; severe bleeding can lead to negative maternal and fetal outcomes, including a significant contribution to maternal mortality[3–5].

In recent years, the incidence of PAS disorders has increased and has been linked by some authors with

CONTACT T. N. Neustroyeva tatyananik1234@mail.ru Republic of Sakha (Yakutia), Sergelyakhskoe highway str., 4, Yakutsk 677010, Russia

an increase in the number of Cesarean deliveries across the majority of developed countries[6–9]. Other sources report an increase in the risk of PAS disorders in pregnancies after assisted reproduction technology (ART)[10,11] and in women with a history of PAS disorders in a previous pregnancy[12,13]. Early diagnosis of PAS disorders using ultrasound and color Doppler is being actively investigated[14] alongside the more recent approach of using magnetic resonance imaging (MRI) for the assessment of the depth of myometrial invasion[15].

The conventional approaches of managing PAS through hysterectomy are no longer the standard of care, while fertility-sparing strategies are being increasingly adopted. However, there is no consensus on the extent of surgical intervention in women with placenta percreta. Additionally, despite the early and accurate diagnosis, hysterectomy remains the most common surgery in women with placenta praevia accreta[16,17]. Therefore, there is a need for the development of a new and straightforward approach for the reduction of intrapartum blood loss in women with PAS disorders that can be easily implemented by a practicing obstetrician. Since 2014, we have been using distal hemostasis such as compression hemostasis with tournuqettes and its combination with Zhukovsky's double-balloon tamponade. The aim of our study was to evaluate the risk factors for placenta praevia accompanied by PAS disorders and evaluate the efficacy of three different distal haemostasis techniques during Cesarean delivery.

2. Patients and methods

We performed a cohort study in 532 pregnant women with placenta praevia and suspected PAS disorders who delivered at the Regional Clinical Hospital of Omsk (Russia) and the Perinatal Center of the State Autonomous Institution of the Republic of Sakha (Yakutia) Republican Hospital No. 1 (Yakutsk, Russia) between 2014 and 2020. The study protocol was approved by the local ethics committee of the Omsk State Medical Academy (№104, date: 14.11.2013).

The inclusion criteria were: gestational age 28–42 weeks, placenta praevia and a suspected PAS disorder. The exclusion criteria were: relapses of non-gynaecological comorbidities, tumors, genital abnormalities, recurrent pregnancy loss, multiple pregnancy, pregnancy loss before 28 weeks, cervical insufficiency, infections, fetal chromosomal pathology or congenital malformations, congenital fetal viral or microbial infection, cord prolapse in labor, chorioamnionitis and maternal injuries in labor.

All patients underwent ultrasound scans, Doppler, and MRI to diagnose PAS. The diagnosis was not confirmed in 368/532 women. In 164 women, PAS was diagnosed during surgery and confirmed by histology. Depending on the surgical approach during the Cesarean delivery, all women placenta praevia were divided into 3 groups: Group 1 ($n = 52$) with bilateral uterine artery ligation only; Group 2 ($n = 33$) with additional compression hemostasis using tourniquets and intrauterine balloon tamponade, and Group 3 ($n = 79$) with bilaterial uterine artery ligation and double-balloon tamponade.

Surgical techniques

In Group 1, uterine arteries were ligated immediately after the fetal extraction, followed by the examination of the placental bed. If the depth of myometrial invasion was less than one-third, we excised the placenta accreta and simultaneously ligated the bleeding vessels and placed an 8-shaped stitch on the placental bed; we then separated the vesicouterine fold in the inferior direction. If the depth of myometrial invasion was more than two-thirds or the area exceeded 5 cm in diameter, we excised the uterine wall together with the placenta accreta; we then separated the vesicouterine fold in the inferior direction and restored the uterine wall with single Vicryl stitches. In the cases of placental hernia, we performed a high transverse incision on the uterus to extract the fetus, and then isolated the hernia sack, separated the vesicouterine fold, excised the uterine wall together with the placenta accreta, and performed metroplasty. The uterine wall was restored with single Vicryl stitches.

In Group 2, we performed the standard low midline laparotomy and the fundal Cesarean delivery. After the fetal extraction, we closed the uterine incision without placental separation and performed combined compression haemostasis by placing tourniquets on the bases of broad uterine ligaments and an intrauterine balloon inside the uterine cavity. We created "windows" in the broad uterine ligament on both sides for tourniquet placement, and tightened the tourniquets using two clamps. The ovaries were moved laterally to the tourniquets so that the loop included the uterine tube, mesosalpynx, and ovarian ligament proper to achieve the compression of the tubal branches and communicants between the ovarian and uterine arteries. We placed the third tourniquet through the same "windows" at the level of the

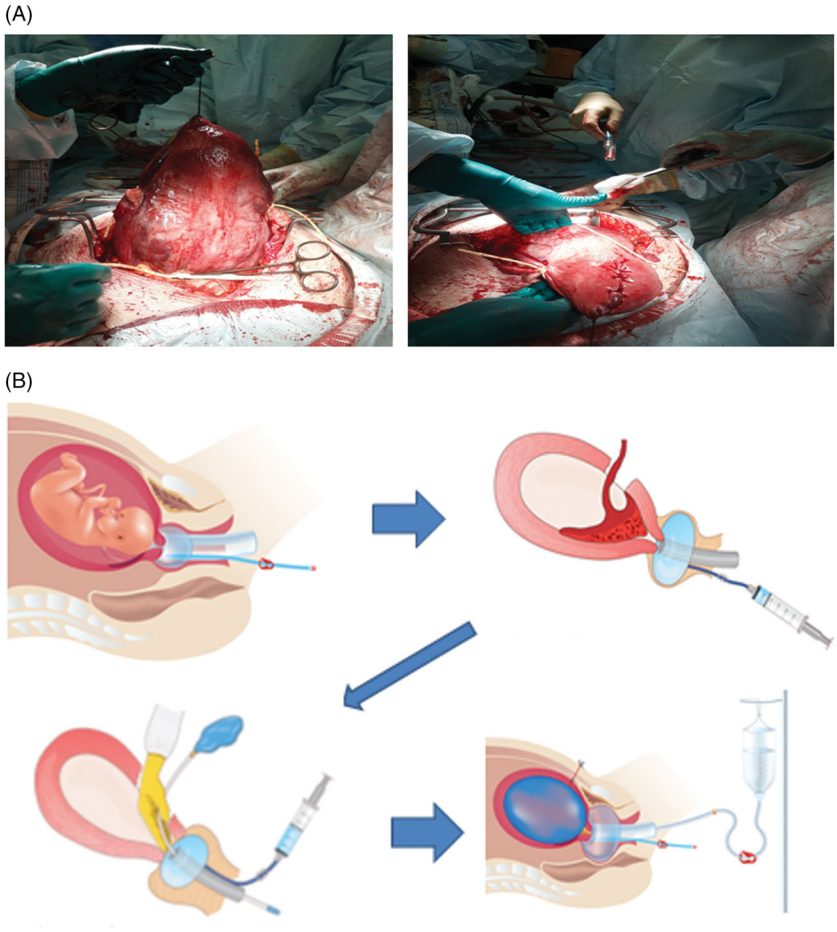

Figure 1. Distal haemostasis in women with PAS disorders. (A) Combined compression haemostasis with tourniquet placement. (B) Insertion of the vaginal and uterine Zhukovsky balloon catheters in women with placenta praevia and PAS disorders.

cervix and tightened it with a clamp. After the main surgical steps were completed, all tourniquets were removed. Before the final uterine incision closure, we performed retrograde prophylactic controlled balloon tamponade and restoration of the uterine wall (Figure 1A).

In Group 3, the vaginal module was positioned inside the vagina in parallel with the urinary catheter placement. The vaginal module was expanded with 180 ml saline after the fetus had been extracted. Surgery continued with the expanded vaginal balloon in place. Immediately after the fetal extraction, the descending branches of uterine arteries were ligated, and the placental bed was examined. If the depth of myometrial invasion was less than one-third, we excised the placenta accreta and simultaneously ligated the bleeding vessels, and placed an 8-shaped stitch on the placental bed.

If the depth of myometrial invasion was more than two-thirds of the area exceeded 5 cm in diameter, we excised the uterine wall together with the placenta accreta; we then separated the vesicouterine fold in the inferior direction. In the cases of placental hernia, we performed a high transverse incision on the uterus to extract the fetus, excised the uterine wall together with the placenta accreta and metroplasty; specifically, we isolated the hernia sack, separated the vesicouterine fold, and performed uterine wall excision.

After the uterine stitches were placed at the ends of the wound, the uterine balloon was inserted through the uterine incision and guided manually through the cervix into the vaginal coaxial tube. The balloon was then expanded, and the uterine incision was then closed with separate Vicryl stitches. The vaginal and uterine balloons were kept in place for 10–14 h (Figure 1B).

Indications for hysterectomy included placental infiltration of the cervix or the parametrium or uncontrolled bleeding during surgery. Efficacy endpoints included total blood loss volume, rate of hysterectomies, rate of blood transfusions, and duration of hospital stay.

Statistical data analysis was performed using the SAS 9.2, STATISTICA 10 и SPSS-20 software. Data were

Table 1. – Obstetric history and comorbidities.

	Participants with placenta praevia ($N = 532$)		
Parameter	With PAS ($n = 164$)	Without PAS ($n = 368$)	p
Obstetric history			
Previous pregnancies:			.0003*
1	2 (1.2%)	26 (7.2%)	
2	9 (5.5%)	66 (17.9%)	
3	31 (18.8%)	66 (17.9%)	
4	42 (25.6%)	52 (14.1%)	
5	40 (24.4%)	60 (16.3%)	
6 and more	40 (24.4%)	98 (26.6%)	
Previous deliveries:			.001*
1	2 (1.2%)	50 (13.6%)	
2	35 (21.3%)	126 (34.3%)	
3	84 (51.3%)	120 (32.6%)	
4	32 (19.5%)	39 (10.6%)	
5 and more	11 (6.7%)	33 (8.9%)	
Number of uterine scars:			.0001*
0	11 (6.7%)	281 (76.4%)	
1	65 (39.7%)	60 (16.3%)	
2	75 (45.7%)	25 (6.8%)	
3 and more	13 (7.9%)	2 (0.6%)	
Previous abortions:			.18
0	83 (50.61%)	182 (49.5%)	
1	37 (22.6%)	91 (24.7%)	
2	29 (17.7%)	41 (11.1%)	
3	11 (6.7%)	27 (7.4%)	
4 and more	4 (2.4%)	27 (7.3%)	
Previous miscarriages:			.34
0	97 (59.2%)	238 (64.7%)	
1	50 (30.5%)	91 (24.7%)	
2	12 (7.3%)	23 (6.3%)	
3	2 (1.2%)	13 (3.5%)	
4 and more	3 (1.8%)	3 (0.8%)	
Comorbidities			
Cardiovascular disease	21 (12.8%)	23 (6.2%)	.055
Upper respiratory tract pathology	19 (11.6%)	59 (16.0%)	.38
Diabetes mellitus	9 (5.5%)	14 (3.8%)	.47
Skin infections and STDs	9 (5.5%)	18 (4.9%)	.89
Gastrointestinal pathology	37 (22.5%)	84 (22.8%)	.92
Obesity	7 (4.2%)	22 (5.9%)	.67
Thyroid pathology	26 (15.8%)	55 (14.9%)	.96
Neurocirculatory dystonia	9 (5.5%)	10 (2.7%)	.18
Urinary tract pathology	85 (51.8%)	153 (41.6%)	.07
Anemia	116 (70.7%)	216 (58.7%)	.03*
Hypertension	4 (2.4%)	27 (7.3%)	.10
Blood disorders	3 (1.8%)	10 (2.7%)	.86
Joint disorders	3 (1.8%)	6 (1.6%)	.77
Varicose veins of the legs	24 (14.6%)	96 (26.1%)	.018*

Note: * indicates significance between groups.

tested for normality using the Shapiro-Wilk and Kolmogorov-Smirnov tests. Non-normally distributed variables were presented as medians (Me) and interquartile ranges between the 25th and the 75th percentile [Me (25%; 75%)], and as absolute numbers (proportions). Categorical variables were compared using the χ^2 test (Pearson Chi-Square) with adjustment for degrees of freedom (df). Differences were considered statistically significant at $p < .05$.

3. Results

Placental attachment disorders in women with placenta praevia were diagnised in 164/532 (30.8%) patients during Cesarean delivery and confirmed histologically. The mean age of women with placenta praevia was 31.1 ± 3.5 years. Among women with PAS, the proportion of women aged 30–35 years was twice higher than in women without PAS, but the mean age between the groups was not significantly different. Among women with placenta praevia and PAS, there was a significantly higher number of past pregnancies, deliveries, and Cesarean deliveries than in those without PAS (Table 1).

Approximately 5.2% (28/532) of women with placenta praevia were primigravidae, 9.7% (52/532) were nulliparous and 21.6% (115/532) multiparous. Almost a half (50.2% [267/532]) of women with placenta praevia had a history of abortions and 37.0% (197/532) of women had a history of miscarriages. Among women

Table 2. Pregnancy and surgery outcomes in study participants.

Parameter	Group 1 ($n = 52$)	Group 2 ($n = 33$)	Group 3 ($n = 79$)
Gestational age at delivery, Me (25%; 75%) weeks	36.0 (33.5–37.0)	35.0 (32.5–36.0)	34.5 (32.0–36.5)
Duration of hospital stay after delivery, Me (25%;75%), days	10.5 (8.0–13.0)	7.0 (7.0–9.0) $p = .0001$^	6.5 (5.5–7.0) $p = .0002$^
Blood loss Me (25%;75%), mL	2000 (1800–4000)	1500 (1000–3050) $p = .001$^	1300 (900–2950) $p = .001$^
Placental hernia, %	11.5%	12.1%	25.3%
Metroplasty, %	13.4%	30.3%	50.6%
Hysterectomy, %	53.8%	12.1% $p = .003$^	2.5% $p = .0437$#
Bladder injury, %	38.5%	18.2% $p = .012$^	2.5% $p = .030$#
Blood transfusion, %	42.3%	24.2% $p = .025$^	8.8% $p = .036$#
Autologous transfusion using cell salvage, %	53.8%	75.8%)	82.3%

Note: ^ indicates difference versus Group 1; # indicates difference versus Group 2.

with placenta praevia and PAS, there was a significantly higher proportion of multiparous women (26.8% [43/164]) compared with women without PAS (19.5% [72/368]; $p = .001$).

Over 40% of women with placenta praevia (45.1% [240/532]) had a history of Cesarean delivery; 23.5% (125/532) were planning to undergo the second Cesarean and 21.6% (115/532) – third or more Cesarean. Among women with PAS, second Cesarean delivery was taking place in 39.6% (65/164) women and third or more in 53.7% (88/164) women ($p = .0001$).

More than two-thirds of women (73.1% [383/532]) had at least one comorbidity. Among women with placenta praevia and PAS, this value reached 85.4% (140/164). There was a significantly higher rate of anemia in women with PAS vs those without (58.7% [216/368] and 70.7% [116/164], respectively; $p = .03$). Women with placenta praevia and no PAS has significantly higher rates of varicose leg veins than women with PAS (26.1% [96/368] versus 14.6% (24/164); $p = .018$).

Delivery occurred at the following gestational ages: 20–28 weeks in 5.1% (27/532) women, 29–34 weeks in 30.1% (160/532) women, 35–37 weeks in 33.1% (176/532) women and 37–42 weeks in 31.7% (169/532) women. Among women with PAS, deliveries, in general, occurred earlier and before the term (85.4% [140/164], including 54.9% [90/164] between 32 and 36 weeks). Emergency Cesarean has performed in 31.9% (170/532) women with placenta praevia, mainly due to bleeding in pregnancy.

Placental attachment Grade 1 and 2 A according to the FIGO classification of placental attachment in labor was diagnosed in 69.8% (368/532) women with placenta praevia. Of those, normal placental attachment (Grade 1) defined as spontaneous placental separation after uterotonics or gentle umbilical cord traction was present in 53.8% (198/368) cases. Partial placenta accreta (Grade 2A) defined as incomplete placental separation after uterotonics and gentle umbilical cord traction, requiring manual removal, occurred in 46.2% (170/368) of cases. In 30.8% (164/532) of patients, after the examination of placental bed, we diagnosed a PAS disorder. Specifically, complete placenta accreta (Grade 3 A) requiring manual placental removal was present in 38.4% (63/164) women. In 34.7% (57/164) of women, safe bladder separation during surgery was possible (Grade 4). In 18.3% (30/164) of women, safe bladder separation during surgery was not possible (Grade 5). In 8.5% (14/164) women, placenta invaded the parametrium (Grade 6).

Histology showed normal placental attachment in 42.9% (228/532) women, placenta accreta in 28.2% (150/532) women, placental invasion into the myometrium (placenta increta) in 16.7% (89/532) women, and placental invasion into the blood vessels, retrovesical space and uterine ligaments (placenta percreta) in 12.2% (65/532) women.

The efficacy of distal haemostasis methods used in the study is summarized in Table 2. We evaluated the number of hysterectomies, volume of blood loss, and the rate of blood transfusions across the study groups. In Group 1, placental hernias during the Cesarean delivery were found in 11.5% (6/52) women, and metroplasty was performed. Despite the surgical haemostasis, hysterectomy for persistent bleeding had to be performed in 53.8% (28/52) women with placenta praevia and PAS. In Group 2, placental hernias were present in 12.1% (4/33) women. Metroplasty has performed in 30.3% (10/33) women and hysterectomy in 12.1% (4/33) women. In Group 3, placental hernias were present in 25.3% (20/79) women, metroplasty was performed in 50.6% (40/79) women, and hysterectomy in 2.5% (2/79) women. The number of hysterectomies was in Group 3 was 4.8 times less than in

Group 2 ($p = .043$), and in Group 2 – 4.4 times less than in Group 1 ($p = .003$). A lower volume of blood loss in women who underwent compression haemostasis reduced the number of blood transfusions in Groups 2 and 3 (by 1.7-fold and 4.8-fold, respectively). Bladder injury in Group 1 occurred 2.1 times more often than in Group 2 ($p = .012$), and in Group 3 – 7.8 times less often than postpartum ($p = .036$). The duration of hospital stay after delivery in Group 1 was 10.5 (8.0–13.0) days and reduced by 3.5 days in Group 2 versus Group 1 ($p = .0001$), and by 4 days in Group 3 versus Group 1 ($p = .0002$). The odds ratio for hysterectomy for Group 1 vs 2 was 8.5 (95% CI 2.6, 27.5) and for Group 1 vs 3 was 44.92 (95% CI 10, 202.5).

4. Discussion

Our study showed that PAS is prevalent in women with placenta praevia. In our study population, the rate of PAS was 30.8% and in line with previously published data[18,19]. Most researchers have linked a recent increase in the prevalence of PAS with an increase in the Cesarean delivery rate[20–22]. Indeed, the odds of PAS have been directly associated with many previous Cesarean deliveries[23]. In our study, 93.3% of participants had a post-Cesarean uterine scar, with 39.6% planning to undergo the second Cesarean, and 53.6% – third or more Cesarean.

Cesarean delivery in women with PAS may be complex, and the surgeon performing the intervention has to have sound knowledge of the pelvic anatomy, appropriate surgical techniques, including specific dissection and haemostasis techniques, and be able to tailor them to the patient. Therefore, continuous upskilling of obstetricians on the retroperitoneal vessel and plexi anatomy is an important part of delivering best-practice care to women with PAS[24].

Currently, surgical management of women with PAS utilizes the techniques of proximal and distal haemostasis. Proximal haemostasis is based on the ligation or occlusion of the internal iliac artery. However, this method carries certain surgical risks and does not stop the bleeding from the multiple cervico-isthmic collaterals and paravesical plexi. Endovascular balloon occlusion of pelvic vessels has been suggested as a technique to reduce blood loss during surgery and improve maternal outcomes, but also allow the surgeon to perform the intervention in a "cleaner" surgical field, with better visibility. Nevertheless, PAS is often associated with a wide network of vascular collaterals, which can become the source of profound bleeding after some pelvic vessels have undergone occlusion[25]. Some authors report that the total number of units of red blood cells transfused to patients with PAS after balloon catheterization of iliac arteries was the same as in patients who did not[26,27]. Therefore, most international professional societies currently do not recommend a wide use of temporary balloon tamponade of common iliac arteries in women with suspected PAS before delivery[28–31].

Our study evaluated three techniques of proximal haemostasis in women with placenta praevia undergoing Cesarean delivery: bilateral uterine artery ligation, combined compression haemostasis involving the placement of tourniquets and a uterine balloon catheter[32] and a combined approach utilizing the uterine and vaginal Zhukovsky balloon catheters[33].

Some authors have shown that bilateria ligation of the uterine arteries before placental separation helped reduce the volume of blood loss during surgery and post-partum and reduce the number of hysterectomies[34,35]. It is, however, worth noting that uterine artery ligation impacts only the uterine artery region, and in the cases of advanced PAS, especially associated with placental herniae, its efficacy can become significantly reduced. In our study, the method failed to stop the bleeding in 53.8% of cases and prompted advancement to hysterectomy.

Our study showed that combined compression haemostasis including tourniquets and intrauterine balloon tamponade reduced the volume of blood loss by 1.3-fold, the rate of hysterectomy by 4.4-fold, and haemotransfusions by 1.7-fold compared with uterine artery ligation. However, this approach enables only temporary occlusion of the cervico-isthmic collaterals and the balloon tamponade exerts mechanical pressure only on the placental bed area, therefore not fully eliminating the risks of postpartum bleeding or paravesical hematomas.

In contrast to other techniques of distal haemostasis, the combined approach using the uterine and vaginal Zhukovsky catheters enables the simultaneous compression of the cervico-isthmic plexi and the placental bed area. Specifically, the vaginal balloon exerts mechanical pressure on the areas of blood supply from the uterine, vaginal and different branches of the internal pudendal arteries, allowing to perform the uterine wall resection if required. The additional uterine catheter exerts mechanical pressure on the blood vessels of the placental bed and delivers long-term compression (for 10–14 h) of the lower uterine segment and pelvic blood vessels (Figure 2). Collectively, this helps prevent the bleeding into the parametrium and pelvic hematomas and improves the overall

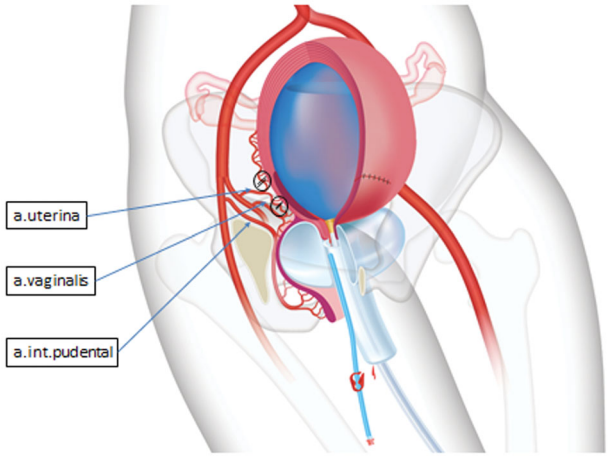

Figure 2. Mechanism of action of Zhukovsky's double-balloon tamponade.

surgery outcome. Our study has shown that the combined approach for haemostasis during Cesarean delivery in women with placenta praevia using the double-balloon Zhukovsky tamponade reduced the number of hysterectomies by 4.8-fold ($p = .043$) and haemotransfusions by 2.7-fold ($p = .036$) versus Group 2.

5. Conclusions

The risk factors for PAS in our study were placenta praevia, two more post-Cesarean uterine scars, and a history of more than 3 deliveries. The vaginal Zhukovsky catheter helped perform long-term compression of the multiple collaterals of cervico-isthmic plexi and retrovesical blood vessels and perform resection of the uterine wall together with the adherent portion of the placenta. The compression techniques of surgical haemostasis used during Cesarean delivery in women with PAS evaluated in our trial are more accessible, easy to implement, and low-risk compared with expensive endovascular techniques and can be more readily integrated in wide clinical care.

Transparency

Declaration of financial/other relationships

No potential conflict of interest was reported by the author(s).

Funding

The author(s) reported there is no funding associated with the work featured in this article.

ORCID

S. V. Barinov http://orcid.org/0000-0002-0357-7097
R. G. Shmakov http://orcid.org/0000-0002-2206-1002
I. V. Medyannikova http://orcid.org/0000-0001-6892-2800
Yu. I. Tirskaya http://orcid.org/0000-0001-5365-7119
T. V. Kadtsyna http://orcid.org/0000-0002-0348-5985
O. V. Lazareva http://orcid.org/0000-0002-0895-4066
T. N. Neustroyeva http://orcid.org/0000-0003-4296-0141
S. S. Stepanov http://orcid.org/0000-0003-0741-3337

References

[1] Mavrides E, Allard S, Chandraharan E, et al. Prevention and management of postpartum haemorrhage. Bjog. 2016;124:e106–e149.
[2] ACOG. Committee on practice bulletins-obstetrics. Practice bulletin no. 183: postpartum hemorrhage. Obstet Gynecol. 2017; 130(4):e168–e186.
[3] Vintzileos AM, Ananth CV, Smulian JC. Using ultrasound in the clinical management of placental implantation abnormalities. Am J Obstet Gynecol. 2015;213(4 Suppl):S70–S7.
[4] Silver RM. Abnormal placentation: placenta previa, vasa previa, and placenta accreta. Obstet Gynecol. 2015;126(3):654–668.
[5] 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: Int J Obstet Gy. 2014;121(1):62–71.
[6] Wu S, Kocherginsky M, Hibbard JU. Abnormal placentation: twenty-year analysis. Am J Obstet Gynecol. 2005;192(5):1458–1461.
[7] Klar M, Michels KB. Cesarean section and placental disorders in subsequent pregnancies – a meta-analysis. J Perinat Med. 2014;42(5):571–583.
[8] Creanga AA, Bateman BT, Butwick AJ, et al. Morbidity associated with cesarean delivery in the United States: is placenta accreta an increasingly important contributor? Am J Obstet Gynecol. 2015;213(3): 384.e1–e11.
[9] Jauniaux E, Collins S, Burton GJ. Placenta accreta spectrum: pathophysiology and evidence-based anatomy for prenatal ultrasound imaging . Am J Obstet Gynecol. 2018;218(1):75–87.
[10] Karami, et al. The association of placenta previa and assisted reproductive techniques: a meta-analysis. J Matern Fetal Neonatal Med. 2019;32(24):4191.
[11] Gasparri ML, Nirgianakis K, Taghavi K, et al. Placenta previa and placental abruption after assisted reproductive technology in patients with endometriosis: a systematic review and meta-analysis. Arch Gynecol Obstet. 2018;298(1):27–34.
[12] Zhang L, Bi S, Du L, et al. Effect of previous placenta previa on outcome of next pregnancy: a 10-year retrospective cohort study. BMC Pregnancy Childbirth. 2020;20(1):212.
[13.] Ozdemirci S, Akpinar F, Baser E, et al. Moraloglu tekin O. Effect of the delivery way and number of parity in the subsequent incidence of placenta previa. J Matern Fetal Neonatal Med. 2020;33(19):3238–3243.

[14] De Vita D, Capobianco G, Gerosolima G, et al. Clinical and ultrasound predictors of placenta accreta in pregnant women with antepartum diagnosis of placenta previa: a multicenter study. Gynecol Obstet Invest. 2019;84(3):242–247.

[15] Chen X, Shan R, Zhao L, et al. Invasive placenta previa: placental bulge with distorted uterine outline and uterine serosal hypervascularity at 1.5T MRI – useful features for differentiating placenta percreta from placenta accreta. Eur Radiol. 2018;28(2):708–717.

[16] Jauniaux E, Bhide A. Prenatal ultrasound diagnosis and outcome of placenta previa accreta after cesarean delivery: a systematic review and meta-analysis. Am J Obstet Gynecol. 2017;217(1):27–36.

[17] Peng ZH, Xiong Z, Zhao BS, et al. Prophylactic abdominal aortic balloon occlusion: an effective method of controlling hemorrhage in patients with placenta previa or accreta. Exp Ther Med. 2019;17(2): 1492–1496.

[18] Thurn L, Lindqvist PG, Jakobsson M, et al. Abnormally invasive placenta-prevalence, risk factors and antenatal suspicion: results from a large population-based pregnancy cohort study in the Nordic countries. BJOG. 2016;123(8):1348–1355.

[19] Tanaka M, Matsuzaki S, Kakigano A, et al. Placenta accreta following hysteroscopic myomectomy. Clin Case Rep. 2016;4(6):541–544.

[20] 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.

[21] Solheim KN, Esakoff TF, Little SE, et al. The effect of cesarean delivery rates on the future incidence of placenta previa, placenta accreta, and maternal mortality. J Matern Fetal Neonatal Med. 2011;24(11):1341–1346.

[22] Cheng KK, Lee MM. Rising incidence of morbidly adherent placenta and its association with previous caesarean section: a 15-year analysis in a tertiary hospital in Hong Kong. Hong Kong Med J. 2015; 21: 511–517.

[23] Silver RM, Landon MB, Rouse DJ, et al. National institute of child health and human development maternal-fetal medicine units network. Maternal morbidity associated with multiple repeat cesarean deliveries. Obstet Gynecol. 2006;107(6):1226–1232.;

[24] 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 Maternal-Fetal Neonatal Med. 2020;1:1–8.

[25] Morlando M, Collins S. Sally Collins placenta accreta spectrum disorders: challenges, risks, and management strategies. Int J Womens Health. 2020;12: 1033–1045.

[26] Salim R, Chulski A, Romano S, et al. Precesarean prophylactic balloon catheters for suspected placenta accreta: a randomized controlled trial. Obstet Gynecol. 2015;126(5):1022–1028.

[27] Chen M, Liu X, You Y, et al. Royal college of obstetricians and gynaecologists. Placenta praevia and placenta accreta: diagnosis and management: green-top guideline no. 27a. BJOG. 2019;126(1):e1–e48.

[28] Jauniaux E, Alfirevic Z, Bhide AG, et al. Royal college of obstetricians and gynaecologists. Placenta praevia and placenta accreta: diagnosis and management: green-top guideline no. 27a. BJOG. 2019;126(1): e1–e48.

[29] Collins SL, Alemdar B, van Beekhuizen HJ, et al. Evidence-based guidelines for the management of abnormally invasive placenta: recommendations from the International Society for Abnormally Invasive Placenta. Am J Obstet Gynecol. 2019;220(6): 511–526.

[30] Allen L, Jauniaux E, Hobson S, et al. FIGO consensus guidelines on placenta accreta spectrum disorders: nonconservative surgical management. Int J Gynaecol Obstet. 2018;140(3):281–290.

[31] Placenta accreta spectrum. Obstetric care consensus no. 7. American college of obstetricians and gynecologists. Obstet Gynecol. 2018;132:e259–75.

[32] Shmakov RG, Vinitskiy AA, Chuprinin VD, et al. Alternative approaches to surgical hemostasis in patients with morbidly adherent placenta undergoing fertility-sparing surgery. J Matern Fetal Neonatal Med. 2019;32(12):2042–2048.

[33] Barinov S, Tirskaya Y, Medyannikova I, et al. A New Approach to Fertility-Preserving Surgery in Patients with Placenta Accreta Journal of Maternal-Fetal and Neonatal Med. 2019;32(9):1449–1453.

[34] Lin J, Lin F, Zhang Y. Uterine artery ligation before placental delivery during caesarean in patients with placenta previa accreta. Medicine. 2019;98(36):e16780.

[35] Abbas AM, Shady NW, Sallam HF. Bilateral uterine artery ligation plus intravenous tranexamic acid during cesarean delivery for placenta previa: a randomized double-blind controlled trial. J Gynecol Obstet Hum Reprod. 2019;48(2):115–119.