Perspective

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Ligation or Occlusion of the Internal Iliac Arteries for the Treatment of Placenta Accreta Spectrum: Why Is This Technique Still Performed?

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Introduction

The major complication of placenta accreta spectrum (PAS) disorder is massive bleeding; therefore, multiple vascular interventions have been described to prevent or treat pelvic bleeding.

Ligature of the internal iliac arteries (IIAs) was published more than 130 years ago,[1] and although research relating to the physiology of this procedure has demonstrated poor vascular control over the last few decades,[2–4] this technique has evolved into an established technique known as endovascular IIA balloon occlusion.[5] However, not all specialists appear to understand the hemostatic effects, safety, and complications associated with this particular technique. Consistent with previous physiologic research that described a broad collateral pelvic arterial network,[6] several expert consensuses and international guidelines have reported that IIA occlusion is not fully efficacious for the management of PAS.[7,8] Several controlled clinical trials[9–11] and systematic reviews[12–14] have reported the low efficacy of this procedure. However, IIA occlusion continues to be used by multiple PAS referral centers[15,16] and is the most frequently used vascular intervention according to PAS teams in Latin America.[17]

Here, we aim to consider the arguments against the use of IIA occlusion for the management of PAS and provide reference guidelines for the critical reflection that each PAS team must consider with regard to the most appropriate vascular control strategy to be implemented for patients with PAS.

PAS is a condition with multiple presentations

PAS disorder is associated with a wide range of clinical presentations. Some cases at the "benign end" of the spectrum carry risks that are similar to a challenging cesarean section if handled by expert teams, whereas other cases at the opposite end of the spectrum carry a high risk of mortality if appropriate vascular control strategies are not applied. In the case of unexpected bleeding, it is vital to ascertain when patients require vascular interventions according to their severity.[15]

Some patients who are suspected of having PAS disorder on ultrasound will then undergo a complex surgical protocol; and during laparotomy, physicians confirm that the final diagnosis is uterine dehiscence.[18] Other patients undergoing cesarean section with no previous signs of PAS disorder can be diagnosed with this condition by evidence of an obvious abnormality during laparotomy.[19] This potential discrepancy between prenatal suspicion and intraoperative findings suggests that an ideal form of vascular control strategy should be applied rapidly after the intraoperative confirmation of a diagnosis of PAS disorder and appropriate evaluation of the surgical difficulty of each case.

Endovascular procedures are not commonly performed during active bleeding[20]; this is because catheters need to be introduced before laparotomy. The IIA ligation technique could be performed after intraoperative staging or fetal extraction. However, exteriorizing the uterus and dissecting the retroperitoneum is time-consuming and may induce significant blood loss until the bilateral ligation of these vessels is completed. These considerations highlight the reduced utility of IIA occlusion techniques in protocols where treatment is individualized according to the individual characteristics of each case during surgery.

IIA occlusion cannot sufficiently control pelvic bleeding

More than 50 years ago, it was confirmed that ligation of the main trunk of the IIA reduced the pressure of the pelvic

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arterial system but did not fully control bleeding.[4] A low vascular filling pressure may favor vascular control; however, this argument may be invalid in the context of the severe hypervascularization observed in patients with PAS disorder. In addition, the bilateral arterial ligature is the minimum procedure required to achieve hemostasis in a medial organ because most vascular pelvic anastomoses are vertical.

The technique described for IIA surgical ligation[15] and arterial balloons[21] emphasizes that only the IIA anterior division is occluded. The primary goal of maintaining flow in the posterior division of the IIA is to avoid gluteal necrosis.[22] However, at the same time, the branches of the posterior division of the IIA (the lower vaginal and inferior vesical arteries) are left open[23]; this plays a vital role in PAS disorder–related bleeding and placenta previa (Fig. 1). These anatomical considerations may explain the results of three previous randomized controlled trials (RCTs) and 4 systematic reviews (Table 1). Since 2018, 3 RCTs have compared IIA balloon occlusion/surgical ligation with standard management protocols.[9–11] Moreover, the 3 RCTs concluded that IIA occlusion did not reduce intraoperative bleeding or the number of transfusions.

Until now, only 4 systematic reviews of the literature have evaluated the efficacy of IIA occlusion for the management of PAS disorder, as determined by a literature search of PubMed[12–14,24]; 3 of these reviews compared IIA balloon occlusion with no vascular interventions.[12–14,24] Only the study by Nankali *et al.*[24] showed clinically significant reduction in bleeding volume and reported a loss of 1436 mL in the balloon group compared with 2503 mL in the non-balloon group. However, there were high levels of heterogeneity in the included studies (I^2 = 97.4%), and the 3 recent RCTs were not included. The other 2 studies showed no benefit[13] or only a slight benefit (–232.11 mL; 95% confidence interval, –392 to –72.2 mL; P = 0.004) that was statistically significant but not clinically relevant.[12,13]

The fourth systematic review compared IIA balloons with aortic balloons[14] and reported greater benefits for aortic balloons when compared with iliac balloons (–410.61 mL; 95% confidence interval, –779.74 to –41.47 mL; P < 0.001).

Although some cohort studies have suggested that the use of IIA balloons is beneficial for patients with severe cases of PAS disorder,[25] the body of evidence mostly originates from retrospective studies[26] or studies that included small populations,[27] which does not exceed the information listed in Table 1. In addition, IIA balloons must be placed before laparotomy in patients who have a high risk of bleeding. Recent studies have concluded that the severity of PAS disorder can only be determined intraoperatively.[28] The definition of a "severe case" when applying the International Federation of Gynecology and Obstetrics (FIGO) classification is controversial because the relationship between this classification and the volume of blood loss has yet to be determined.[29] It is difficult to differentiate cases of dehiscence from cases of PAS disorder when applying presurgical ultrasonographic criteria or when based on the appearance of the uterus during laparotomy.[30] The anatomical considerations described herein, along with the available scientific evidence, collectively indicate that IIA occlusion does not offer significant advantages for the management of PAS disorder.

Two other methods that can be used to occlude the IIA are temporary clamping and embolization (permanent or transient); however, because these 2 strategies are used less frequently to treat PAS disorder, they will not be addressed in this article. In addition, some reports have demonstrated the efficacy of common iliac artery occlusion; however, this is beyond the scope of this article.

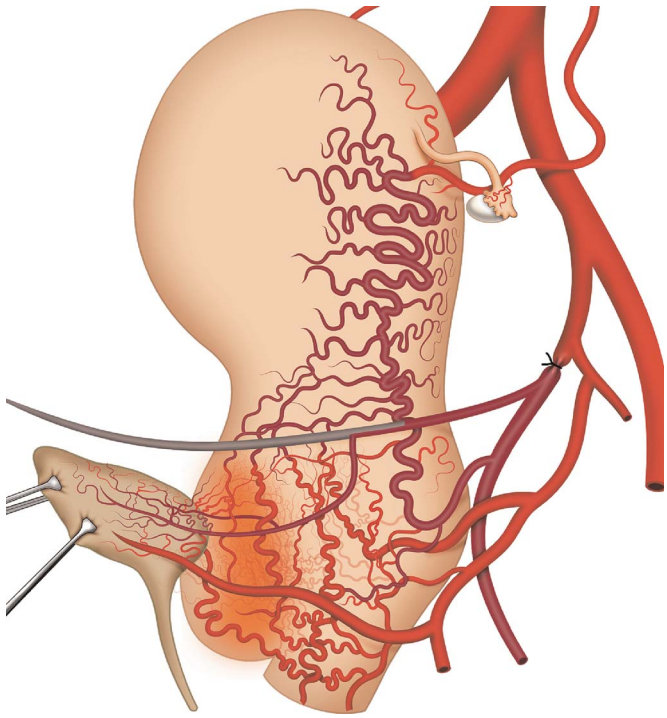

Figure 1. Arterial flow persists after ligation of the IIA anterior division in cases of PAS disorder. This figure illustrates the ligation of IIA distal to the origin of its posterior division. The uterine, superior vaginal, and superior vesical arteries and branches of the IIA anterior trunk (shown in purple or magenta) are without flow following bilateral ligation. The bulge in the anterior part of the uterine segment, posterior to the bladder, shows the dense anastomotic network and hypervascularization generated by PAS disorder and placenta previa. This network continues to be irrigated by branches of the IIA posterior division (inferior vesical artery, vaginal arteries) after ligation of the anterior division. IIA: Internal iliac artery; PAS: Placenta accreta spectrum.

Endovascular or surgical IIA occlusion is associated with risk

Although previous reports have described rupture of the IIA when applying endovascular balloons,[31–33] most authors have not reported any complications associated with the endovascular procedure.[10,21] However, our group has experienced at least four complications associated with IIA occlusion/ligation. Two patients had femoral venous thromboses that were related to accidental venipunctures during arterial access[34]; one patient presented external iliac artery thrombosis after the use of IIA balloons (Fig. 2), and another patient suffered rupture of the internal iliac vein during IIA surgical ligation (Supplemental Digital Content, Supplementary Video 1, http://links.lww.com/MFM/A35).

It is clear from the existing literature that IIA occlusion, whether performed surgically or endovascularly, requires significant training, and complications can occur, even when performed by experts.

Table 1

Recent level 1 evidence relating to the efficacy of IIA occlusion for the management of PAS disorder.

Author	Publication year	Assessed Interventions	Main outcome	Population	Results
Randomized controlled trials					
Hussein *et al.*[9]	2019	IIA balloon occlusion or ligation *vs.* standard management	Intraoperative blood loss	29 *vs.* 28 Patients	ND (1632 ± 804 *vs.* 1698 ± 1251) mL, $P = 0.83$
Yu *et al.*[10]	2020	IIA balloon occlusion or ligation *vs.* standard management	Intraoperative blood loss	20 *vs.* 20 Patients	ND 1451 mL (1024–2388) mL *vs.* 1454 mL (888–2300) mL, $P = 0.945$
Chen *et al.*[11]	2020	IIA balloon occlusion or ligation *vs.* standard management	Number of packed red blood cell units transfused	50 *vs.* 50 Patients	ND (5.3 ± 5.3 *vs.* 4.7 ± 5.4) units $P = 0.54$
Systematic reviews					
Shahin *et al.*[12]	2018	PBOIIA *vs.* no endovascular intervention	Intraoperative blood loss	7 Studies, 470 patients No heterogeneity ($I^2 = 0\%$)	SD –232.11 mL (95% *CI*, –392 to –72.2), $P = 0.004$
Nankali *et al.*[24]	2021	PBOIIA *vs.* no endovascular intervention	Intraoperative blood loss	29 Studies, 1225 *vs.* 1140 patients Heterogeneity was high ($I^2 = 97.4\%$)	SD (1436 ± 211 *vs.* 2503 ± 403) mL
Liang *et al.*[13]	2021	PBOIIA *vs.* no endovascular intervention	Intraoperative blood loss	12 Studies, 946 patients Heterogeneity was high ($I^2 = 93.7\%$)	ND –0.525 mL (95% *CI*, –1.112 to –0.061), $P = 0.079$
Liu *et al.*[14]	2021	AA balloon occlusion *vs.* IIA balloon occlusion	Intraoperative blood loss	6 Studies, 239 *vs.* 281 patients Heterogeneity was high ($I^2 = 94\%$)	SD –410.61 mL (95% *CI*, –779.74 to –41.47), $P < 0.001$

PBOIIA: Preoperative balloon occlusion of the internal iliac artery; AA: Abdominal aortic; ND: No significant differences; SD: Significant differences; *CI*: Confidence interval.

IIA occlusion is challenging to implement in low- and middle-income countries

The utilization of radiology and the participation of vascular interventional specialists increases the costs associated with the management of PAS disorder.[21,35] Furthermore, many PAS referral centers lack these resources.[17]

Some previous authors have reported that IIA ligation is inexpensive and available in both low- and middle-income countries.[36] However, the availability of personnel trained in the application of IIA ligature varies among hospitals in different regions of the world, with only 27% of hospitals in Latin America possessing gynecological oncologists on their PAS teams.[37] The administrative and economic investments associated with training personnel to perform IIA occlusion for the management of PAS in resource-limited settings have yet to be evaluated, although this is certain to require significant effort.

Other options are available for effective and immediate vascular control

Other practical and straightforward vascular interventions can be applied after laparotomy in patients with severe PAS disorder and a higher risk of bleeding. One such example is aortic outflow occlusion by internal manual compression, aortic balloons, or aortic loops (Table 2).

An aortic balloon occlusion is an attractive option because this procedure can be performed directly on the operating table without fluoroscopy in a relatively short period.[38]

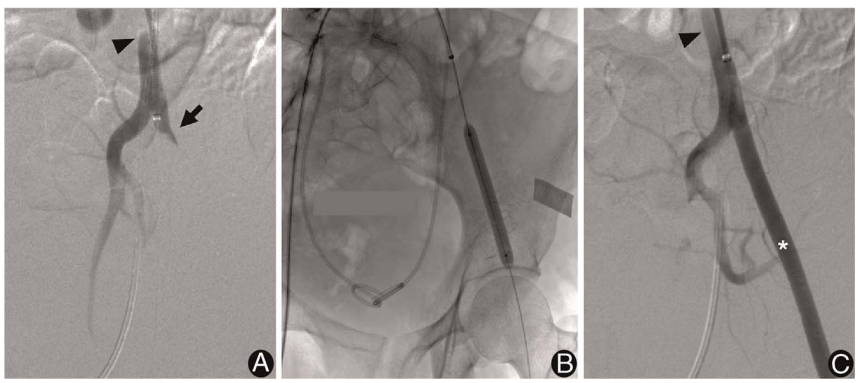

Figure 2. Arterial thrombosis caused by IIABO in patients with PAS disorder. Twenty-four hours after cesarean delivery and hysterectomy for PAS disorder, the absence of a left pedal pulse was detected. The patient required IIABO, which took 40 minutes to complete. A Absence of contrast medium distal to the origin of the external iliac artery (arrow) because of thrombosis. B External iliac artery balloon angioplasty after thrombectomy. C Contrast medium typically fills the left external iliac artery (asterisk) after thrombectomy. The arrowhead points to the left common iliac artery. IIABO: Internal iliac artery balloon occlusion; PAS: Placenta accreta spectrum.

Table 2

Main vascular control methods for the female pelvis.

Procedure	Resources	Time necessary	Upper uterus hemostasis	Lower uterus, parametrium, bladder trigone area hemostasis	Possible complications	Arterial pedicles controlled
IIA ligature	Expertise required	Moderate to long according to experience Bilateral	Good	Poor	Internal iliac vein injuries	UA, lateral sacral and obturator anastomosis (partial)
IIA balloon occlusion	Expertise and equipment (balloons, fluoroscopy room) required	Moderate to long according to experience Bilateral	Good	Poor	IIA rupture, femoral or iliac thrombosis and other puncture related complications	UA, lateral sacral and obturator anastomosis (partial)
Ao balloon occlusion	Expertise and equipment (balloon) required	Moderate to long according to experience	Excellent	Excellent	Femoral thrombosis and other puncture related complications, misplaced balloon	UA, all femoral and iliac internal arteries branches, and external anastomosis
Ao cross-clamping	Vascular or general surgeon and Satinsky clamp required	Moderate to short according to experience	Excellent	Excellent	Lumbar arteries bleeding, inferior vena cava injuries	UA, all femoral and iliac internal arteries branches, and external anastomosis
Ao loop	A vascular or general surgeon required	Moderate to short according to experience	Excellent	Excellent	Lumbar arteries bleeding, inferior vena cava injuries	UA, all femoral and iliac internal arteries branches, and external anastomosis
Internal manual Ao compression	Not necessary	Very short	Excellent	Excellent	Not related	UA, all femoral and iliac internal arteries branches, and external anastomosis

Ao: Aortic; IIA: Internal iliac artery; UA: Uterine artery.

However, this is an expensive procedure that is associated with complications.[39]

Aortic clamping requires retroperitoneal dissection to separate the aorta from the vena cava. However, some general surgeons (the specialty available in almost all hospitals of medium complexity) can perform this procedure.[40]

Internal manual compression of the aorta can partially limit access to the surgical field because an operator must retain his or her hand on the aorta; at this time, surgeons can successfully control the source of bleeding. However, widening the incision in the abdominal wall may allow an assistant to compress the aorta from a position that does not limit the surgeons. In addition, low-cost devices can enable aortic compression without taking up space in the surgical field.[41] The most significant benefits of this maneuver are that there are no associated complications and only minimal training is required.[4,42] Because this maneuver is simple and only requires a short period to complete, aortic flow occlusion is the preferred strategy to prevent massive or unexpected pelvic bleeding. Except for extrapelvic anastomoses,[4] occluding the aorta can successfully control the arterial pedicles involved in the most severe cases of PAS disorder.[43]

Our experience

Before 2016, we used IIA balloons or ligatures during all PAS surgeries.[34,44] Our results showed that 23% of patients who received IIA balloons before laparotomy had a final diagnosis other than PAS.[44] In addition, 2 patients were diagnosed with venous thrombosis; 1 case also developed pulmonary embolism. In both cases, venous puncture occurred during arterial access without ultrasound guidance.[34] Self-assessment also revealed that 19% of our cases were only diagnosed during the cesarean section for another obstetric condition.[44] Thus, these patients would not benefit from the placement of IIA balloons before laparotomy.

Since 2006, our group has actively sought to identify a faster vascular control strategy that does not require retroperitoneal dissection or result in the exposure of the fetus to radiation. Therefore, our group has performed resuscitative endovascular balloon occlusion of the aorta (REBOA) to prevent massive bleeding in patients with PAS disorder. Although we initially performed REBOA for all patients, we found that intraoperative staging allowed us to safely identify patients with a higher risk of massive bleeding. Consequently, we reserved the use of REBOA for aortic occlusion for these patients with a higher risk of significant bleeding, thereby reducing the number of patients exposed to the potential complications associated with this procedure.[43]

Conclusion

Our literature review indicates that there is little to no benefit of performing IIA occlusion for the treatment of patients with PAS disorder.

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Conflicts of Interest

None.

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