# Occlusion of the common and internal iliac arteries for aortoiliac aneurysm repair: experience with the Amplatzer vascular plug

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**Background:** We sought to evaluate and describe our centre's experience with the Amplatzer vascular plug (AVP) for the occlusion of common and internal iliac arteries (CIA; IIA) during endovascular aortic aneurysm repair (EVAR).

**Methods:** We performed a retrospective analysis of 20 consecutive patients between October 2006 and December 2007, who underwent occlusion of the CIA or IIA before or during EVAR to prevent endoleak.

**Results:** Among these 20 patients, 21 occlusion procedures occurred and 20 were successful. In the only unsuccessful case, the patient had EVAR, but occlusion with an AVP was not possible because of severe narrowing at the origin of the vessel. Of the successfully treated patients, 2 presented with ruptured aneurysms, whereas the others had elective procedures. Eleven patients received aortouni-iliac grafts and femoral–femoral bypass, and 9 patients received a bifurcated stent graft. In 5 patients, the AVP occlusion and EVAR procedures were staged; in these cases occlusion occurred first, followed by EVAR on average 29 (standard deviation [SD] 23) days later. We deployed 7 AVPs in the CIA, whereas 13 were deployed in the IIA. The average diameter of the vessels occluded was 10 (SD 1) mm and the average size of the device used was 13 (SD 1) mm, representing a device diameter 28% (SD 2%) greater than the vessel diameter. We used a single device in 18 patients, whereas 2 devices were deployed in the same artery in 2 patients. Four patients underwent concomitant coil embolization. On follow-up computed tomography (CT) scans, all occlusion procedures were clinically successful. At the 14-month (SD 1 mo) follow-up, 4 patients had a small type-II endoleak unrelated to the occlusion procedure and 1 had a type-I endoleak that required graft limb extension. Four patients had buttock claudication but none had changes in sexual function, ischemic complications or device dislodgement on CT scans.

**Conclusion:** The AVP is a safe and effective method to occlude the CIA and IIA in patients undergoing EVAR.

**Contexte :** Nous avons cherché à évaluer et à décrire l'expérience que notre centre a acquise de l'utilisation de l'obturateur vasculaire Amplatzer (OVA) pour l'occlusion des artères iliaques commune et interne (AIC; AII) au cours d'un traitement endovasculaire d'un anévrisme de l'aorte (TEVA).

**Méthodes :** Nous avons procédé à une analyse rétrospective du cas de 20 patients vus consécutivement, entre octobre 2006 et décembre 2007, qui ont subi une occlusion de l'AIC ou de l'AII avant ou durant le TEVA afin de prévenir une endofuite.

**Résultats :** Chez ces 20 patients, on a pratiqué 21 interventions d'occlusion, dont 20 ont réussi. Dans le seul cas qui n'a pas réussi, le patient a subi un TEVA, mais il n'a pas été possible de pratiquer l'occlusion au moyen d'un OVA à cause d'un rétrécissement important à l'origine du vaisseau. Sur les patients traités avec succès, 2 avaient un anévrisme rupturé, tandis que les autres ont subi des interventions électives. Onze patients ont reçu un greffon aorto-uni-iliaque et subi un pontage fémoro-fémoral, et on a implanté un stent bifurqué à 9 patients. Chez 5 patients, l'occlusion par OVA et le TEVA se sont déroulés par étapes. Dans ces cas, on a pratiqué l'occlusion en premier et le TEVA ensuite, en moyenne 29 jours (ET 23) plus tard. Nous avons posé 7 OVA dans l'AIC, et 13 dans l'AII. Le diamètre moyen des vaisseaux bloqués s'établissait à 10 mm (ET 1), et la grosseur moyenne du dispositif utilisé, à 13 mm (ET 1), ce qui représente un diamètre du dispositif qui dépasse de 28 % (ET 2 %) celui du vaisseau. Nous avons utilisé un seul dispositif chez 18 patients et nous en avons posé 2 dans la même artère chez 2 patients. Quatre patients ont subi une embolisation concomitante par stent. Les tomodensitométries de suivi ont révélé que toutes les

 

interventions d'occlusion avaient réussi sur le plan clinique. Au suivi à 14 mois (ET 1 mois), 4 patients avaient une légère endofuite de type-II non liée à l'intervention d'occlusion et un avait une endofuite de type-I qui a obligé à prolonger le greffon. Quatre patients avaient une claudication fessière, mais aucun n'avait subi de changement de la fonction sexuelle, de complication ischémique ou de déplacement du stent révélé par tomodensitométrie.

**Conclusion :** L'OVA constitue un moyen sécuritaire et efficace de bloquer l'AIC et l'AIA chez les patients qui subissent un TEVA.

Aneurysms of the abdominal aorta (AAA) were traditionally treated by open surgical repair until the development of endovascular aneurysm repair (EVAR), as described by Parodi in 1991.[1] Since then, many studies have demonstrated the safety and efficacy of EVAR, even in patients with ruptured aortic aneurysms.[2–4]

An important requirement for EVAR is the presence of a suitable distal landing zone, most commonly in the common iliac arteries (CIAs) or the external iliac arteries. It is estimated that 20% of patients with AAAs have aneurysms extending into the CIA,[5,6] thus requiring landing in the external iliac artery. In these situations, therapeutic embolization of the internal iliac arteries (IIAs) before or concurrent with EVAR deployment is required to avoid retrograde perfusion of the aneurysm sac and potential endoleaks.[5,6] Typically, coil embolization is the standard technique for inducing thrombosis of the IIAs in these patients.[7–10]

The Amplatzer vascular plug (AVP; AGA Medical) is a self-expanding, cylindrical occluding device made of 144 nitinol mesh wires, with no occlusive fabric. At both ends of the device are platinum marker bands, which can be readily identified on radiological studies. The delivery system is a stainless steel wire attached by a microscrew mechanism to the AVP. This delivery system allows for easy repositioning with multiple recapturing and redeployment capabilities during AVP placement. The AVP was initially available in diameters ranging from 4 to 16 mm (in 2-mm increments), but the diameters of second-generation devices range from 3 to 22 mm. The AVP can be delivered with standard guiding catheters or sheaths. The minimal sheath diameters required range from 4- to 7-Fr.

Amplatzer vascular plugs have been largely used in the heart for pulmonary and portal circulation and for arteriovenous malformations.[11–17] Their use in EVAR procedures for occlusion of the IIAs has only recently been addressed in small and limited series.[18–21] To our knowledge, AVP placement in the CIA has only been reported in case reports. Our centre has had experience with AVP for EVAR both in the CIA and IIA in recent years. The goal of the present study is to describe this experience and assess the effectiveness of AVPs in this role.

## Methods

We performed a retrospective analysis on consecutive patients who received an AVP as part of their treatment for EVAR between October 2006 and January 2008. This series included patients with asymptomatic and ruptured aneurysms.

All procedures took place at St. Paul's Hospital or Vancouver General Hospital in Vancouver, British Columbia. Both are tertiary care university-affiliated teaching hospitals. All patients had preoperative computed tomography angiograms (CTAs) before aneurysm repair. Criteria used for repair were rupture, rapid growth, size greater than 5.5 cm at the largest diameter for AAA, and diameter greater than 3 cm for isolated iliac artery aneurysms. The choice of grafts used in each patient was based on preferences of the attending vascular surgeons or interventional radiologists, patient anatomy and device availability. Procedures took place either in the operating room with a mobile C–arm or the interventional suites of the hospitals.

The AVP placement was preoperative or intraoperative during EVAR placement based on the surgeons' preference. Surgeons favoured a 2-stage approach if they anticipated a difficult placement, in patients with bilateral IIA occlusions or in patients with elevated creatinine to decrease the contrast load. Both the contralateral and ipsilateral approaches were used, and the AVP was delivered with a Destination sheath (Terumo Medical). The diameter of the AVP chosen was based on vessel size: 30%–50% greater than the vessel to be occluded, in accordance with the manufacturer's recommendation. After placement of the AVP and/or EVAR, patients underwent completion angiography. If the result was not satisfactory, either a second AVP or Helical Nester platinum-fibre coils (Cook Medical) were used based on preference of the vascular surgeon or the interventional radiologist. Heparin, administered at the beginning of endovascular manipulations, was not reversed at the end of the case. Later on in the series, as the surgeons gained experience with the AVP, we stopped treating persisting flow through the AVP after it was appropriately placed, trusting it to thrombose after the heparin wore off.

We obtained a follow-up CTA within the first month after EVAR, at 3 months and then once a year. We reassessed the patients at 6 weeks, 6 months and once a year thereafter unless closer follow-up was necessary. At each follow-up visit, patients were questioned about symptoms of buttock claudication, bowel ischemia and sexual dysfunction. We instructed patients to contact their vascular

surgeons at the onset of new or worsening symptoms including those mentioned previously.

The outcomes of our study include technical success (proper placement in the intended vessel without need for further procedures), clinical success (target vessel occlusion with absence of endoleak or aneurysm enlargement on postoperative CTAs) and patient outcomes (mortality and morbidity).

We performed the Student *t* test using STATA software (StataCorp LP). We considered results of $p < 0.05$ to be significant.

## Results

Twenty patients (17 men, 3 women) had occlusion procedures attempted in the 15-month period defined. The mean age of patients was 70 (standard deviation [SD] 3) years. Sixty-seven percent of patients had a history of smoking, 76% had hypertension, 13% had diabetes, 29% had chronic obstructive pulmonary disorder and 32% had coronary artery disease. Five percent of patients had chronic renal failure and were on dialysis.

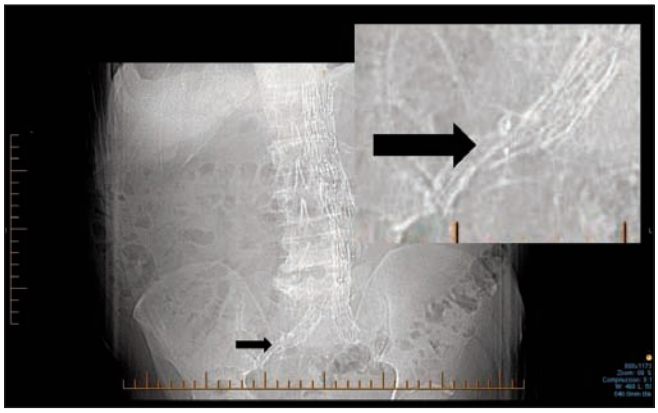

**Fig. 1.** Typical computed tomography scan showing positioning of the Amplatzer vascular plug in the right internal iliac artery.

Two patients presented with a ruptured aneurysm and 1 presented with a chronic anastomatic false aneurysm after having had a tube graft open AAA repair. In terms of the type of aneurysms, 10 patients had AAAs, 1 had a CIA (bilateral), 7 had combined AAAs and CIAs and 2 had CIAs with IIAs. Eleven patients received an aortouni-iliac graft with femoral–femoral bypass and 9 received a bifurcated graft. Four patients received a fenestrated EVAR graft (2 of them were bifurcated grafts).

There were 21 occlusion procedures attempted in these 20 patients. In 5 patients, the occlusion and EVAR were staged. In staged procedures, the occlusion occurred first followed by EVAR on average 29 (SD 23) days later. Figure 1 is a typical computed tomography (CT) scan after occlusion and EVAR. Figure 2 is a schematic representation of the types of occlusions performed.

In 1 patient, the device could not be delivered because of severe narrowing at the origin of the vessel. We counted this patient as a technical failure. He was a 78-year-old man with a history of coronary artery disease, atrial fibrillation, congestive heart failure, chronic renal failure and chronic obstructive pulmonary disease. He had undergone open AAA repair in 1995 and presented with an asymptomatic false aneurysm above the proximal aortic anastomosis and a left common iliac aneurysm. He underwent EVAR with a bifurcated graft. The plan was to embolize the left IIA to prevent endoleak into the left common iliac aneurysm. The procedure was not successful because of severe narrowing at the origin of the IIA. The procedure was abandoned in favour of an iliac extension that landed in the external iliac artery. The orifice of the IIA was covered by the limb extension, and there was no endoleak on postoperative CTA.

Seven patients had AVP placement in the CIA whereas 13 had placement in the IIA. Six of 20 patients required additional procedures, corresponding to a predefined technical success rate of 70%. Two patients required more than 1 AVP device: 1 patient required 2 devices (14 mm and

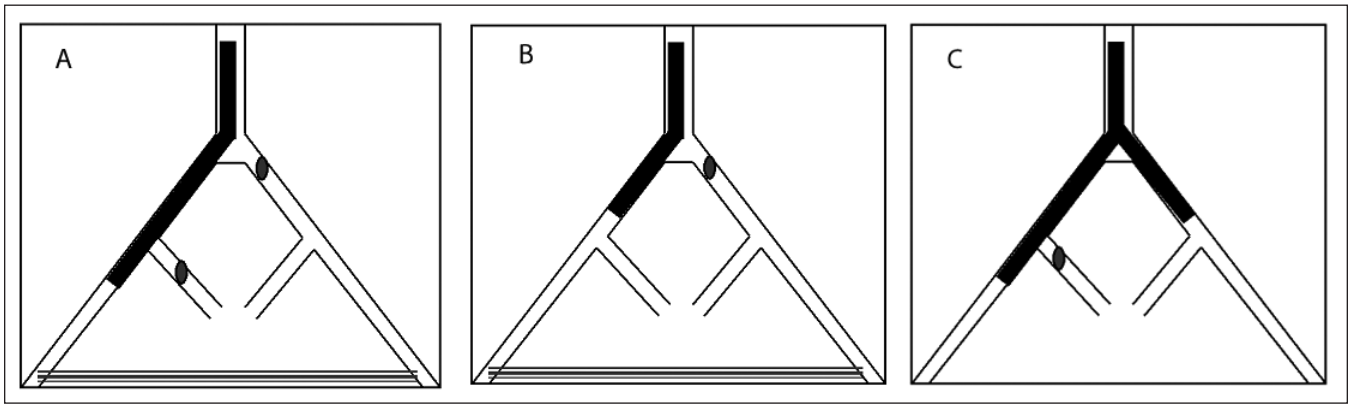


**Fig. 2.** Types of deployment of the Amplatzer vascular plug based on endovascular aortic aneurysm repair. (**A**) Aortouni-iliac repair with femoral–femoral bypass landing in the external iliac artery and requiring occlusion of the contralateral common iliac artery (CIA) and ipsilateral internal iliac artery (IIA). (**B**) Aortouni-iliac repair with femoral–femoral bypass landing in the CIA and requiring occlusion of the contralateral CIA. (**C**) Bifurcated graft with occlusion of 1 IIA.

16 mm) to occlude the CIA, and the other patient required 2 devices (7 mm and 10 mm) to obtain complete thrombosis of the IIA. Four other patients (20%) required coils in addition to the AVP device. In 1 patient, anterior and posterior branches of an IIA aneurysm were occluded before deployment of the AVP. In a second patient, although the IIA was thrombosed, a small branch was embolized to avoid endoleak. One patient required 4 coils in addition to the AVP. The fourth patient required coils to supplement occlusion of the CIA. On first postoperative CTA, all patients had complete thrombosis of the target vessel.

The average diameter of the CIA occluded was 13 (SD 1) mm. The average diameter of the IIA occluded was 8 (SD 1) mm. The size of the AVP device used for the CIA was 16 (SD 1) mm and that used for the IIA occlusion was 12 (SD 1) mm. Overall, the size of the device was 28% (SD 2%) greater than the vessel diameter.

The average duration of follow-up was 14 (SD 1) month; 2 patients were lost to follow-up. Overall, 5 patients experienced an endoleak after EVAR, but none was related to the vessel occluded with AVP. None of the patients experienced aneurysm enlargement. This corresponds to a predefined clinical success rate of 100%. Four patients had small type-II endoleaks, which were followed clinically. One patient had a type-I endoleak unrelated to the AVP occlusion, which required limb extension of the graft after 3 months.

Four patients had buttock claudication after the procedure. No patients reported changes in sexual function or were found to have peripheral ischemic complications. There was no AVP dislodgement on follow-up CT.

The mean duration of fluoroscopy for combined EVAR and occlusion was 49 (SD 7) minutes. When the EVAR and occlusion were performed as 2 different procedures, the mean duration of fluoroscopy was 57 (SD 4) minutes. This difference was not significant ($p = 0.50$). The amount of contrast per EVAR procedure was 229 (SD 29) mL.

## Discussion

We report our experience with 20 patients who underwent occlusion of an iliac artery with AVP during treatment for EVAR at our institutions. To our knowledge, this is the first and largest report combining experience of occlusion of both CIAs and IIAs with the AVP device.

The occlusion was successful in most patients; vessel cannulation failed and the device could not be delivered in only 1 patient. Although a few patients required supplementation of the AVP with a second AVP or with coils (technical success rate of 70%), all vessels were completely thrombosed postprocedure and did not contribute to an endoleak on the follow-up CTA (clinical success rate 100%). The reason for supplemental coils can partly be explained by our initial unfamiliarly with the device and our reluctance to accept device porosity during deployment in our early patients. As we grew more familiar with the device, we realized vessel thrombosis would occur later as long as the device was appropriately sized and deployed in the proper position. This is supported by other reports using the AVP.[18–21] For example, Kickuth and colleagues[19] reported a success rate of 100% in 9 patients. Ferro and colleagues[20] reported success in 5 patients. Tuite and colleagues[22] reported that in 5 patients with IIA occlusion, 1 needed coils. Ha and Calcagno,[21] in their report comparing coil embolization and AVP occlusion, reported successful occlusion of IIA in 5 patients with 1 AVP.

The typical clinical features after occlusion of 1 or both IIAs are buttock claudication, bowel ischemia and sexual dysfunction. In our study, 4 patients reported buttock claudication, but no bowel ischemia or sexual dysfunction were reported. This compares favourably to the literature. Kickuth and colleagues[19] reported an incidence of 33% of buttock claudication, with no bowel ischemia or sexual dysfunction. Ferro and colleagues[20] reported no complications among 5 patients after IIA occlusion. Ha and Calcagno[21] reported 60% buttock claudication, but no ischemic bowel, buttock necrosis or sexual dysfunction. Interestingly, sexual dysfunction appears low in our report and in the literature. Several factors could contribute to that, including the underreporting of this complication by patients, the relatively old age of our patients and the fact that less emphasis by the vascular surgeon may have been placed on this complication in patient follow-up.

The AVP has several advantages that may favour its use. First, the device is easy to position and deploy accurately. If we miss the target, it is easy to resheath the device and reposition it. The devices can be placed through 6- or 7-FR sheaths, which are much more user-friendly than the large sheaths usually needed for stent graft occluders (and may potentially lead to less vessel trauma). The increased size range of second-generation AVPs allows for occlusion of most CIAs. We demonstrated in this series the high reliability of the AVP for occluding the CIA and IIA.

Another advantage is the relatively low cost of the AVP compare with the stent graft occluders. In our institution, the difference amounts to one-tenth of the price of the other occluder device.

In the IIA position, AVPs have a distinct advantage over embolization coils for several reasons. Accurate localized occlusion of the AVP ensures occlusion of the IIA near its origin, allowing better collateral blood flow in the pelvis, which in turn may explain the lower incidence of buttock claudication. There is also economic advantage for using AVPs instead of coils, as described by Ha and colleagues.[21] Although length of the procedure was not analyzed in our study, we found that AVPs were very user-friendly and seemed to have a time-saving advantage as they simplified the embolization to fewer steps. In our centre, we routinely occlude the IIA when the stent grant is extended to the external iliac artery.

The length of the AVP is a potential problem since the length increases with the size of the diameter. This characteristic is particularly important for the Amplatzer II plug (diameters > 16 mm) and potentially problematic when the intended vessel for occlusion is short. This is not a problem for the Amplatzer I plug since it is relatively short. We generally aim to place these devices in the most proximal portion of the target vessel to avoid branch occlusion. For the IIA, this is usually not a problem since the diameter is generally small enough that and Amplatzer I plug is sufficient and the target vessel usually has a long landing zone. The CIA can be short, particularly in Asian patients. Our strategy in the short CIA is as follows:

- avoid oversizing (30%–50% of target vessel diameter),
- use Amplatzer I plugs (≤ 16 mm) when possible, and
- ensure precise placement with clear visualization of distal branches.

The internal iliac origin is clearly defined and should be used as the landing target. The AVP can be recaptured multiple times, so repositioning can occur until placement of the device is perfected. Sometimes protrusion of part of the AVP into the aneurysm is necessary if the device is too long to preserve the internal iliac orifice; we have had good results in such cases.

In conclusion, we have reviewed our centre's experience with AVP and found it to be satisfactory based on the success and reliability of the procedure. We recommend the use of this device in the CIA and the IIA.

**Competing interests:** None declared.

**Contributors:** Drs. Grenon, Gagnon, Hsiang and Chen designed the study. Dr. Grenon acquired the data and wrote the article. Drs. Gagnon, Sidhu, Taylor, Clement and Chen reviewed the article. All authors analyzed the data and approved publication.

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