Surgical and endovascular treatment of abdominal aortic pseudoaneurysms

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Aim. **Personal experience with surgical and endovascular repair of aortic and iliac anastomotic pseudoaneurysms is described.**
Methods. **Between January 1991 and December 2002, 28 aortic or iliac anastomotic pseudoaneurysms were treated in 27 patients; 18 patients (66.7%) underwent standard surgical repair of an anastomotic pseudoaneurysm, one of them due to an aortoenteric fistula. A further 10 anastomotic pseudoaneurysms (6 aortic, 4 iliac) in 9 patients (33.3%) were treated by endovascular graft exclusion.**
Results. **The early total technical success rate was 89.3%; 88.9% in the open repair group and 90% in the endovascular repair group with a postoperative mortality rate of 11.1% and 10%, respectively. In the surgical repair group, 4 patients were lost to follow-up, and there were 2 deaths unrelated to the procedure. In the remaining 10 patients, there was only 1 recurrent aortic distal anastomotic pseudoaneurysm (mean follow-up: 6.6 years). In the endovascular repair group, there were 2 open repair conversions and 2 unrelated deaths. In the remaining 5 patients the pseudoaneurysms were successfully excluded with stent-grafts at a mean follow-up of 3.4 years.**
Conclusion. **The treatment of aortoiliac anastomotic pseudoaneurysms is advocated only in cases of expanding aneurysms or those with a diameter ≥ 5 cm, given the generally high operative morbidity and mortality. Endovascular repair which is technically feasible and provides a high rate of lesion exclusion, appears to be a good alternative to standard surgical repair in selected cases.**

KEY WORDS: Aneurysm, false - Aorta - Iliac artery.

Paper presented to the conference on Abdominal Aortic Aneurysms, Florence, Italy, June 4-5, 2003.

Received May 24, 2004
Accepted for publication February 1, 2005

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Anastomotic pseudoaneurysms of the abdominal aorta and iliac arteries (AAPA) constitute a complication of aortic graft surgery, the pathogenesis and history of which are as yet unclear.

Also called para-anastomotic aneurysms,[1] their origin is probably multifactorial and 2 distinct types can be identified: proper pseudoaneurysms and true aneurysms.

The various clinical series published do not distinguish between the 2 and uncertainty remains about their actual incidence. However, a review of the literature suggests that AAPA are found in 0.2-15% of cases.[2-5]

The reasoning behind the treatment of AAPA is not very different from the approach to primary aneurysms of the abdominal aorta. In both types, in fact, the aim of elective treatment is to prevent the expansion and rupture of the aneurysm.

What makes their treatment particularly complex is the need to exercise a direct control over the aorta and possibly the iliac arteries as well, in a scar tissue area with the risk of damage to the surrounding organs and structures.

Materials and methods

In the period January 1991 - December 2002, 27 patients, all males with a mean age of 70 years (range

TABLE I.—*Aortoiliac pseudoaneurysms 1991-2002.*

	No. cases	%
Open surgery	18	66.7
Endovascular surgery	9	33.3

TABLE II.—*Aortoiliac pseudoaneurysms treated by open surgery 1991-2002.*

Partial proximal grafting	12
Partial distal grafting	3
Total graft	2
Axillobifemoral aorto-bypass ligature	1

66-80) were treated for aortic and/or iliac pseudoaneurysms at the Institute of Vascular Surgery and Angiology of the University of Milan.

In most cases, the initial procedure involved treatment of a subrenal aortic aneurysm: 25 cases (92.6%), against 2 cases of aortoiliac obstructions (7.4%). Fifteen of these operations (55.5%) were performed in other hospitals.

The mean size of the pseudoaneurysms encountered was 5.1 cm (3.5-10.4 cm), and the average time lapse since the original operation was 11.2 years (range 3-18 years).

The diagnosis involved a computed tomography (CT) study, to which intra-arterial subtraction angiography was added after the introduction of endovascular treatment.

Surgical resection of the pseudoaneurysm with grafting (Tables I, II) was performed on 18 patients (66.7%). These included 1 patient with a ruptured pseudoaneurysm and another with an aortoenteric fistula.

Access to the abdominal aorta was *via* a median transperitoneal laparatomy in 17 cases and *via* an extraperitoneal lumbotomy in 1 case of true aneurysm.

The level at which the aorta was clamped varied with the proximal extension of APAA and the clinical features. Infrarenal control was possible in 15 patients. Two other patients required a suprarenal aorta clamping; in these cases, the clamp was moved to an infrarenal position after the proximal anastomosis was completed, without necessity of renal reimplantation into the graft. Finally, a supraceliac clamping through the small epiploic cavity was done in 1 case of ruptured APAA.

In 12 cases the treatment involved corrective surgery of the proximal pseudoaneurysm: the damaged graft segment was detached from the insertion in the aorta and replaced with a new prosthesis between the juxtarenal aorta and the old graft. In 3 cases, the involvement of the distal anastomosis made it necessary to replace the distal section of the graft with a bifurcated graft anastomosed onto the iliac arteries.

TABLE III.—*Aortoiliac pseudoaneurysm given endovascular surgery in 1991-2002.*

Straight aortic grafts	1
Straight iliac grafts	4
ABI graft	4
AUI graft+FF crossover	1

In 2 patients the presence of a pseudoaneurysm that was both proximal and distal required a total graft replacement, aortoaortic in 1 case and aortobifemoral in the other.

The patient with a pseudoaneurysm and an aortoenteric fistula had his original graft removed followed by ligature of the aortic stump, a duodenal suture and preparation of an axillobifemoral bypass.

Access to the abdominal aorta was *via* a median transperitoneal laparotomy in 17 cases and *via* an extraperitoneal lumbotomy in 1 case.

In 2 cases it was also necessary to clamp the suprarenal aorta and in 1 case supraceliac clamping through the small epiploic cavity.

Endovascular treatment was applied to 9 patients (33.3%): 5 of these presented a pseudoaneurysm of the proximal aortic anastomosis, while in 1 case the aneurysm was on the distal aortic anastomosis. In 3 patients, the pseudoaneurysm was on the iliac anastomosis of an aortobiiliac graft and in one of those patients the pseudoaneurysm was bilateral.

Ten grafts were inserted into these patients. In particular, aortic pseudoaneurysms (Table III) were excluded by the insertion of a straight aortic endovascular graft in 1 case (Vanguard-Boston Scientific), an aortobiiliac graft in 4 cases (1 Excluder-Gore; 1 PowerLink-Endologix; 1 Vanguard-Boston Scientific; 1 Talent-Medtronic) and an aortoiliac endoprosthesis (Zenith-Cook) with a contralateral iliac occluder and a femorofemoral crossover bypass in another patient. Endograft with transrenal fixation was employed in 2 patients: in 1 patient, treated with a bifurcated device for an APAA presenting a short proximal neck and in the another patient treated for a distal APAA with an aortouniliac device, commercially avalaible only with suprarenal placement.

TABLE IV.—*Aortoiliac pseudoaneurysm conventionally treated in 1991-2002: 18 cases.*

	Immediate results	Long-term results
Success	16	9
Mortality	2	2*
Recurrences		1
Lost to follow-up		4

*Unrelated to procedure

TABLE V.—*Aortoiliac pseudoaneurysms treated by endovascular surgery: 1991-2002: 10 cases.*

	Immediate results	Long-term results
Straight iliac grafts	1 success	1 surgical conversion
Straight iliac grafts	4 successes	4 successes
Biiliac grafts	3 successes	2 deaths*
	1 surgical conversion➪ death	1 surgical conversion
Aortic graft	1 success	1 success

*Unrelated to procedure

In 2 more cases, a straight iliac endograft was used to exclude an iliac pseudoaneurysm (1 Corvita-Corvita Europe; 1 Passager-*Boston Scientific*) while 2 endovascular grafts were inserted at different times (1 Passager-*Boston Scientific*; 1 Aneurix-*Medtronic*), in the patient with a bilateral pseudoaneurysm. A patent hypogastric artery was present in 2 cases, both with chronic occlusion of the contralateral vessel. In one patient, the origin of the hypogastric artery was covered with the endograft, while in the other patient we performed a coil embolization inmmediatly before the deployment of the graft. In both cases, we did not observe ischemic symptoms and recurrence of the pseudoaneurysm at follow-up.

Results

The early total technical success rate was 89.3%; 88.9% in the open repair group and 90% in the endovascular repair group.

Of the patients submitted to conventional surgery, 2 died in the immediate postoperative period (11.1%): 1 patient died as a result of severe intraoperative bleeding and the patient treated for an aortoenteric fistula, when the duodenal suture failed (Table IV).

A total of 12 patients were followed up for 3-11 years (mean: 6.6 years). The figure reflects 4 lost to follow-up and 2 deaths unrelated to the procedure. One of these patients underwent surgery for a distal aortic aneurysm in another hospital. Nine patients, however, showed no signs of any recurrence at clinical check-up accompanied by a Doppler ultrasound scan.

TABLE VI.—*Aortoiliac pseudoaneurysms: onset times.*

Authors	Mean time lapse	Range
Edwards,[1] 1992	12±8.4 yrs	8 m-28 yrs
Gautier,[6] 1992	8 yrs	6 m-15 yrs
Curl,[7] 1992	9.5 yrs	3-23 yrs
Allen,[2] 1993	9.4 yrs	6 m-23 yrs
Hagino,[8] 1993	10 yrs	36 m-14.5 yrs
Yuan,[9] 1997	9 yrs	1-15 yrs
Mulder,[10] 1998	8 yrs	0-25 yrs
Matsumura,[11] 2001	8 yrs	1-18 yrs
Present series, 2003	11.2 yrs	3-18 yrs

Of the patients submitted to endovascular treatment (Table V), there was 1 death in the immediate postoperative period (10% of the 10 endovascular operations performed). This was a patient who died of acute heart failure after an intraoperative attempt to deal with thrombosis of his biiliac endoprosthesis.

In the 1.6-6 year follow-up period (mean 3.4 years) there were 2 deaths unrelated to the procedure.

In the absence of any leakage or expansion in the aneurysm diameter, the procedure was curative in 4 patients; 1 with an aortoiliac graft, 2 with a straight iliac graft and another with a bilateral iliac graft.

By contrast, 1 year after the first procedure, 2 further surgical procedures were required in 3 cases (30%). Corrective surgery was required due to distal slippage of a straight aortic graft in 1 patient and a biiliac graft in another. In the latter case an extraperitoneal lombotomic access route was used.

Discussion

Anastomotic pseudoaneurysms of the abdominal aorta are generally a late complication of aortic grafting, since early onset is quite rare, accounting for just 1-6% of cases.[1, 2] According to personal experience, most of these AAPAs develop 8-10 years after the original operation and never before 5 years (Table VI).[1, 2, 6, 7]

Given the nature of redo surgery, the treatment of AAPAs shows a higher risk than the initial aortoiliac procedure, presenting a morbidity of 8-73% and a mortality of 17-21%.[5] It is therefore very important

to weigh up the potential advantages against the surgical risk, especially in the presence of small AAPAs.

Nevertheless, surgical correction of such lesions is always indicated in the presence of symptomatic AAPAs, as it is for pseudoaneurysms over 5 cm in maximum diameter or with a pseudoaneurysmatic sac diameter that is over 50% greater than the diameter of the aortic graft.[4-6]

Currently, the choice of surgical treatment is based on the images provided by spiral AngioCT and angiography. This diagnostic approach makes it possible to select the most appropriate way to correct pseudoaneurysms and also, thanks to the information provided on the relationship between the aneurysm and the visceral blood vessels, the status of the hypogastric arteries and, above all, the type and size of the aneurysm, to plan the access route.

AngioTC makes it possible to distinguish between a genuine para-anastomotic aneurysm and a false aneurysm. The former is characterised by a symmetrical, circular, regular and fusiform expansion adjacent to the earlier anastomosis. By contrast, the false aneurysm features a series of asymmetrical bulges on the anastomosis combined with extensive perianastomotic fibrosis.[3]

If the fundamental approach to corrective surgery in AAPA cases is the replacement of the affected graft segment with a new one, the access route is also a vital factor, in selecting the position for aortic clamping.

Median transperitoneal laparotomic access, which may also be employed for transverse subcostal access, was most commonly used in our own and other series,[2, 7, 9] in treating genuine pseudoaneurysms. In such cases, the fact that the renal arteries are not involved in the aneurysmatic lesion allows subrenal or suprarenal clamping of the aorta.

The same access route also allows supraceliac aortic clamping through the lesser omentum cavity, which was our own choice in treating a ruptured pseudoaneursym.

The involvement of the renal arteries, as may occur in true aneurysms, makes the procedure far more complex, since the aorta has to be clamped between the renal and the superior mesenteric arteries. An alternative to subcostal transperitoneal approach in such cases is the retroperitoneal approach. This requires an incision from the outer edge of the rectus sheath to a position half way between the umbilicus and the pubic symphysis up to 8-10 cm into the 11th intercostal space.

This approach, which may also require lifting the left kidney and moving it towards the midline, makes it possible to determine the exact extension of the pseudoaneurysm and to conduct a more extensive examination of the proximal aorta.[12]

TABLE VII.—*Aortoiliac pseudoaneurysms: problems with endovascular grafting.*

— Involvement of the iliac arteries
— Twisted iliac arteries
— Rigidity of iliac arterioes of grafts due to the presence of scar tissue around the graft or the anastomosis
— Graft kinking
— Patency of hypogastric arteries

The awareness of the difficulties presented by the surgical treatment of aortic pseudoaneurysms led us to the use of endovascular procedures, in cases where that seemed preferable to conventional surgery.

Though we still lack sufficient data for any assessment of this procedure's long-term efficacy, since the literature only reports individual clinical cases or a very few clinical series [3, 11, 13, 14, 15] backed by short-term follow-up, some conclusions can already be drawn.

Various commercially available models are used in the endovascular treatment of AAPAs and the surgical team's choice will depend on the location and the anatomical/morphological characteristics of the pseudoaneurysm.

The advantages to be derived from the use of endovascular grafts in the treatment of anastomotic aneurysms are based on a variety of factors. First of all, they avoid the problem of isolating the aorta and iliac arteries embedded in scar tissue with the risk of iatrogenic damage to the surrounding organs and blood vessels. Secondly, the procedure can be performed under local or epidural rather than general anesthesia. Finally, there is reduced blood loss and a faster postoperative recovery.

Endovascular treatment of AAPAs can present more problems than its use on primary aortic aneurysms and some of these may represent potential contraindications to their use (Table VII).

Particularly in the case of a pseudoaneurysm or a true aneurysm arising after aortic endoaneurysmectomy, the involvement of the renal arteries in the latter or a residual proximal stump that is either too short or too wide, may make it difficult to perform suprarenal anchorage for the endovascular graft without part of the graft occluding the ostium of the renal arteries.

Furthermore, the presence of twisted iliac arteries or a kinked graft can make the introduction or release of

the graft difficult to negotiate. That is because, while the use of a stiffer guide wire can straighten out such twisting in the treatment of primary aortic aneurysms, the presence of scar tissue around the anastomosis or the original graft can make this difficult or even impossible to achieve.[5]

A kinked aortic graft was the cause of failure in 2 out of 3 cases of endovascular corrective surgery that required surgical conversion kinking at the centre of the original straight aortic graft and its inability to adapt to the new aortobiiliac endovascular graft caused thrombosis in the latter, which required immediate intraoperative conversion. In the second case, the kinking of the graft at the level of the proximal aortic anastomosis caused slippage of the aortobiiliac endovascular graft inserted a year earlier, despite its suprarenal anchorage.

The length of the pseudoaneurysm is another vital element in the choice of an endovascular graft. A straight graft is only indicated for small pseudoaneurysms. In the presence of a large pseudoaneurysm, in fact, the graft can slip, requiring intraoperative conversion, as happened in our first case.

Finally, the need to cover one or both of the iliac bifurcations presents the surgical team with 2 conflicting problems: the need to avoid any reflux from the hypogastric arteries, while at the same time avoiding pelvic ischemia. It is therefore vital to start by clamping one of the hypogastric arteries, while maintaining the patency of the contralateral vessel.[3, 13, 15] While we await confirmation of the validity of endovascular grafting combined with hypogastric artery shunts, the use of an aortoiliac graft with an occluder positioned inside the contralateral common iliac artery and a femorofemoral crossover bypass may represent one solution to this problem.

Being relatively easy to use, more flexible and smaller than a bifurcated graft,[16] this type of endovascular graft may also be preferable in the treatment of any AAPA cases, in which the original graft is neither excessively large nor kinked.

Aortoenteric fistula, which caused a pseudoaneurysm in one of our clinical cases, is one of the most daunting complications of aortic graft surgery with a mortality that rises to as much as 49%.[17]

With the advent of more sophisticated aortic grafts, the presence of an aortoenteric fistula may be one indication to the use of endovascular procedures, as we found in several of our own cases, in which the fistula was not accompanied by a pseudoaneurysm. Though, for the moment, there are insufficient data in the literature to confirm the validity of endovascular grafting as the definitive treatment of such complications, it could well be appropriate in critical, or emergency patients as a "bridge" procedure for the short-term control of bleeding.[18] That would make it possible to delay conventional surgical treatment until the patient's clinical and hemodynamic conditions have stabilised.

TABLE VIII.—*Aortoiliac pseudoaneurysms.*

	Mortality	
	Aorto-iliac pseudoaneurysms	Aortic aneurysms
Open surgery	11.1%	2.9%
Endovascular surgery	10.0%	5.7%

As also reported in the literature,[6, 9, 19] perioperative bleeding, especially from venous lesions, is a major cause of morbidity and mortality in the traditional surgical treatment of AAPAs. In fact, bleeding caused by clotting factor consumption necessitated redo surgery in one of our patients, while heavy bleeding caused by damage to both the renal and the left spermatic veins was the primary cause of death in another of our cases.

The particular complexity of conventional surgical treatment in AAPA cases may explain its postoperative mortality of 11.1%. While the comparison is being made with a much larger group of patients, this does represent a far higher incidence than the mortality figure for surgical treatment of aortic aneurysms which came to 2.9% in a group of over 500 patients treated in the same period [20] (Table VIII).

In the context of endovascular surgery, the morphology of the original graft was the primary cause of morbidity and mortality (10%) requiring surgical conversion followed by postoperative death from heart failure in one patient. Here too, this is a higher incidence that the mortality resulting from the endovascular treatment of primary aortoiliac aneurysms (5.7%).

Conclusions

In conclusion, we feel that the greater complexity and the greater risks presented by the treatment of aortic pseudoaneurysms than by the initial procedure indicates a cautious approach to endovascular treatment, which ought to be confined to expanding or large (≥5

cm) pseudoaneurysms. This is well known and is a clear indication to traditional surgery.

Endovascular treatment is certainly a less invasive alternative to open surgery.

However, the endovascular approach can also present complex problems. In fact, while there is nothing particularly difficult about eliminating an iliac pseudoaneurysm and the long-term results are highly satisfactory, the positioning of an endovascular graft as treatment for an aortic pseudoaneurysm may become problematic due to the particular anatomy of the lesion, the involvement of the renal arteries, and the greater rigidity of the original graft due to surrounding scar tissue. In addition, long-term leakage, which is mostly caused by slippage of the graft constitutes a serious complication in the follow-up period, especially in view of the fact that redo surgery is the only solution to the problem. Hence, in the case of aortic pseudoaneurysms, endovascular treatment should only be considered reliable and effective in carefully selected cases.

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