Percutaneous Closure Devices for Endovascular Repair of Infrarenal Abdominal Aortic Aneurysms: A Prospective, Non-randomized Comparative Study

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Purpose. This study was designed to describe and evaluate our preliminary results with a percutaneous arterial closure device as compared to those obtained with conventional femoral surgical cut down during endovascular repair of abdominal aortic aneurysms (AAA).

Material and Methods. Between January 2004 and December 2006, 40 of 86 AAA patients selected for endovascular repair met the criteria for inclusion in this study. Nineteen of these patients (Group A) received a bifurcated endograft placed by direct puncture of the femoral arteries (38 femoral triangles) with closure by a Prostar/C210 percutaneous arterial closure device (Abbott). The other 21 patients (control group B) were managed with a bifurcated endograft placed by conventional open surgery (42 femoral triangles). Data concerning all 40 patients were collected prospectively and analyzed.

Results. The technical success rate was 92% (group A) vs 90% (group B), \( P = 0.79 \). The incidence of perioperative complications was 16% (3/19) in group A and 14% (3/21) in group B (\( P = 0.89 \)). The mean hospital stay was 5.8 days in group A and 7.8 days in group B (\( P = 0.05 \)). The difference in the length of hospitalisation was associated with reduced cost for the percutaneous group (5579.60 euros vs. 7503.60 euros; \( P = 0.04 \)), that counterbalanced the cost induced by the Prostar XL/C211 suture mediated device. Mean follow-up in both groups was 12 months. The overall incidence of locoregional complications after one year of follow-up was 11% (2/19) in group A and 19% (4/21) in group B (\( P = 0.45 \)).

Conclusion. This study confirms the feasibility and safety of total percutaneous endovascular AAA repair. Our preliminary results suggest that the costs paid by healthcare providers for endovascular AAA repair might not be increased with the selective use of percutaneous closure devices.

Keywords: Aneurysm; Aorta; Endovascular treatment; Endograft; Percutaneous closure.

Introduction

The feasibility of endovascular aneurysm repair (EVAR) by a total percutaneous approach has been confirmed by several recent literature reports.\(^1\)\(^-\)\(^3\) However, few studies have compared these patients with those undergoing conventional EVAR by open surgical cut-down of the femoral triangles\(^3\)\(^-\)\(^5\). Thus, the true benefits of total percutaneous EVAR compared to conventional EVAR remains unclear. In January 2002, a protocol for evaluation of total percutaneous EVAR was instituted at our centre. The purpose of this study was to describe our preliminary results.

Materials and Methods

Between January 2004 and December 2006, all patients with an AAA selected for EVAR at our institution were considered for inclusion in this study. The clinical criteria used in our center for selection of patients for EVAR have been published previously.\(^6\) All patients provided informed consent before procedures.

Inclusion criteria

The main criterion for inclusion in the current study was the anatomic feasibility of EVAR using a bifurcated endograft. Two different protocols were used for bifurcated endograft insertion at our institution.
resulting in two contemporaneous cohorts of patients with an AAA treated with a bifurcated endograft. Patients were assigned to one or the other group according to their first consultation date which determined their operating surgeon and thereby the study arm in which they were enrolled. One subgroup of operating surgeons (RHK, PH, and EJB) used a percutaneous closure device routinely except when formally contraindicated while the other subgroup (MB, SD, and PJB) always performed conventional open surgical access during EVAR.

**Exclusion criteria**

Patients with aortic aneurysm rupture (requiring emergency surgery) were excluded. Patients unsuitable for total percutaneous EVAR due to the presence of circumferential femoral artery calcification, and hostile femoral triangles (prior surgery on the femoral triangle or inguinal scarring incompatible with use of a percutaneous closure system) were also excluded. In contrast, neither obesity, iliac artery tortuosity, nor the presence of atheromatous iliac lesions (TASC A, TASC B, TASC C) suitable for percutaneous transluminal angioplasty were considered formal contraindications for either of our two EVAR protocols using a bifurcated endograft.

**Technique**

In the first cohort (group A, study subjects), the bifurcated endograft was placed by a total percutaneous technique using a percutaneous arterial closure device, the Prostar XL® (Abbott). Details of the Prostar device and its use have been previously published. In our experience, an 18 gauge needle was used to puncture the anterior aspect of each common femoral artery via the skin. A 7F introducer sheath was initially inserted according to the Seldinger technique and immediately substituted for a 10 F introducer sheath. A straight tip soft hydrophilic 0.035 guidewire was introduced and the EVAR procedure continued as routine. At the end of EVAR procedure, the knots were tied according to the recommendations provided by the Prostar’s manufacturer. The stent graft delivery system was removed whereas the super stiff guidewire (Lunderquist®) was kept in place and temporary haemostasis achieved by manual compression. The knots were partially pushed down with the guidewire still maintained in the iliac artery lumen. This allowed the use of an additional Prostar device if satisfactory haemostasis were not achieved. This guidewire was removed before the knots were locked with aid of a knot pusher.

In the second cohort (control group B), patients underwent EVAR via a 4 to 6 cm long transverse oblique incision located in the groins just below the inguinal ligaments. Both common femoral arteries were circumferentially exposed and encircled twice with 2 vessels loops. An 18 gauge needle was used to puncture the anterior aspect of each common femoral artery between the two vessels loops via a separate site located 2 cm inferior to the incision. A 7F introducer sheath was inserted into each common femoral artery according to the Seldinger technique. A soft 0.035 hydrophilic guidewire was then introduced and the EVAR procedure continued as routine. At the end of EVAR procedure, both stent graft delivery system and super stiff guidewire (Lunderquist®) were removed, while temporary haemostasis was achieved by tightening the vessels loops. The common femoral arteries were clamped and the puncture sites closed by a few interrupted 5-0 polypropylene suture using standard techniques. Adjunctive endarterectomy and patch angioplasty could be performed as indicated.

In both group received 50 IU/Kg of unfractionated heparin at the beginning of procedures. Activated clotting time was not monitored during the procedure and the heparin load was not reversed by protamine use.

**Preoperative work-up**

In addition to clinical examination, preoperative evaluation for both groups consisted of an aortogram with a graduated pigtail catheter and contrast-enhanced CT with 1 to 3 mm slices width.

**Post-operative follow-up**

In the immediate post-operative period, local and regional complications were detected clinically, and then evaluated, when necessary, by Doppler ultrasound. Post-operative follow-up for both groups included clinical examination and follow-up CT studies before hospital discharge, after 1, 6, 12 and 18 months, and then annually if the results of the 18-month follow-up.
up examination were satisfactory. Alternatively, patients with moderate renal insufficiency (Creatinine clearance between 60 and 30 cc/min) were followed-up by Doppler ultrasound and underwent CT when indicated.

Data collection and analysis

Data concerning the diagnosis, the operative risk, procedure details, and follow-up for the patients in both groups were collected prospectively in a register, and the database thus created was then analyzed. The main criteria studied for both groups were the technical success rate, the incidence of operative complications, the length of the hospital stay, the cost of the procedure, and the mid-term complication rate. In the Prostar group (group A), technical success was defined as percutaneous closure of the arteriotomy without any locoregional complications requiring medical therapy or surgical conversion within 30 days of the procedure. For the control group (group B), technical success was defined as the absence of locoregional complications directly related to the surgical approach requiring an additional procedure, salvage surgery, or conservative medical treatment within the first 30 days after surgery. Locoregional complications could include for both groups: haematoma or access site haemorrhage, wound infection, lymph leak, acute false aneurysm or burst operative wound.

Statistical analysis was performed using StatView software (SAS Institute, Inc. 1992-1998; version 5.0) on the basis of the number of patients or the number of femoral triangles in each cohort, depending on the criterion analyzed. Nominal variables were expressed as the number and the percentage of patients. Continuous variables were expressed as the mean ± standard deviation or as the range for non-Gaussian distributions. Comparisons between the two groups were performed using the chi square test for nominal variables, t-test for continuous variables, and Mann-Whitney test for cost calculation. A value of \( P < 0.05 \) was considered statistically significant.

Results

Between January 2004 and December 2006, 86 patients admitted to our department with an AAA were selected for EVAR. Forty-six (53\%) met our criteria for EVAR using a bifurcated endograft and were considered for inclusion in the present study. The others were considered ineligible and were managed with an aorto-uni-iliac endograft because of the clinical context (12 cases of AAA rupture) or were morphology unsuitable for aorto-iliac bifurcation grafts (28 patients had an aortic bifurcation <20 mm in diameter or TASC D iliac lesions). Of the 46 patients managed by a bifurcated endograft, 6 were excluded because of a hostile femoral triangles (4 cases of prior surgery on the femoral triangle) or because they had received a fenestrated endograft (2 cases) (Fig. 1). In all, 40 patients who underwent elective repair with a bifurcated endograft were entered in this study (i.e. 80 femoral triangles accessed by conventional open surgery or percutaneously). Nineteen of these patients (i.e. 38 femoral triangles) underwent total percutaneous endograft placement using the Prostar arterial closure system (group A). The other 21 patients (42 femoral triangles) underwent bifurcated endoprosthesis placement using conventional surgical access to the femoral artery (control group B). Table 1 presents the demographic and comorbidity data for both groups.

Two different models of bifurcated endografts were used in this study: 36 Zenith endovascular grafts (Cook, Australia) and 4 Excluder endoprosthesis (Gore, USA). Group A patients received 17 Zenith and 2 Excluder grafts while group B patients received 19 Zenith and 2 Excluder grafts (\( P = 0.91 \)). Table 2 lists the sizes of the introducer sheaths used to place the endografts in both groups. Two patients, one in each group, required iliac angioplasty prior to insertion of the endograft delivery system. All group A patients received 2 Prostar devices on the side on which the main body of the endograft was deployed. In contrast, on the contralateral side where only one limb of the endograft was inserted, a single Prostar was used in 18 of the 19 patients. The last patient required a second Prostar device to achieve haemostasis on the side where the second limb of the endograft was inserted.

Some technical details of the procedures and the anaesthesia techniques used in both groups are listed in Table 3. The technical success rate was 92\% in group A (35 technical successes for 38 femoral triangles closed by a percutaneous approach), and 90\% in group B (38 of 42 femoral triangles accessed without any locoregional complication) (\( P = 0.79 \)). In two group A patients (3 femoral triangles), arterial closure could not be achieved percutaneously, and conversion to surgery was necessary because of haemorrhage. Failure of the percutaneous closure system in two patients was due to a technical error (both cases occurred early in our experience with the system). In both cases the failure was recognized immediately, and surgical conversion took place before the patient left the operating room. Two group B patients (4 femoral triangles) developed local postoperative complications (before Day 30) specifically related to surgical access (lymph...
leak that resolved spontaneously, without secondary infection). The overall incidence of peri-operative complications was 16% (3 of 19 patients) in group A and 14% (3 of 21 patients) in group B ($P = 0.89$). Complications in group A included three intra-operative complications: the two cases of hemorrhage at the puncture site and one case of iliac rupture. The iliac rupture occurred due to excessive balloon expansion of an iliac artery. This patient suffered a fatal cardiac arrest before conversion to surgery was possible. In group B, in addition to the two patients who developed post-operative lymph leak that resolved spontaneously, one patient developed an obliterating dissection of the common femoral artery during the procedure that necessitated thrombo-endarterectomy and polyurethane patch angioplasty.

Operative mortality was 1 of 19 patients in group A and 0 in group B ($P = 0.28$). Iliac rupture was responsible for the sole death in the entire study population.

The mean hospital stay was 5.8 days in group A and 7.8 days in group B (mean deviation 1.9 days; $-0.08 < 95\% \text{ CI} > 3.91$; DDL = 38; $P = 0.05$).

The mean follow-up was 12 months in both groups. During follow-up, no deaths occurred in group A. One death occurred in group B two months after surgery owing to a stroke. No local complications occurred in group A, but one patient developed a distal Type I endoleak and one had stenosis of an endograft limb. These two patients required distal extension and stenting of the endograft limb respectively. Two group B patients developed local complications two months post-operatively (bilateral femoral triangle lymphoceles). One patient was successfully treated conservatively by repeat puncture evacuation. The other underwent repeat surgery for lymphocele evacuation and sealing with biological glue. Neither femoral artery stenosis nor femoral pseudoaneurysms were diagnosed during follow-up in either group according to CT studies. During the entire follow-up period,

**Table 1. Demographic data and risk factors**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group A</th>
<th>Group B</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age (range)</td>
<td>76 (58–88)</td>
<td>75 (52–91)</td>
<td>0.79</td>
</tr>
<tr>
<td>Sex</td>
<td>Males: 18</td>
<td>Males: 20</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Females: 1</td>
<td>Females: 1</td>
<td></td>
</tr>
<tr>
<td><em><em>BMI</em> (range)</em>*</td>
<td>24 kg/m$^2$ (15–32)</td>
<td>26 kg/m$^2$ (19–34)</td>
<td>0.21</td>
</tr>
<tr>
<td>Arterial hypertension, N (%)</td>
<td>18 (95%)</td>
<td>14 (67%)</td>
<td>0.02</td>
</tr>
<tr>
<td>Diabetes, N (%)</td>
<td>1 (5%)</td>
<td>2 (9%)</td>
<td>0.60</td>
</tr>
<tr>
<td>Cardiopathy, N (%)</td>
<td>11 (58%)</td>
<td>14 (67%)</td>
<td>0.16</td>
</tr>
<tr>
<td>Creatinemia ≥ 190 µmoles/l, N (%)</td>
<td>2 (10%)</td>
<td>4 (19%)</td>
<td>0.45</td>
</tr>
<tr>
<td>COPD*, N (%)</td>
<td>6 (31%)</td>
<td>7 (33%)</td>
<td>0.90</td>
</tr>
<tr>
<td>Tobacco use, N (%)</td>
<td>11 (58%)</td>
<td>12 (57%)</td>
<td>0.96</td>
</tr>
<tr>
<td>ASA II, N (%)</td>
<td>2 (10%)</td>
<td>3 (14%)</td>
<td></td>
</tr>
<tr>
<td>ASA III</td>
<td>14 (74%)</td>
<td>14 (67%)</td>
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<tr>
<td>ASA IV</td>
<td>3 (16%)</td>
<td>4 (19%)</td>
<td>0.88</td>
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</table>

* BMI: Body Mass Index.

<table>
<thead>
<tr>
<th>Table 2. Size of the introducer sheaths used in the two groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introducer size$^1$</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Main body of the endograft</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Contralateral endograft limb</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

$^1$ Introducer sizes are reported as sheath inner diameter.
including the immediate post-operative period, the overall incidence of local complications linked to the access technique was 10.5% (2/19 patients) in group A and 19% (4/21 patients) in group B (P = 0.45), i.e. respectively 7.8% (3/38) vs 19% (8/42) when reported to the number of femoral triangles accessed (P = 0.14).

The cost for operating room usage (130 minutes vs 122 minutes) and ancillaries (not counting the percutaneous closure devices) were the same in both groups. We calculated the extra cost incurred in light of the differences in the two groups. At our institution, hospital costs during the study were evaluated at 962 euros per day. The cost of each Prostar® percutaneous closure device was 185 euros. For group A, with a mean hospital stay of 5.8 days (962 euros × 5.8 days = 5579.60 euros) and the use of 3 Prostar devices per patient (185 euros × 3 = 555 euros), the cost of the procedure thus amounted to 6134.60 euros per patient. In group B, with a mean hospital stay of 7.8 days (962 euros × 7.8 jours), the cost for the procedure was estimated at 7503.60 euros per patient, not including the cost of the staples and sutures used for skin and subcutaneous closure. Thus, there was no statistically significant difference (Mann-Whitney test) between the cost calculated for the two groups (P = 0.31), despite the initial advantage in favour of group A patients as regard to the hospitalisation cost (5579.60 euros vs. 7503.60 euros; P = 0.04).

**Discussion**

With a technical success rate of 92%, the results of this study confirm the feasibility of total percutaneous EVAR. The existence of a learning curve, previously described by others,²¹³ may explain the technical errors and the complications that occurred during the initial phase of our experience. The technical success rates reported for percutaneous EVAR vary between 46.2% and 100%.¹⁻³,¹³ The best rates have been reported in those series where only the contralateral limb of the endograft (requiring small size introducer sheaths) was placed percutaneously. The most recent series of patients treated by a total percutaneous approach nevertheless report excellent feasibility rates, despite a proportionally higher rate of complications on the side of the larger size introducer sheath.¹⁻³,¹³ No such correlation was noted in our series, but our sample size might be too small. The variability of technical success rates among series might also reflect patient selection, since the criteria for use of total percutaneous EVAR vary from one study to another. Obesity, calcified femoral arteries, prior surgery on the femoral triangle, and tortuous iliac arteries are the main factors incriminated in technical failures (Table 4). In our experience, circumferential femoral calcifications and prior surgery on the femoral triangle were criteria for exclusion from total percutaneous EVAR. In contrast, we did not consider obesity or iliac tortuosity as exclusion criteria. However, during the study period, we did not have to treat any AAA patient with a body mass index (BMI) greater than 35 kg/m² (morbid obesity). All of our patients had a BMI of 34 kg/m² or less (Table 1). Obese patients appear at highest risk for local complications after conventional surgical access to the femoral triangles. Moderate obesity (BMI < 35 kg/m²) should prompt selection of a total percutaneous technique. Careful preparation of a subcutaneous tunnel up to the arterial access site, around the initial guidewire inserted, should prevent premature tightening of the Prostar knots in the subcutaneous tissue. We systematically prepared this tunnel with a Leriche haemostatic clamp, paying particular attention in obese patients. Tortuous iliac arteries are a potential obstacle for total percutaneous repair,⁶ although in our experience iliac tortuosity never caused Prostar failure. In patients with severe iliac tortuosity, we used a guide catheter to insert a hydrophilic guidewire before placing the Prostar devices under fluoroscopic guidance. In our opinion, severe aorto-iliac occlusive disease (TASC D lesions) is a contraindication for the method. In contrast, more moderate lesions suitable for transluminal angioplasty do not appear to contraindicate Prostar devices. Anterior wall calcifications of the common femoral artery has been considered an indication for conventional endovascular treatment with open surgical access of the femoral triangle.⁴ However, this remains highly controversial in the literature.⁷

As regard to the anaesthesia technique, it is now possible to perform percutaneous EVAR under local anaesthesia with sedation. This could be one of the major potentially attractive features of suture mediated closure devices which could reduce further the morbidity of EVAR. Nevertheless, local anaesthesia was not part of our local policy for elective EVAR (Table 3). EVAR by femoral surgical cut down could be performed under local anaesthesia and sedation. However, our general feeling is that spinal anaesthesia or general anaesthesia may provide greater comfort...
and security to surgeons and patients alike than local anaesthesia in an elective AAA repair setting.

Total percutaneous endovascular AAA repair appears safe and effective based on comparison of the incidence of short- and mid-term operative complications in our two groups. Haemorrhage was the only complication specifically related to the percutaneous closure system in our study. One case of fatal iliac rupture occurred in group A, but it was not related to the percutaneous closure device. Technical failure with haemorrhage requires rapid surgical conversion in order to avoid patient death.1,10 Teh et al.10 reported one death related to technical failure with a Prostar before it was possible to convert to surgery. The arterial access site in that case was located above the inguinal ligament.10 Like other authors, 1,4 we feel that percutaneous endovascular AAA repair should be performed by a surgical team or in a structure with capacity for rapid conversion to surgery if necessary. An attractive alternative to a total percutaneous EVAR could be the cribiform fascia suturing technique as reported by Larzon et al.14 but its reproducibility needs to be assessed.

Aside from hemorrhagic complications, distal embolization and arterial thrombosis are the other immediate complications reported with total percutaneous EVAR.9,4 Traul et al. preferred a conventional endovascular approach rather than a percutaneous technique for AAA patients with extensive mural thrombus in order to avoid distal embolisation.9 Distal embolization related to a percutaneous closure system has rarely been described in the literature, and did not occur in any of our patients. Mobilization of atheromatous ilio-femoral plaque during introduction or removal of the endograft delivery system might be a more important etiologic factor in distal embolization. Various authors9,5 have reported dissection of the ilio-femoral axis with a total percutaneous approach. However, none of these complications are specific to percutaneous closure devices. One patient in control group B developed obliterating dissection of the common femoral artery caused by the endograft delivery system.

The mean hospital stay was longer in control group B than in the group treated percutaneously. However, this observation may require confirmation in a larger sample size. Although slight (1.9 days), this difference in the length of hospitalisation translated in terms of in-hospitalisation cost into a clear advantage in favour of the percutaneous group. However, this trend would be even more significant with a larger sample size. This may appear surprising because the literature contains contrary reports,3,5 but to the best of our knowledge the length of the hospital stay was not taken into account for cost calculations in earlier studies. It should be noted, however, that the hospital stays in the two groups were much longer than those usually reported for EVAR.1,4 This could be explained by our local policy to obtain a control CT scan on every patient before discharge. This hypothesis could not however account for the difference in length of stay observed between the two groups of our study.

During follow-up, a trend toward fewer local complications was observed in the percutaneous group than in the control group. Aside from per-operative complications, no new local complication occurred in group A after a mean follow-up of 12 months. In the open access group, local complications were noted postoperatively. Morasch et al. reported similar results after a mean follow-up of 6 months.4 Between 8% and 20% of AAA patients treated by a conventional endovascular approach develop local

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Table 4. Factors incriminated in technical failures (literature review)

<table>
<thead>
<tr>
<th>Author (N×)</th>
<th>Traul1 (30)</th>
<th>Teh10 (82)</th>
<th>Torsello5 (30)</th>
<th>Watelet2 (47)</th>
<th>Starnes1 (79)</th>
<th>Lee1 (279)</th>
<th>This series (38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Device**</td>
<td>4</td>
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<td>1</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td>2</td>
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<tr>
<td>Femoral calcifications11</td>
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<td>1</td>
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<td>0</td>
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<td>0</td>
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<tr>
<td>Iliac tortuosity11</td>
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<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>Poor puncture site16</td>
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<td>3</td>
<td>0</td>
<td>0</td>
<td>2</td>
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<td>1</td>
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<tr>
<td>Femoral triangle fibrosis16</td>
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<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Introducer size</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Other/unidentified</td>
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<td>1</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>


1 Number of femoral triangles accessed percutaneously.
** Dysfunction or poor use of the percutaneous closure device.
11 Small diameter femoral arteries or circumferential femoral calcification.
12 Highly tortuous or severely calcified iliac arteries.
16 Punction located high (above the inguinal ligament) or low (in the deep femoral or superficial femoral vessel) due to poor localization of the femoral bifurcation (technical error or anatomic variant).

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complications.\textsuperscript{4,5,15–17} Pseudoaneurysms, arteriovenous fistulas, and even infection\textsuperscript{3,18} have all been reported with percutaneous closure devices. However, these complications are neither specific nor frequent, and we did not observe any complication of this type.

Use of percutaneous closure devices for initial endograft placement might also facilitate the secondary procedures that are sometimes necessary after EVAR.\textsuperscript{5} However, our current data and those reported in the literature are insufficient to verify this hypothesis.

The main potential limitations of our study relate to the sample size and the absence of randomization during establishment of the two groups. Nevertheless, our findings demonstrate the impact of patient selection on the feasibility of total percutaneous EVAR. Furthermore, it is the first study on the subject to find that use of suture mediated closure devices did not increase the costs paid by healthcare providers as compared to femoral surgical cut down during EVAR.

Conclusion

The results of this study confirm the feasibility and the safety of endovascular treatment of AAA by a total percutaneous approach. Although no additional clinical benefit was observed for the patients, the cost of endovascular AAA repair might not be increased with the selective use of this approach, as shown by our preliminary results. Furthermore, factors such as post-operative pain, self-perception, and quality of life merit evaluation and have prompted us to continue evaluation of the technique.

References


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