Mid-term Results after Endovascular Repair of Abdominal Aortic Aneurysms: A Four-year Experience

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Objectives. The purpose of this retrospective, single-institution study is to describe a 4-year experience of examining early and late clinical outcomes after endovascular repair of abdominal aortic aneurysm (AAA).

Materials and methods. Between October 1998 and January 2003, 455 patients were submitted for AAA treatment, of whom 269 underwent open repair and 186 were treated with an endovascular procedure. All endovascular-treated patients underwent preoperative arteriography, contrast enhanced CT scanning or spiral-CT to define the morphological characteristics of the aneurysm, including precise diameter and length measurements.

Results. Technical success was achieved in 182 (98%) of the endovascular procedures, as intraoperative conversions to open repair and/or aborted procedures occurred in four patients. The perioperative (30-day) mortality rate was 1% (two patients). During the follow-up period (9–60 months) CT, duplex ultrasound scanning and plain abdominal X-ray evaluation were performed at 3, 6, 12 months, and annually thereafter.

Type I endoleak occurred in 12 patients (6.6%), required a further endovascular procedure (11) or late conversion to open repair (1). Type II endoleak occurred in five patients (3%).

Conclusions. In our clinical experience the endovascular repair of AAA is a safe and effective technique with good mid-term results in patients at standard and high risk.

Key Words: Endovascular surgery; Endoprothesis; Abdominal aortic aneurysms.

Introduction

Since the introduction of endoluminal techniques for the treatment of abdominal aortic aneurysms (AAA) in the early 1990s,7 186 patients have been treated with different types of stent-grafts in our department. The aim of this single-institution study is to describe our 4-year experience by examining the early and late clinical outcome of the endovascular repair of AAA.2

Patients and Methods

Between October 1998 and January 2003, 186 of the 455 patients who were admitted to our institution for AAA, underwent endovascular repair. Seventy-five percent of them were male. The mean age was 71 years (range 61–88 years). Mean follow-up was 26 months (range 9–60 months).

Indications for treatment included an AAA of 5 cm or greater in males, or an AAA > 4 cm that increased rapidly in size (> 0.5 cm in 6 months) and an AAA of 4 cm or greater for females.

Comorbidity and risk factors were analyzed by the anaesthesiological team prior to the surgical procedure to all 186 patients.2 This defined the preoperative risk according to the American Society of Anesthesiologists’ classification (ASA)4 (Fig. 1). The most frequent risks were smoking history, hypertension, and coronary artery disease (Table 1).

Anatomical and morphological features5 were evaluated by a combination of pre-procedural imaging techniques. Contrast enhanced or conventional, colour duplex scanning, contrast enhanced CT scanning of 3 or 5 mm cuts, or spiral CT and angiography were always performed preoperatively. Some patients underwent abdominal X-rays and angio-magnetic resonance.

Selection criteria for endovascular treatment included clinical parameters: age and short-life expectancy, (associated pathology, neoplasms),6 ASA classification (80% of the patients were 3 or 4); as well as anatomical parameters: proximal aneurysm neck length and diameter, the angulation7 between the longitudinal axis of the proximal neck and the
longitudinal axis of the aneurysm, the diameter and the status of the iliac arteries (without significant stenosis, tortuosity or calcification), (Table 2). Specifically, the mean diameter of the aneurysms was 6.4 cm, (range 4.4–8.4 cm). The mean length of the proximal aortic neck was 23 mm, (range 15–38 mm), with a mean diameter of 22 mm, (range 18–28 mm). The mean diameter of the common iliac arteries was 9 mm, (range 7–16 mm). The median angulation between the longitudinal access of the proximal aortic neck and the access of the aneurysm was 30° (range 0–75°). We avoided treating aneurysms with accessory renal arteries or with ‘critical’ inferior mesenteric artery arising from the aneurysm sac.

In particular we preferred treating patients with iliac arteries of 9 mm or less with the Excluder endograft which is the most flexible. It is self-expandable, with a low profile delivery system, 18F for the trunk and the ipsilateral leg, and 12F for the contralateral leg. The endograft’s maximum diameter was 28.5 mm (during the period of the study), and it is constructed without a free-flow part, which makes the intra-renal implantation impossible. We implanted Excluder endograft with a maximal proximal aortic neck diameter of 25 mm and a minimal length of 20 mm.

In short aortic necks, <20 mm long, and cases with aortic angulation, we preferred implanting the Lifepath endograft which has a balloon-expandable aortic trunk, which provides the maximal radial force for a better fixation. When iliac arteries had a diameter of between 14 and 16 mm, we preferred using the Lifepath endograft because the legs are balloon-expandable (less need for over sizing) and extend to 16 mm. We used the Lifepath endograft in cases that needed increased demodulation in order to save both hypogastric iliac arteries. Lifepath comprises three parts: the trunk and the two legs. It therefore gives more possibilities for demodulation. It is more likely to save internal iliac arteries as each of its legs are a different length and it can give the correct overlapping.

The opposite is true of the Endologix endograft. This is made by a unicyclic body that has the advantage of preventing endografts overlapping. An accurate study of the aorto-iliac anatomy of each patient is necessary for every endograft, but in particular for cases using the Endologix implantation, in terms of aneurysm length, distance between renal arteries and aortic bifurcation, and distance of the hypogastric arteries.

Endovascular surgery was performed by vascular surgeons using epidural anesthesia (92%) or general anesthesia (8%). All endografts were implanted with surgical exposition of both common femoral arteries, except in those cases using the Endologix, which were implanted with a single surgical exposition and a percutaneous placement of a 9F introducer sheath in the contralateral common femoral artery.

Radiological imaging was performed with a portable C-arm fluoroscopic device with digital imaging and road mapping capability. All patients were judged to be acceptable candidates for conventional open operation if endovascular repair was not feasible.

Endograft configurations included. Excluder, Endologix, Lifepath, Vanguard, Anaconda, and Talent, (Fig. 2); most of them were bifurcated endografts, and some were tube, or aorto-uni-iliac (Fig. 3).

Initial assessments of endograft function and verification of satisfactory exclusion of the aneurysm were evaluated by means of intraoperative post-deployment anterior–posterior and lateral–lateral angiography with delayed filming. This determined whether any contrast enhancement of the aneurismal sac was present.

### Table 1. Comorbidity factors

<table>
<thead>
<tr>
<th>Comorbidity factors</th>
<th>No. of patients</th>
<th>%</th>
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<tbody>
<tr>
<td>Smoking history</td>
<td>155</td>
<td>85</td>
</tr>
<tr>
<td>Hypertension</td>
<td>113</td>
<td>62</td>
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<tr>
<td>Chronic obstructive pulmonary disease</td>
<td>16</td>
<td>9</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>67</td>
<td>37</td>
</tr>
<tr>
<td>Peripheral vascular disease</td>
<td>20</td>
<td>11</td>
</tr>
<tr>
<td>Diabetes</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Renal dysfunction</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Neoplasias</td>
<td>7</td>
<td>4</td>
</tr>
</tbody>
</table>

### Table 2. Basic inclusion criteria

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Requirement</th>
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<tbody>
<tr>
<td>Length of proximal neck</td>
<td>≥ 15 mm</td>
</tr>
<tr>
<td>Diameter of proximal neck</td>
<td>≤ 28 mm</td>
</tr>
<tr>
<td>Angulation of proximal neck</td>
<td>≤ 75°</td>
</tr>
<tr>
<td>Diameter of the iliac arteries</td>
<td>Between 7 and 16 mm</td>
</tr>
</tbody>
</table>
Follow-up examination. The mean follow-up period was 26 months (range 9–60 months). Aneurysm exclusion, endograft position and patency, were assessed using contrast-enhanced CT scanning and plain abdominal radiography at 1, 3, 6, 12 months and annually thereafter. If endoleak was present, the patient underwent angiography. Colour-duplex scanning was performed to evaluate patients with endograft thrombosis.

Results

Stent-graft implantation was successful in 182 (98%) of 186 attempted cases. Four patients required immediate conversion to open repair after unsuccessful endografting. The reasons for conversion included accumulation of atherosclerotic plaque in the iliac artery which prevented sheath insertion in two patients—in one case the endograft was not fixed to the aortic neck and fell down to the aneurysm sac, and in one case an immediate conversion was required for an iliac artery rupture. The perioperative (30-day) mortality rate was 1% (two patients). One death for severe heart failure occurred in a patient who required a conversion to open repair due to an iliac artery rupture. The second death occurred in a patient who had a successful endovascular repair without evidence of postoperative endoleak. He had an anaerobic infection secondary to an abdominal puncture for the soministration of a low molecular weight heparin, that developed an abdominal suppurrative panniculitis. He died of septicemia.

The mean operation time was 182 min (range 115–240 min), the mean contrast volume was 160 ml (range 120–250 ml) and the mean blood loss was 370 ml. The mean time from operation to regaining a regular diet was less than 24 h, and from operation to discharge from hospital was 5 days (range 4–9).

Perioperative (30-day) complications

The perioperative complications are demonstrated in Table 3. The most frequent was fever, which manifested in 62 patients (33%), with a medium duration 2 days. These patients were treated with paracetamol.

Late complications

There were four late conversions to open surgery. One, three months after the procedure, was due to a persistent proximal type I endoleak for a proximal endograft migration, which was not possible to treat with a stent-graft extension. The second, 18 months post-implantation, was for a persistent type II endoleak from two lumbar arteries, with an increased aneurysm diameter of 1 cm in 1 year. The third, 1-month postoperatively, was for a stent-graft occlusion, due to a technical error in the placement of the endoprothesis. This third case was due to a Lifepath endoprothesis. The two iliac branches were placed in the right short-branch of the aortic trunk, in this case the special Lifepath directional catheter had not been used for crossing the idrofilic guide-wire to the contralateral leg. The balloon dilatation (they are balloon expandable) occluded the left short-branch of the aortic trunk so no endoleak was seen. The patient returned with symptomatology of aortic occlusion; the CT-scanning confirmed the diagnosis, and the endoprothesis was removed and replaced with a bifurcated graft. The fourth conversion occurred 6 months after endografting. The patient underwent a CT-scan after 6 months, as our follow-up protocol shows, which showed an endoleak that the angiography confirmed as a type III endoleak (graft rupture). Intraoperating found an advanced inflammatory process of the aorta and the aneurysm. Excision of the aneurysm and the endoprothesis, and bifurcated graft substitution, was performed. The stent-graft was sent for cultivation and

Fig. 2.

Fig. 3.
bacteriological examination that gave a negative result.

Endoleaks

There were a total of 17 (9%) endoleaks. Twelve of type I, 10 proximal (four Excluders, one Endologix, two Vanguard, two Lifepath and one Anaconda) and two distal (one Vanguard and one Excluder). Five of type II, three from the inferior mesenteric artery (two Excluder, and one Vanguard) and two from a lumbar artery (one Excluder and one Lifepath) (Table 4). In four of the 10 proximal endoleaks, the length of the proximal aneurismal neck was between 15 and 20 mm, and in one it was 75% angulated. Eleven of the 12 type I endoleaks were successfully treated with a stent-graft extension; one patient underwent an open surgery procedure. No patients were dismissed with a type I endoleak. In two of the 10 cases of proximal endoleak (one Endologix, one Excluder), the endograft was deployed far from the renal arteries, although the aneurysm was excluded with no endoleak in the intraoperative post-deployment control angiography. The remaining eight endoleaks (three Excluders, two Vanguards, two Lifepath, one Anaconda) were deployed in the correct position close to the renal arteries, so it is believed that they probably migrated during the post-implantation aortic remodulation process. Three of the five type II endoleaks were automatically regressed, two 3 months and one 6 months after the intervention. One remains under observation with no increased diameter in the aneurysm sac. One patient with a persistent type II endoleak had an increased aneurysm diameter of 1 cm in 1 year and he underwent a conversion to open surgery 18 months post-implantation as previously described.

Discussion

In recent decades many vascular surgery centres report excellent mortality rates of under 3% for elective, direct, surgical repair of AAA. Despite this figure, community-based reports suggest that surgical repair of AAA continues to carry a mortality rate of approximately 10%. Our data, and that from other multiple reports within the past few years, support the concept that many properly selected patients with AAA can be successfully treated with endoluminal repair, at least in the short to mid-term. If transfemoral endovascular procedure is also shown to be durable in the long term, it will have a major impact on the 30-day mortality rates of patients who undergo aneurysm repair. The primary determinants of the feasibility of endovascular repair remain the anatomic features of the aneurysmatic aorta.

In our experience endoluminal repair was possible and safe in 41% of the cases. With the increasing frequency of this procedure in most vascular surgery centers along with the careful training of vascular surgeons in endovascular techniques, and the technical improvements of the stent-grafts and devices, this percentage is likely to increase in the near future. An even higher percentage of patients with AAA with complex anatomy and extensive aneurysmal disease involving both iliac axis may be treated with endoluminal procedures if both internal iliac arteries are excluded. We have avoided this because of the potential consequences of pelvic and colon ischemia.

Endoleak development constitutes one of the prime reasons to insist upon strict postoperative surveillance by regularly performed image studies, mainly CT scanning. The prime purpose of endovascular repair of AAA is to prevent death from rupture of the aneurysm, and early identification of endoleaks is intended to help obtain this goal. We treated type I endoleaks, and one type II; three automatically regressed and one remains under observation. Analyses of the outcome of endoleaks by using a more extensive patient data set may lead to a greater consensus on treatment protocols.

Conclusions

In our clinical experience, the endovascular repair of AAA in patients at standard and high risk is both a safe and effective technique with good mid-term
results. However, strict surveillance in follow-up is still necessary to detect stent-graft failure and endoleak.

References


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