Original Article

Endovascular Repair for Abdominal Aortic Aneurysms: Initial Experience of an Endograft Programme

Albert C.W. Ting, Stephen W.K. Cheng and Pei Ho, Division of Vascular Surgery, Department of Surgery, University of Hong Kong Medical Centre, Queen Mary Hospital, Hong Kong.

OBJECTIVE: To evaluate early clinical results of elective endovascular repair of abdominal aortic aneurysms during the initial phase of an aortic endograft programme and to compare them with conventional open surgery.
METHODS: Between July 1999 and September 2001, all patients with infrarenal abdominal aortic aneurysms undergoing elective repair were studied. The results of endovascular repair were compared with those of conventional repair.
RESULTS: Twenty-seven endovascular repairs (24 men and three women; mean age, 74 yr) and 25 conventional repairs (19 men and six women; mean age, 73 yr) for infrarenal abdominal aortic aneurysms were evaluated. The aneurysm diameters in the two groups were similar (mean, 6.1 cm in the endovascular repair group and 6.6 cm in the conventional repair group). The comorbidities of the two groups were also comparable. The duration of operation was longer in the endograft group (249 ± 86 min vs. 206 ± 56 min), while the blood loss was significantly less (600 ± 486 mL vs. 1074 ± 1220 mL). The length of stay in the Intensive Care Unit (ICU) and the overall duration of hospitalization was also significantly less in the endograft group (1 ± 1 d vs. 3 ± 2 d in ICU; 9 ± 5 d vs. 13 ± 6 d of hospitalization). There was one hospital death in each group (4%), and the complications were similar between the two groups. During a mean follow-up period of 11.6 ± 7.5 months, there was no rupture or open conversion in the endograft group.
CONCLUSIONS: In the initial phase of the aortic endograft programme, the mortality and morbidity were acceptable and comparable to that of open surgery. *(Asian J Surg* 2003;26(1):17–21)

Introduction

Abdominal aortic aneurysm is a common disease in the elderly and its prevalence increases sharply with advancing age.[1] Despite improvements in surgical techniques and perioperative care, operative mortality for the repair of intact and ruptured abdominal aortic aneurysms remains at 5% and 50%, respectively.[2,3] Major systemic postoperative morbidities are also common.[4] With the ageing population, more elderly patients with multiple comorbidities and high operative risk will be seen.

The introduction of endovascular abdominal aortic aneurysm repair has provided a less invasive therapeutic alternative to conventional open surgery.[5] With improvements in endovascular devices and greater experience, favourable early and mid-term results were reported for various commercially available devices.[6–8] As with all new procedures, there is a definite learning curve,[9] and there is always concern over their safety and efficacy, especially during the initial phase of an aortic endograft programme. The aim of this study was to evaluate the early clinical results of elective endovascular repair for abdominal aortic aneurysms during the initial phase of an aortic endograft programme and to compare them with that of conventional open surgery.

Address reprint requests to Professor Stephen W.K. Cheng, Division of Vascular Surgery, Department of Surgery, University of Hong Kong Medical Centre, Queen Mary Hospital, Pokfulam, Hong Kong.
E-mail: wkcheng@hku.hk • Date of acceptance: 2nd October, 2002

Patients and methods

Aortic endografting was introduced to the Division of Vascular Surgery, University of Hong Kong Medical Centre in July 1999. Since then, all patients with infrarenal abdominal aortic aneurysms undergoing elective repair are considered for the possibility of endografting. All patients who agreed to endograft repair of their aortic aneurysms underwent fine-cut, spiral computed tomography (CT) and aortography for further assessment. The aortic neck (length and angulation), the size of the common iliac arteries (landing zones) and the adequacy of the access arteries (lumen diameter and tortuosity) were evaluated. Those who refused or were judged unsuitable for endograft repair underwent conventional repair of their aneurysms. Demographics, operative details, complications and follow-up data were recorded prospectively.

Endograft implantation was performed in the operating room by a team of vascular surgeons, under general anaesthesia, with bilateral groin incisions, using image guidance with a mobile C-arm fluoroscope (Philips BV29, Philips Medical System, Netherlands). Embolization of one internal iliac artery was performed at the same setting if necessary. Conventional repair was performed under general anaesthesia with epidural anaesthesia for postoperative pain management, using midline or rooftop incisions, depending on the morphology of the aneurysms.

The follow-up protocol for patients with endograft implants included CT prior to discharge, and every 6 months thereafter, to assess for the presence of endoleakage and to measure the size of the aneurysm sac. Patients with persistent endoleakage underwent angiography, with further endovascular intervention where appropriate.

Demographics, operative details and complications were compared between the endograft group and the conventional open surgery group during the study period. Fisher's exact test and the chi-square test were used for categorical variables and the Mann-Whitney U test was used for continuous variables. Statistical significance was indicated by a p value of less than 0.05.

Results

Between July 1999 and September 2001, 118 patients presented electively for evaluation of infrarenal abdominal aortic aneurysms. Of these, 66 patients did not undergo surgical repair of their aneurysms (37 patients had small aneurysms less than 5 cm in diameter, 29 patients refused surgical treatment or were too ill for surgical intervention). The remaining 52 patients with infrarenal abdominal aortic aneurysms underwent elective repair. Six patients refused endografting and underwent conventional surgery instead. Of the remaining 46 patients who underwent evaluation with fine-cut CT together with aortography, 27 (59%) were deemed suitable for endovascular repair. The reasons for exclusion of the other 19 patients were: short or angulated aortic neck in 12 patients (63%), bilateral iliac aneurysms extending to the hypogastric artery in two patients (11%) and both unsatisfactory neck together with bilateral iliac aneurysms in five patients (26%). Twenty-five conventional open repairs (18 bifurcated grafts and seven tube grafts) were performed during this period. Demographics, size of aneurysms and patient comorbidities are shown in Table 1. Data between the two

Table 1. Demographics and co-morbidities in patients who underwent either endovascular repair or conventional repair

	Endovascular repair (n = 27)	Conventional repair (n = 25)
Demographics		
Age (mean ± SD) (yr)	74 ± 6 (range, 61–91)	73 ± 7 (range, 56–85)
Sex (male:female)	24:3	19:6
Size of aneurysm (cm)	6.3 ± 0.9 (range, 4.7–8.2)	6.6 ± 1.4 (range, 5.0–10.0)
Comorbidities		
Cardiac disease (ischaemic heart disease, congestive heart failure, cardiac arrhythmia)	12 (44%)	8 (32%)
Hypertension	17 (63%)	19 (76%)
Respiratory disease	5 (19%)	3 (12%)
Renal impairment (creatinine > 120 mmol/L)	8 (30%)	8 (32%)
Cerebral vascular accident	0 (0%)	3 (12%)
Diabetes mellitus*	0 (0%)	6 (24%)

*p < 0.05. SD = standard deviation.

groups were similar, with the exception that there were more diabetic patients in the conventional surgery group.

Operative details and postoperative complications are shown in Table 2. The duration of operation for endografting was longer, while the blood loss was significantly less. Duration of hospitalization and length of stay in the Intensive Care Unit (ICU) were significantly shorter in the endograft group. All endografts were successfully implanted, including: 20 AneuRx grafts (Medtronic AVE, Santa Rosa, CA, USA), six Talent grafts (Medtronic World Medical, Sunrise, FL, USA) and one Zenith graft (Cook Australia, Queensland, Australia). Each endograft cost approximately HK$80,000. Graft configuration was bifurcated in 23 patients (85%), while an aorto-uni-iliac device with a femoro-femoral bypass was performed in the remaining four patients.

There was one death in hospital in each group. A 75-year-old man with longstanding hypertension who underwent endografting died suddenly on postoperative day 4, and the post-mortem examination showed a type A thoracic aortic dissection with cardiac tamponade. In the group with conventional surgery, a 78-year-old woman died on postoperative day 7 due to multiple organ failure. The postoperative complications encountered were similar in the two groups.

Patients who underwent endografting were monitored for a mean of 11.6 ± 7.5 months. There was one late complication requiring operative intervention. An aorto-uni-iliac graft thrombosed 3 weeks after endografting due to a kinked iliac limb. This was salvaged with an additional extension cuff placed distally. The graft remained patent at the patient's last follow-up 12 months after surgery.

The endoleakage rate was 33% at discharge and 14% at 6 months postoperatively. Three angiograms were performed for patients with persistent endoleakage. In one patient, a type II endoleak from the inferior mesenteric artery was identified and embolization was performed. Angiograms did not identify any endoleakage in the other two patients. Follow-up CT at 12 months showed the endoleak had sealed in one patient, and that the size of the aneurysmal sac had decreased by 2 mm. Nonetheless, in the remaining patient, the endoleak persisted while the aneurysm sac remained static in size.

During the mean follow-up period (11.6 ± 7.5 months), the size of the aneurysm was observed to decrease in 18 patients, and by more than 5 mm in six (24%). Seven aneurysms had remained static in size. There was no abdominal aortic aneurysm rupture or conversion in the endograft group. There was one late death from a ruptured thoracic aortic aneurysm.

Discussion

The clinical results of elective endovascular repair for abdominal aortic aneurysms during this initial phase of an aortic endograft programme appear satisfactory, with 100% successful endograft deployment and an operative mortality of 4%. When compared with conventional open surgery, the incidence of cardiac and pulmonary complications was

Table 2. Perioperative details and complications in patients who underwent either endovascular or conventional aneurysm repair

	Endovascular repair (n = 27)	Conventional repair (n = 25)
Perioperative details		
Duration of operation* (min)	249 ± 86	206 ± 56
Blood loss* (mL)	600 ± 486	1074 ± 1220
Transfusion (mL)	144 ± 315	378 ± 661
Need for transfusion	6 (22%)	10 (40%)
Unilateral hypogastric artery covered/embolized	13 (48%)	—
Bilateral hypogastric artery covered/embolized	4 (15%)	—
Stay in Intensive Care Unit* (days)	1 ± 1	3 ± 2
Duration of hospitalization* (days)	9 ± 5	13 ± 6
Perioperative complications		
Cardiac	5 (19%)	4 (16%)
Respiratory	2 (7%)	2 (8%)
Renal	0 (0%)	1 (4%)
Wound complication	1 (4%)	1 (4%)
Buttock claudication	2 (7%)	0 (0%)

*$p < 0.05$

expected to decrease due to the avoidance of laparotomy and extensive tissue dissection. Although the number of complications was similar in both groups in our study, complications in those who underwent endografting were much less severe. This was reflected by the significant decrease in the duration of hospitalization and the duration in the ICU. Thus, endovascular repair may be attractive to poor-risk patients who may not tolerate conventional surgery.[10] The duration of hospital stay for those who underwent endovascular repair was longer than for comparable Western procedures. This is due to the unique, local, medical charge system where patients only pay a minimal amount for their hospitalization, as well as the Chinese culture whereby patients prefer to stay in hospital until they perceive themselves to be completely well.

The mean operating time was significantly longer for endovascular repair. Although blood loss was less in endovascular repair, the amount was still significant. When the operating time and blood loss for endovascular repair in the latter part of the study were compared with the initial stage, a trend of decreasing operating time and blood loss was observed. As with any new surgical procedure, there is a definite learning curve associated with aortic endografting.[9] With increasing experience in the operative technique and set up, the operating time and blood loss will probably be decreased further.

Endografting is not applicable to all patients with abdominal aortic aneurysms, because there are certain anatomical features that may preclude successful endovascular repair. Common anatomical barriers are short or wide aneurysm neck, inadequate iliac access, bilateral iliac aneurysms extending to the hypogastric artery and excessive neck angulation.[11] In our study, 59% of patients evaluated were deemed suitable for endovascular repair. This was comparable to the experience reported by Zarins et al,[10] where 44% to 62% of abdominal aortic aneurysms were suitable for endovascular repair. We did not exclude patients based on iliac tortuosity or calibre alone in our early experience. In our study, two patients had external iliac artery lacerations requiring replacement due to unfavourable iliac anatomy, although the endografts were successfully deployed. More careful selection should be exercised to exclude those with unfavourable iliac access vessels in order to avoid iliac artery injury. On the other hand, with the introduction of systems that are of smaller calibre[12] and possess more flexibility, this type of injury would probably decrease.

In extreme situations, where surgical intervention would otherwise be denied in the high-risk patient, endovascular repair may be possible even in patients with bilateral iliac aneurysms extending to the hypogastric artery. By extending the graft limbs to both external iliac arteries with coverage or embolization of both hypogastric arteries, retrograde perfusion of the aneurysm through these vessels was prevented. There has always been a concern over the risk of complications, especially of bowel ischaemia.[13] In recent reports, fatal complications associated with internal iliac artery occlusion were rare, although buttock claudication was a concern.[14,15] Some studies reported reimplantation of the hypogastric artery as an adjunct to endovascular repair to avoid such complications.[16] In our early experience, coverage or embolization to both hypogastric arteries were performed in four patients (15%), with no resultant life-threatening complications, although two patients had buttock claudication.

Endoleakage is always a concern after endovascular repair of aneurysms. Although some regard endoleaks as failure to exclude the aneurysm, and carrying a risk of aneurysm growth and rupture,[17] the clinical significance of endoleaks and their impact on the natural history of an aneurysm remain uncertain.[18,19] The degree of endoleakage in our study was comparable to the experience reported in the AneuRx Multicenter Clinical Trial, where endoleakage was detected in 38% of patients at discharge, 16% of patients at 6 months and 13% of patients at 12 months postoperatively.[19] Close follow-up is imperative, and secondary intervention may be necessary for endoleakage and for late complications such as graft limb thrombosis.

All procedures were performed in the operating room. Because open vascular access via groin incisions and other adjunctive vascular procedures such as repair of damaged access vessels, femoro-femoral bypass or ligation of the common iliac artery in aorto-uni-iliac device may be necessary, a sterile, well-equipped and appropriately staffed environment such as an operating room is most suitable for the procedure.

Aortic endografting appears to be a promising procedure that may allow repair to patients who would not be candidates for conventional, open, surgical aneurysm repair. Even in this initial phase of our aortic endograft programme, the resulting mortality and morbidity were acceptable and comparable to those of open repair surgery. Nonetheless, we emphasize that there is a need for close follow-up surveillance for late complications and endoleakage. Furthermore, the long-term efficacy of endoluminal treatment in preventing aneurysm rupture remains unknown.

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