Results of Urgent and Emergency Thoracic Procedures treated by Endoluminal Repair

R. E. Bell, P. R. Taylor*, M. Aukett, T. Sabharwal and J. F. Reidy

Departments of 1General and Vascular Surgery and 2Radiology, Guy’s and St Thomas’ Hospital, Lambeth Palace Road, London, U.K.

Introduction: emergency surgery on the thoracic aorta is associated with a high mortality. Endovascular treatment for these patients may offer a realistic alternative to open surgery.

Method: between 1997 and 2002 data was collected prospectively on all patients who underwent urgent or emergency endoluminal repair for thoracic aortic pathology. All patients had ruptured or were at risk of rupture, and had been assessed as high risk for open surgery.

Results: twenty-four patients required urgent/emergency stent grafts. The median age was 74 (range 17–90). Indications included: trauma (transection in 3 and traumatic dissection in 1), acute symptomatic type B dissection (4), symptomatic degenerative aneurysms (7), false aneurysms associated with infection (6), Takayasu’s vasculitis causing rupture of the descending thoracic aorta (1), symptomatic aneurysm associated with chronic dissection (1) and a secondary aorto-oesophageal fistula (1). The 30-day survival was 83.3% (20/24) and the survival at 1 year was 70.8% (17/24). The median follow-up was 13.5 months (range 2–57). The complications included: transient paraplegia (1), non-disabling stroke (1), distal endoleak treated with an extension cuff (1) and a proximal endoleak (1) which required removal of the graft at open surgery.

Conclusion: endoluminal repair of thoracic aortic disease requiring urgent/emergency treatment has encouraging results with low morbidity and mortality rates compared with open surgery. Long-term follow-up is required to assess the durability of the grafts.

Key Words: Thoracic aneurysm; Rupture; Emergency; Endoluminal repair.

Introduction

Thoracic aneurysms are potentially life threatening with an estimated incidence of six cases per 100,000-person years. Post-mortem studies have shown that less than 50% of patients who suffer thoracic rupture reach hospital alive and of those, 75% die within 24 h without surgical intervention. Survivors usually have contained ruptures, as free rupture into the pleural cavity universally results in exsanguination and death. Despite improvements in perioperative care, emergency surgery is frequently complicated by respiratory failure (51%), renal failure (17%), paraplegia (7–27%), and death (13–50%). Urgent intervention is required for: ruptured or symptomatic aneurysms, complicated acute type B aortic dissection or traumatic aortic rupture. In these situations open surgery is often technically difficult and hazardous.

Endoluminal repair offers a minimally invasive alternative to conventional surgery. The avoidance of open thoracotomy, anticoagulation and aortic cross clamping is beneficial in these patients, who are often moribund or have multiple injuries. We report our series of 24 patients who required urgent or emergency treatment for descending thoracic aortic pathology.

Patients and Methods

Sixty-four patients underwent endoluminal repair for thoracic aortic pathology between July 1997 and July 2002, of whom 24 (37%) required urgent treatment. All these patients were deemed to be at risk of aortic rupture or had radiological evidence of rupture (Figs 1 and 2). There were 12 male patients with a median age of 65.5 years (range 17–85), and 12 female
patients with a median age of 75.5 years (range 45–90). 21/24 patients were transferred from other hospitals. Indications for treatment are summarised in Table 1. Those classified as having "symptomatic" aneurysms presented with back pain (1), stridor (2) and left recurrent laryngeal nerve palsy (2). The indications for intervention in the patients with acute type B aortic dissection were on-going pain (1), rupture (2) and acute limb ischaemia (1). The eight patients classified as having "infected" aneurysms presented with symptoms of fevers and weight loss (4), aorto-oesophageal fistula (1), aorto-bronchial fistula (2) and an aortocutaneous fistula (1). All of these patients had a leucocytosis and elevated erythrocyte sedimentation rate (ESR) with saccular aneurysms of the thoracic aorta on computed tomography. One patient had positive blood cultures for Methicillin-resistant Staphylococcus aureus (MRSA).

Nine patients were treated within 24 h, eleven within 48 h and four within 72 h of admission. Six patients required adjunctive surgical procedures: carotid-carotid bypass to allow intentional occlusion of the left common carotid origin (3), simultaneous endovascular repair of an infrarenal aneurysm (1) and temporary grafts to the common iliac artery or aorta to bypass small iliac arteries (2) via an oblique incision in the right iliac fossa and extraperitoneal exposure of the iliac artery. All procedures were performed in the endovascular theatre of the radiology department. In the majority of patients the common femoral artery was used for access. Prophylactic antibiotics and unfractionated heparin (5000 units) was given prior to insertion of the 22-24F delivery sheath. Systemic hypotension was not induced during deployment. A post-deployment angiogram was performed to check the position of the stent graft and to identify any endoleaks. The procedure was performed under general (17), regional (5) or local anaesthesia (2). The median length of the procedures was 120 min (range 55–225). All patients were observed for 4 h in recovery before returning to the surgical ward. One patient with a ruptured thoracic aneurysm required admission to the Intensive Care Unit postoperatively. The types of stent graft used were: Thoracic excluder™ (W. L. Gore Associates, Inc, Flagstaff, AZ, U.S.A.) in fifteen patients, AneuRx™ (Medtronic AVE, Sunnyvale, CA, U.S.A.) in four, Talent™ (Medtronic AVE, Sunnyvale, CA, U.S.A.) in four and Vanguard™ (Boston Scientific, Natick, MA, U.S.A.) in one. Computed tomography (CT) and, where possible, calibration angiography was used to obtain the measurements for the stent graft dimensions (Table 2). Devices were oversized by a minimum of 10% relative to the normal aorta at the fixation sites. Follow-up CT and plain chest radiograph were performed at 3, 6, 12 months and then annually thereafter.

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Number of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>False &quot;mycotic&quot; aneurysm</td>
<td>6</td>
</tr>
<tr>
<td>Symptomatic aneurysm</td>
<td>4</td>
</tr>
<tr>
<td>Ruptured aneurysm</td>
<td>4</td>
</tr>
<tr>
<td>Acute type B dissection</td>
<td>4</td>
</tr>
<tr>
<td>Trauma</td>
<td>4</td>
</tr>
<tr>
<td>Chronic type B dissection</td>
<td>1</td>
</tr>
<tr>
<td>Aorto-oesophageal fistula</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 1. Indications for treatment.

Fig. 1. CT scan showing a ruptured descending thoracic aneurysm with associated haemothorax.

Fig. 2. CT scan showing acute type B dissection.
All stent grafts were deployed successfully. The median follow-up was 16.5 months (range 5–60). The 30-day survival was 83.3% (20/24). The causes of death were: myocardial infarction (2), on-table rupture (1) and rupture of an unrecognised false aneurysm of the distal thoracic aorta at 48 h (1). There was no significant difference between the median age of the survivors and the non-survivors (72 vs 71.5 years, \( p = \text{ns Mann–Whitney U-test} \)).

Eleven patients (46%) had definite radiological or clinical evidence of a leaking aneurysm. The remaining 13 (54%) patients had symptomatic thoracic aneurysms or acute type B aortic dissections. The risk of death in patients who had ruptured was 18% (2/11) and the risk of death for patients with symptomatic aneurysms was 15% (2/13, \( p = \text{ns Chi squared} \)).

There were three late deaths: one at 2 months from bronchopneumonia, one at 3 months from a myocardial infarction and one at 5 months from rupture of a mycotic aneurysm. The 1-year survival rate was 70.8% (17/24).

### Morbidity

2/24 (8.3%) patients developed neurological complications after the procedure: stroke (1) and paraplegia (1). The cerebrovascular event was embolic and caused by manipulation of the guidewire in the aortic lumen. The patient recovered fully prior to discharge. The patient who developed paraplegia had simultaneous repair of thoracic and infrarenal false aneurysms under epidural anaesthesia. He had presented with life-threatening haemoptysis and a 3-week history of weight loss and fevers. At the end of the procedure he was unable to move his legs but this completely reversed with cerebrospinal fluid drainage. The following major aortic branches were intentionally covered to adequately secure the stent graft proximally and distally: left subclavian (4), left subclavian and common carotid (3) and coeliac arteries (1). There were no adverse events associated with the deliberate occlusion of these arteries. The device related complications were: one persistent proximal endoleak and one distal endoleak at 3 months. The proximal endoleak failed to seal despite attempts at coil embolisation and the stent graft was removed at open repair 6 weeks after insertion. This patient survived open surgery despite a 2-week stay in intensive care. The distal endoleak was successfully treated with an extension cuff.

Interestingly no type II or III endoleaks have been identified in the follow-up period. No patient developed respiratory or renal failure post-procedure. The median length of hospital stay was 7 days (range 2–32).

### Discussion

Endoluminal repair has significant advantages over open surgery as it avoids aortic cross-clamping, thoracotomy and single-lung ventilation. There is no requirement for full heparinisation and blood loss is minimal. The devices are inserted through a femoral arteriotomy, which can be performed under regional or local anaesthesia. Patients rarely require admission to intensive care postoperatively and the length of stay in hospital is markedly reduced in comparison with open surgery. These factors are beneficial for a patient population that is usually elderly with co-existing medical problems.

Emergency thoracic aneurysm repair in patients over 80 is associated with substantial increases in mortality and morbidity. Although controversial, some groups have advocated withholding operative intervention in octogenarians with ruptured aneurysms and haemodynamic compromise as the mortality rates are often >90%. We perform the procedures in an endovascular suite where there are the facilities to convert to an open operation if required. However the majority of patients in this group had been assessed by cardiothoracic and anaesthetic consultants and were deemed unfit for open surgery.

Endoluminal treatment of infected aneurysms is controversial. Conventional surgery requires extensive debridement and in-situ or extra-anatomical bypass. In our series five out of eight of the patients with “infected” aneurysms are well with no signs of on-going infection at 16.5 months follow-up. The patient in this group who died at 5 months from aortic rupture had a persistent aorto-cutaneous fistula associated with previous radiotherapy to the chest wall.

Paraplegia is a devastating complication of both open surgery and endoluminal repair of thoracic
aortic disease. The use of cerebrospinal fluid (CSF) drainage to reverse immediate and delayed paraplegia associated with thoracic aortic intervention has been reported by several groups.\textsuperscript{11-13} We do not routinely use prophylactic CSF drainage but the procedures are performed under local or regional anaesthesia to allow continual assessment of distal neurological function. A CSF drain is inserted immediately if the patient develops any distal neurological deficit. The CSF pressure is maintained at $<10$ mmHg and the drain is kept in for 72 h.

The majority of patients with acute type B dissection are treated medically with antihypertensive therapy. Emergency intervention is reserved for those patients with rupture, on-going pain or end-organ ischaemia. Conventional surgery in these circumstances has a high mortality (35–50\%\textsuperscript{14,15}) and a significant risk of paraplegia (14–19\%).\textsuperscript{16,17} The main aim of endoluminal treatment is to cover the primary entry tear and decompress the false lumen. The early results of endoluminal treatment have been very promising with low mortality and paraplegia rates.\textsuperscript{18,19}

Thoracic aortic rupture is a complication of blunt chest trauma (Fig. 3). Conventional surgical treatment involves open thoracotomy and interposition grafting. Patients often have multiple injuries and open surgery is extremely hazardous with a high incidence of paraplegia (11–19.2\%) and reported mortality rates of 15–32\%.\textsuperscript{20} Several groups have reported successful use of stent grafts to repair acute and chronic traumatic aortic rupture with good results.\textsuperscript{21,22}

The facilities required to provide an emergency service are: an experienced team, high quality imaging equipment and rapid access to the stent grafts. Ideally there should be a selection of devices available “off the shelf” and some manufacturers provide “rupture” kits for this purpose. However, the high cost of the current devices mean that purchasing a selection of graft sizes for emergency use is not a viable option. The practicalities of offering this service mean that there is frequently a delay in treatment due to the need for preoperative imaging and the time taken to obtain the devices. It is important to note that only the Talent\textsuperscript{TM} and Endofit\textsuperscript{TM} (Endomed, Inc, Phoenix, AZ, U.S.A.) devices are currently available for use in the U.K. The Gore Thoracic Excluder\textsuperscript{TM} was withdrawn for redesigning in November 2001 following problems with fractures of the nitinol skeleton.

It has been shown that elective endovascular infrarenal aneurysm repair causes significantly less intraoperative haemodynamic and metabolic stress in comparison with conventional surgery.\textsuperscript{23} The combination of a minimally invasive procedure performed under local anaesthesia is beneficial for patients with ruptured aneurysms.\textsuperscript{24,25} Early reports of endovascular repair of ruptured infrarenal aneurysms have been promising.\textsuperscript{26,27}

Fig. 3. (a) Aortography showing traumatic aortic rupture. (b) Endovascular repair of the traumatic aortic rupture using a Gore Excluder (28 mm $\times$ 15 cm).
This group of patients is associated with a very poor long-term survival (40%, 1-year survival) and as a consequence the lack of durability of the stent grafts may have less importance. Endovascular repair may provide the opportunity to improve the outcome of patients presenting with ruptured or symptomatic thoracic aneurysms.

References


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