Pathology Specific Early Outcome after Thoracic Endovascular Aortic Repair

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WHAT THIS PAPER ADDS

Endovascular intervention for thoracic aortic pathology is now established as an alternative to open surgery. However the effect of pathology on outcome requires further investigation. In this study we evaluated 309 consecutive patients in a single centre over a 14-year period and showed no difference in the incidence of all-cause mortality, stroke, and spinal cord ischaemia between patients with aneurysm and dissection. There was however a high rate of aortic-related death in the dissection group, which may indicate the need to refine the future clinical management of these patients, including endograft design and procedural technique.

Objectives: Endovascular intervention is established for treatment of thoracic aortic dissection and aneurysm. The aim of this study was to compare the incidence of all-cause and aortic-related in-hospital mortality, stroke, spinal cord ischaemia, and major adverse event rate for patients undergoing thoracic aortic endovascular intervention to see if there is a pathology-specific effect.

Methods: Data were collected prospectively and analysed retrospectively for a cohort of 309 consecutive patients with either thoracic aortic dissection or aneurysm over a 14-year period.

Results: There were 209 men and 100 women with a median age of 72 years (interquartile range [IQR] 63—78 years). Aneurysm affected 62% (193/309) of patients and 37% (116/309) had complicated type B aortic dissection, of whom 43% (50/116) had acute and 57% (66/116) chronic presentations. In patients with aortic dissection compared to aneurysm, there was no significant difference in all-cause in-hospital mortality (6.9% vs. 8.3% respectively, $p = 0.827$, relative risk [RR] 0.83, 95% confidence interval [CI] 0.37—1.88), stroke (6.0% vs 6.2%, $p = 1.00$, RR 0.971, CI 0.39—2.39), spinal cord ischaemia (6.0% vs 6.2%, $p = 1.00$, RR 1.030, CI 0.42—2.54), or major adverse event rate (16.4% vs. 16.6%, $p = 1.00$, RR 0.988, CI 0.59—1.66). The rate of aortic related death was four times greater in the dissection than in the aneurysm group (4/8 = 50% vs 2/16 = 12.5%, $p = 0.06$, RR 6.99, CI 0.92—52.5) although this did not reach statistical significance.

Conclusions: There was no difference in the incidence of in-hospital mortality, stroke, and spinal cord ischaemia between aneurysm and dissection. The higher rate of aortic related death in the dissection group may indicate the need to refine the clinical management of these patients, including procedural planning, endograft design, and operative technique.

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INTRODUCTION

Endovascular intervention for thoracic aortic pathology is now established as an alternative treatment to open surgery and in recent years the number of thoracic endovascular procedures has risen each year.[1] The increased use of endovascular repair has been driven by the early mortality advantage reported when endovascular repair is compared with open surgical treatment of the thoracic aorta.[2,3] Endovascular stent grafts and delivery systems were initially designed for treatment of aneurysmal disease of the thoracic aorta and were subsequently used by Dake and Nienaber in 1999 for treatment of aortic dissection, without any significant change in biomechanical properties or design.[4,5] Given the spectrum of different pathologies that affect the descending thoracic aorta, it is important to define whether the outcome of endovascular repair is pathology specific to refine procedural technique and endograft design.

The aim of this study was to compare the rate of all-cause and aortic related in-hospital mortality, stroke, spinal cord ischaemia, and major adverse event rate (composite endpoint of mortality, stroke, and spinal cord ischaemia) for patients undergoing thoracic endovascular intervention for

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degenerative aneurysm and aortic dissection to see if there was a pathology-specific effect.

METHODS

The cohort consisted of 309 consecutive patients with thoracic aortic aneurysm and complicated type B aortic dissection who underwent endovascular treatment in a 14-year period at a single university teaching hospital. Aneurysms which affected the aortic arch and descending thoracic aorta were included, but those affecting the visceral vessels (thoracoabdominal aneurysms) were excluded. Aneurysms were treated in the presence of symptoms or rupture, and when the maximum transverse diameter was 6 cm or greater.

Patients with dissection presented with either acute or chronic complicated type B dissection. Acute dissection was defined as patients treated within 14 days of symptom onset, and chronic as 15 days or more. Complications in acute dissection were defined as rupture, end-organ ischaemia, refractory hypertension, and continued pain despite the best medical therapy. Complications in chronic dissection were aortic rupture and a total aortic diameter greater than 5.5 cm. No patient in this series had a complex aortic procedure with a branched or fenestrated device.

Patient and procedural details were entered prospectively into a database as were adverse events, including cause of death, stroke, and spinal cord ischaemia, and were analysed retrospectively. Patients treated non-electively were defined as urgent. Patients with mycotic aneurysm, transection, vasculitis, and aneurysm related to coarctation repair made up 15.5% of the database and were excluded from this analysis due to their relatively small number.

Pre-operative imaging

All patients underwent bolus-tracked contrast-enhanced computed tomography (CT). Images were interpreted by experienced radiologists and surgeons to determine the anatomical suitability for endovascular repair. Anatomical suitability was defined as a landing zone of greater than or equal to 15 mm; devices were oversized by 0–10% for dissection and 10–30% for aneurysm depending upon the device and surgeon preference. Duplex sonography was used to assess the status of the carotid and vertebral arteries if deliberate occlusion of the arch vessels was planned.

Initial medical management

Patients with acute aortic dissection were initially treated with hypotensive medication and analgesia on a high-dependency or intensive care unit. Blood pressure was titrated to ensure adequate urine output. Patients who were haemodynamically unstable (systolic blood pressure $<$90 mmHg) were taken immediately to the endovascular suite after a diagnostic CT scan to assess anatomical suitability.

Operative technique

A team consisting of five vascular surgeons and six interventional radiologists assessed the patients and performed the procedures. All operations were performed in a hybrid operating theatre with fluoroscopic and angiographic equipment available. Vascular access was achieved via femoral arteriotomy or prosthetic conduit. A catheter was inserted in the contralateral groin so that continuous angiography could be performed during device deployment. The majority of procedures were performed under loco-regional anaesthesia without routine pre-operative placement of a cerebrospinal fluid (CSF) drain. Prophylactic spinal drain insertion was considered if the procedure was performed under general anaesthetic, there was long segment coverage (the descending thoracic aorta from proximal to the left subclavian to the coeliac axis), planned occlusion of the left subclavian artery, extensive disease (proximal to the left subclavian with involvement of infrarenal aorta and/or internal iliacs); planned occlusion of the internal iliac arteries, or previous infrarenal aortic repair.

Adjuvant procedures

Revascularisation of the brachiocephalic and left common carotid arteries was performed if coverage of the vessel origin with the device was planned. Routine revascularisation of the left subclavian artery was not performed, but was considered for each individual case. Extra-anatomic bypass grafts were performed as a staged procedure if the patient was elective and if they were urgent but stable. Unstable patients had both procedures performed under the same anaesthetic. Conduits to the common iliac artery or infrarenal aorta were performed to bypass diseased, stenotic, and/or tortuous iliac arteries.

Definitions of outcome

In-hospital mortality was defined as death in hospital after the procedure and prior to discharge. All patients who had any degree of paraplegia or paraparesis were classified as having spinal cord ischaemia, even if this occurred preoperatively. This included patients who made a full neurological recovery. Likewise all patients with an anterior or posterior fossa neurological deficit for more than 24 hours were classified as stroke, and this included non-disabling and recovered strokes. All patients suspected to have a stroke or spinal cord ischaemia were assessed by a neurologist to confirm the diagnosis. Patients with neurological events were assessed by imaging studies requested by the neurologist (CT and/or magnetic resonance imaging as appropriate).

Statistical analysis

SPSS Statistics v20.0 (IBM Corporation, NY) software was used for statistical analysis. Following Kolmogorov–Smirnov testing for normality, continuous variables were expressed as medians and interquartile range (IQR) and sample distributions compared using a two-tailed Mann–Whitney

Table 1. Patient demographics and operative details.

Demographics	Dissection		Aneurysm	
	n	%	*n*	%
Total	116	38	193	62
Men	91	78	118	61
Median age (range) in years	66 (58–74)	n/a	75 (69–80)	n/a
Urgent	57	49	44	23
Operative details	**Median**	**Range**	**Median**	**Range**
Blood loss (mL)	200	50–5000	300	50–4000
Operation time (min)	83	67–114	100	80–125
Fluoro dose (Gycm$^{2)}$	197	115–306	181	117–327
Contrast volume (mL)	134	100–190	140	100–180
Devices	***n***	**%**	***n***	**%**
Gore Excluder	10	9	24	12
Gore TAG (TAG, cTAG)	84	72	82	42
Medtronic AneuRx	0	0	3	2
Medtronic Talent	3	3	13	7
Medtronic Valiant	2	2	5	3
Cook TX2	8	7	50	26
Stenford	0	0	2	1
Endomed EndoFit	8	7	8	4
Bolton Relay	1	1	6	3
Single stent	59	51	52	27
>1 stent	57	49	141	73
Ishimaru zone 0–2	63	54	80	42
Ishimaru zone 3	53	46	113	58

test. The incidence of all-cause and aortic related death, stroke, spinal cord ischaemia, and major adverse event rate between dissection and aneurysm was assessed using Fisher's exact test, followed by calculation of the corresponding relative risk (RR) at a 95% confidence interval (CI). A *p*-value $<.05$ was considered statistically significant.

RESULTS

Patient demographics

In total, 309 patients were included in the analysis. The pathology, demographics and procedural details are shown in Table 1. Overall, the male–female ratio was 209:100 and the median age was 72 years (IQR 63–78 years). Aneurysm affected 62% (193/309) of patients and 37% (116/309) had dissection, of whom 43% (50/116) had acute and 57% (66/116) chronic dissection.

The prevalence of dissection was higher in men than in women (43.5% vs. 25.0%, $p = 0.0017$, RR 1.33 (95% CI 1.12–1.56)). Patients presenting with dissection were significantly younger (66 years, 58–74) than those presenting with aneurysms (75, 69–80, $p < .0001$). Overall 30.1% of patients (93/309) presented urgently. Patients were significantly more likely to present urgently with dissection rather than aneurysm (49.1% vs. 22.9% respectively, $p < .0001$, RR 1.60, CI 1.32–1.94). Eleven of the 65 patients (17%) with chronic dissection were treated urgently.

Table 2. Adjuvant procedures during the primary hospital admission.

Procedure	Aneurysm	Dissection	Total
Carotid endarterectomy	1	0	1
Carotid–carotid bypass	17	3	20
Brachial artery exposure	1	0	1
Iliac angioplasty	2	1	3
Iliac conduit	8	1	9
Aortic conduit	4	0	4
Carotid-carotid and left subclavian bypass	7	3	10
Carotid subclavian bypass	8	6	14
Innominate, carotid and subclavian bypass	2	1	3
Renal artery stent	0	1	1
Femoro-femoral bypass	0	1	1
Total	50	17	67

Operating characteristics

The procedural technical success rate was 99.3% (307/309). The two failures were due to inability to seal the proximal landing zone in two patients with a symptomatic aneurysm and a tortuous aorta. General anaesthesia was given in 21.6% (25/116) patients with dissection and 17.1% (33/193) with aneurysm, which was not statistically significant. The details of the devices used are presented in Table 1.

Patients presenting with aortic dissection were significantly more likely to require placement of a stent graft in the aortic arch (Ishimaru zones 0–2) to ensure an adequate proximal landing zone (54.3% vs. 41.5%, $p = 0.034$, RR 1.3, CI 1.03–1.66). Patients with an aneurysm were more likely to require more than one device (72.8% vs. 49.1%, $p < .0001$, RR 1.48, CI 1.21–1.82). Patients presenting with aneurysm were significantly more likely to have a longer

Table 3. Secondary procedures during the primary hospital admission.

Procedure	Aneurysm	Dissection	Total
Elephant trunk and aortic valve replacement	0	1	1
Chimney stents to arch vessels	4	0	4
Superior mesenteric embolectomy and total colectomy	1	0	1
Further aortic stent graft(s)	2	1	3
Bilateral thoracotomy	0	1	1
Axillo-femoral bypass	1	0	1
Internal iliac artery angioplasty to reverse spinal cord ischaemia	0	1	1
Repair iliac artery rupture	6	1	7
Femoral thrombo-embolectomy	2	0	2
Femoral patch angioplasty	6	0	6
Femoro-femoral bypass	2	1	3
Total	24	6	30

procedure than patients with dissection (100 [80–125] vs. 83 [67–114] minutes respectively, $p = 0.0005$) and longer screening time (12.0 [8.2–18.3] vs. 8.9 [5–13.4] minutes respectively, $p = 0.0001$). Aneurysm patients also had significantly greater blood loss (300 [50–4000] vs. 200 [50–5000] mL, $p = 0.0463$).

Adjuvant procedures during the primary hospital admission

Sixty-seven adjuvant procedures were performed in 65 patients (Table 2), 25.9% (50/193) of the aneurysm cohort, and 14.7% (17/116) of the dissection patients; two patients in the aneurysm group required both a conduit and an aortic arch debranching procedure. Brachial artery exposure was performed in preparation for a through-and-through guidewire and the iliac angioplasty was used to dilate the iliac artery for access. The renal artery was treated with a covered stent to stop perfusion of the false lumen and the femoro-femoral bypass was used to treat an ischaemic leg, both in patients with dissection.

Secondary procedures during the primary hospital admission

There were 30 secondary procedures in 28 patients (Table 3), 12.4% (24/193) of the aneurysm cohort and 5.2% (6/116) of the dissection patients; one patient in each group required two procedures (femoral artery reconstruction and ilio-femoral graft). Of the aneurysm patients, one required an axillo-femoral bypass to revascularise an ischaemic leg, and two required further stent grafts for endoleak during the initial hospital admission. In the dissection cohort, one patient required an aortic valve replacement for retrograde type A dissection, one required bilateral thoracotomy to remove the blood to prevent cicatrisation, and one underwent internal iliac artery angioplasty to reverse spinal cord ischaemia.

Outcomes

Death. All in-hospital deaths occurred within 30 days of the procedure. The overall in-hospital mortality was 7.8% (24/309) with no significant difference in all-cause mortality between patients presenting with dissection compared with aneurysm (6.9% vs. 8.3% respectively, $p = 0.827$, RR 0.83, CI 0.37–1.88). The rate of aortic related death was four times greater in the dissection than in the aneurysm group (4/8 = 50% vs. 2/16 = 12.5%, $p = 0.06$, RR 6.99, CI 0.92–52.5) but this did not reach statistical significance. The causes of death in patients with aneurysm and dissection are shown

Table 4. Aneurysm-related deaths.

Presentation	Cause of death	Device	Comments
Urgent	Stroke	TAG	Stroke territory not defined
Urgent	Stroke	TX2	Deliberate coverage of left subclavian; no revascularisation; massive posterior circulation stroke
Urgent	Stroke	TAG	Diffuse with cardiac and respiratory failure
Urgent	Stroke	cTAG	Diffuse brain injury
Urgent	Myocardial infarction	TX2	Subclavian deliberately covered to control bleeding: Chimney stent; LIMA graft
Urgent	Myocardial infarction	Excluder	Coronary artery disease
Urgent	Ruptured aorta	Talent	Exsanguinated before second stent could be inserted
Elective	Stroke	TX2	Diffuse brain injury
Elective	Stroke	TAG	Massive embolus left hemisphere; prior left carotid endarterectomy
Elective	Mesenteric ischaemia	Endofit	Embolus
Elective	Mesenteric ischaemia	TX1	Embolus
Elective	Mesenteric ischaemia	Talent	Coeliac axis deliberately covered
Elective	Mesenteric ischaemia	TAG	Embolus
Elective	SCI, respiratory failure	TAG	Permanent paraplegia, respiratory failure
Elective	Pneumonia	TX2	Probable underlying lung carcinoma
Elective	Ruptured aorta	Endofit	Type I endoleak; ruptured day 3

SCI = spinal cord ischaemia.

Table 5. Dissection-related deaths.

Presentation	Dissection type	Cause of death	Device	Comments
Urgent	Acute	Rupture of infrarenal aortic aneurysm day 7	TAG	Unexpected event proven at post mortem
Urgent	Chronic	Rupture of infrarenal aorta	TAG	Failure to control bleeding from false lumen
Urgent	Acute	Ruptured thoracic aorta false lumen	cTAG	Failure to adequately cover primary entry tear
Urgent	Chronic	Stroke	cTAG	Left subclavian artery covered; carotid subclavian bypass;
Urgent	Acute	Stroke	cTAG	No arch vessels covered; diffuse brain injury;
Urgent	Acute	Myocardial infarction	Excluder	Coronary artery disease
Urgent	Acute	Myocardial infarction	cTAG	Coronary artery disease
Elective	Chronic	Conversion of type B to A	cTAG	Caused by trauma to origin of left subclavian artery during device insertion

in Tables 4 and 5 respectively. In the aneurysm group, the most common cause of death was stroke, which in the majority of cases was reported as diffuse rather than being localised to either the anterior or posterior cerebral circulation. Mesenteric ischaemia was also a common cause of death, occurring in four of the 16 patients; in the majority, these were thought to be embolic. There were two aortic related deaths, one at the time of the procedure because a second stent could not be inserted fast enough to prevent exsanguination; the second due to persistent type I endoleak.

The majority of dissection patients were treated urgently; four of the eight deaths in this group were aortic related: two in patients with acute and two in patients with chronic dissection. The other deaths were due to stroke and myocardial infarction.

Stroke. The overall stroke rate was 6.1% (19/309). The details of the patients who had a stroke are shown in Table 6. There was no difference in the incidence of stroke between dissection (7/116) compared with aneurysm (12/193) patients (6.0% vs. 6.2%, $p = 1.00$, RR 0.971, CI 0.39—2.39).

Spinal cord ischaemia. The overall rate of spinal cord ischaemia was 6.1% (19/309). The details of the patients who had spinal cord ischaemia are shown in Table 7. There was no difference in the incidence of spinal cord ischaemia between dissection (7/116) and aneurysm (12/193) patients (6.0% vs. 6.2%, $p = 1.00$, RR 1.030, CI 0.42—2.54).

Major adverse event rate. The overall incidence of a combined end-point of death, stroke, or spinal cord ischaemia was 16.8% (52/309). There was no significant difference in the overall major adverse event rate between dissection (19/116) and aneurysm (33/193) patients (16.4% vs. 17.1% respectively, $p = 1.00$, RR 0.960, CI 0.57—1.60).

DISCUSSION

This study has shown no difference between aneurysm and dissection in the incidence of all-cause in-hospital mortality, stroke, spinal cord ischaemia, and major adverse events for patients undergoing thoracic endovascular repair. The majority of deaths in the aneurysm group were due to stroke, mesenteric ischaemia, and myocardial infarction. The

Table 6. Details of patients with stroke.

Indication	Presentation	Device	Site	Vessels covered	Revascularisation	Outcome
Aneurysm	Urgent	Talent	Left hemisphere	None		Alive
Aneurysm	Urgent	TX2	Bilateral posterior	Left subclavian	None	Dead
Aneurysm	Urgent	TAG	Unknown	Left subclavian	None	Dead
Aneurysm	Urgent	TAG	Diffuse	None		Dead
Aneurysm	Urgent	cTAG	Diffuse	Left subclavian	None	Dead
Aneurysm	Elective	Excluder	Right hemisphere	None		Alive
Aneurysm	Elective	Endofit	Right hemisphere	None		Alive
Aneurysm	Elective	TAG	Left hemisphere	Left subclavian	None	Dead
Aneurysm	Elective	TAG	Right hemisphere	None		Alive
Aneurysm	Elective	TAG	Right hemisphere	None		Alive
Aneurysm	Elective	TX2	Diffuse	None		Dead
Aneurysm	Elective	cTAG	Unknown	Left subclavian	None	Alive
Dissection	Urgent	Talent	Right posterior	Left subclavian	None	Alive
Dissection	Urgent	TAG	Left hemisphere	Left subclavian	None	Alive
Dissection	Urgent	cTAG	Left hemisphere	Left subclavian	Carotid subclavian bypass	Dead
Dissection	Urgent	cTAG	Diffuse	None		Dead
Dissection	Urgent	TAG	Unknown	None	None	Alive
Dissection	Urgent	TAG	Left hemisphere	Left subclavian	None	Alive
Dissection	Elective	TAG	Right occipital	Left subclavian	None	Alive

Table 7. Details of patients with spinal cord ischaemia.

Indication	Presentation	Device	Arteries covered	Revascularisation	Cerebrospinal fluid drain	Neurological outcome	Outcome
Aneurysm	Elective	TAG	Left subclavian	None	Yes	Recovered	Alive
Aneurysm	Elective	TX2	None	None	Yes	Recovered	Alive
Aneurysm	Elective	TX2	None	None	Yes	Recovered	Alive
Aneurysm	Urgent	Talent	None	None	Yes	Recovered	Alive
Aneurysm	Urgent	TAG	Left subclavian	none	Yes	Recovered	Alive
Aneurysm	Elective	TX2	Left subclavian	None	Yes	Partial	Alive
Aneurysm	Elective	TAG	None	None	Yes	Partial	Dead
Aneurysm	Elective	Excluder	Coeliac	None	Yes	Permanent	Alive
Aneurysm	Elective	TAG	Left subclavian	None	Yes	Permanent	Alive
Aneurysm	Elective	TX2	None	None	Yes	Permanent	Alive
Aneurysm	Elective	cTAG	Left subclavian	Carotid subclavian bypass	Yes	Permanent	Alive
Aneurysm	Urgent	cTAG	Left subclavian and left common carotid	Right to left carotid bypass	Yes	Permanent	Alive
Dissection	Elective	Endofit	Left subclavian	None	Yes	Recovered	Alive
Dissection	Urgent	TAG	None	None	Yes	Recovered	Alive
Dissection	Urgent	TAG	None	None	Yes	Recovered	Alive
Dissection	Urgent	cTAG	None	Internal iliac angioplasty	Yes	Recovered	Alive
Dissection	Elective	TX2	None		Yes	Permanent	Alive
Dissection	Urgent	TAG	Left subclavian	None	Yes	Permanent	Alive
Dissection	Urgent	TAG	None	None	Yes	Permanent	Alive

majority of deaths in the dissection group were aortic related; the incidence of aortic related death was four times greater in dissection than in aneurysm, which is concerning and needs to be assessed in a larger study.

In the Scientific Statement from the American Heart Association, the incidence of death and spinal cord ischaemia with endovascular repair of type B aortic dissection was 0—20.0% and 0—2.8% respectively (no information was given regarding the incidence of stroke).[6] The incidence of death, spinal cord ischaemia, and stroke for endovascular treatment of aneurysms was 0—9.0%, 0—4.4% and 0—13.4% respectively. More recently, the Interdisciplinary Consensus Document for endovascular management of acute type B aortic dissection demonstrated an incidence of death, spinal cord ischaemia, and stroke of 10.2%, 4.2% and 4.9%, respectively, in 2,359 cases.[7] Our data, which included both acute and chronic dissection, are in line with the results of these studies. The data from five registries has recently been combined with data from a single centre, and the results of endovascular treatment of aneurysm was compared with dissection.[8] Pathology has an effect on mid-term outcome although the mode of presentation was an important factor. Stroke was not related to pathology, but spinal cord ischaemia was found mainly in the aneurysm group.

Neurological complications limit the efficacy of endovascular repair and constitute a major source of morbidity and mortality. Our study demonstrated no difference in the rate of stroke and paraplegia between aneurysm and dissection, which is in contrast to other series, which have shown that these occur less frequently in dissection, particularly chronic dissection.[9—11] Some studies have documented an association between aneurysms and embolisation during catheter and wire manipulation in the aortic arch resulting in athero-embolic anterior circulation stroke.[12] In our series the incidence of stroke was approximately the same in both pathologies, and review of Table 6 demonstrates that both anterior and posterior circulation events were present in both aneurysms and dissections. Preoperative assessment of the degree of atherosclerosis affecting the aortic arch may identify high-risk patients who could benefit from prophylactic measures to prevent stroke. Stroke is a significant predictor of death and effective measures to prevent it will have a significant beneficial effect on outcome. Techniques to protect the cerebral circulation include the placement of filters into the carotid arteries or aortic arch, but these are not currently used in clinical practice.[13] Patients presenting with dissection were more likely to require a device placed in the aortic arch than aneurysm patients. We have previously published our results on neurological outcome following thoracic endovascular repair and have shown that the only significant risk factor for stroke on multivariate analysis was deliberate coverage of the left subclavian artery without revascularisation.[14]

Disruption of the collateral blood supply can affect perfusion of the spinal cord and patients with a greater extent of aortic coverage are more susceptible to spinal cord ischaemia. In our series patients with aneurysm compared with dissection were treated with a greater number of stent grafts and therefore had more aortic coverage. No difference was seen in the incidence of spinal cord ischaemia between the groups, which may be because patients with dissection tended to have a proximal landing zone and therefore coverage of the left subclavian artery. This artery gives rise to the vertebral artery, which supplies the anterior spinal artery and therefore the proximal segment of the spinal cord. All grades of spinal cord ischaemia were included in this analysis. The inclusion of all patients with any degree of spinal cord ischaemia will have a negative effect on the outcome, but we believe this gives a more honest appraisal of endovascular repair.

The majority of the patients in this series (aneurysm and dissection) were treated with a Gore device (Flagstaff, AZ, USA): initially the Thoracic Excluder, and more recently the TAG and cTAG. The Cook TX2 (Bloomington, IN, USA) was used mainly in the treatment of aneurysms because early in the series some patients with dissection treated with the TX2 had retrograde type A dissection. This may have been related to the barbs at the proximal end of the device that are used in active fixation. The endovascular devices used in dissection were initially designed for use in aneurysmal disease. However, the biomechanical properties of the aortic wall are different in dissection compared with aneurysm and there has been recent interest in development of a thoracic endograft specifically for dissection. The proximal extent of the device is frequently placed in the aortic arch when treating dissection. This area is a biomechanical transition zone and an area with high-velocity blood flow.

There are many unanswered questions regarding patient selection and the use of endografts in dissection: the degree of oversizing of the device; should sizing measurements be taken in systole or diastole; the optimum the length of the device; and the timing of treatment after presentation. Only patients that developed complications related to dissection were included in this series, in accordance with the best available evidence. In our study there was a high rate of aortic related complications in dissection, which were associated with aortic related death. The current poor results in some individuals with dissection treated with either medical or endovascular treatment underlines the complexity of this disease and the limitations of current data to guide management.[6,7,15,16] These studies demonstrate that with medical treatment survival can be as low as 50% at 5 years. Patients treated endovascularly are at risk of procedure-related complications such as stroke and paraplegia. In the longer term these individuals remain at risk of aortic rupture, due either to continued perfusion of the false lumen or dilation of the infradiaphragmatic segment, both leading to aneurysm formation and rupture.[17]

Thoracic stent grafts undergo considerable remodelling after deployment in dissection, in which the changes in the true lumen diameter, and therefore the change in stent graft diameter, can be substantial.[18] Stent grafts deployed in these situations exist in a dynamic state of continuous geometric alteration, which may affect the durability of repair. Further work using advanced imaging and computational modelling to evaluate the forces acting on stent grafts and their relationship to geometry and blood flow will improve our understanding of this disease. Future reporting standards may select new haemodynamic and biomechanical parameters to assess outcome which are specific for pathology rather than generic to the procedure. The introduction of compliant devices and the development of disease specific endovascular devices may reduce these complications and improve clinical outcome in the future.

Limitations

The data presented in this manuscript represents over 14 years of a single-centre experience in the management of patients with thoracic aortic aneurysm and dissection. Data regarding preoperative risk factors were not included in the database and therefore were not available for analysis and inclusion in the manuscript. The tertiary nature of referrals may introduce a bias due to late presentation and case selection, and the expertise of a specialist referral centre may not be applicable to less experienced centres. Although our analyses have demonstrated no difference between aneurysm and dissection, there is some heterogeneity in the two populations and a sample size of 309 may be too small to investigate patient and procedural factors. Our findings may also have been affected by unknown confounders or under-reporting of events.

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CONFLICT OF INTEREST

None.

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