Outcomes of regional transfers of ruptured abdominal aortic aneurysm in a UK vascular network

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ABSTRACT

INTRODUCTION Rupture of abdominal aortic aneurysm is a surgical emergency. In order to improve operative outcomes, vascular services have been centralised in the United Kingdom. This means that a patient may present to a hospital with a ruptured aneurysm, but require transfer to a vascular centre for definitive treatment.

METHODS This retrospective cohort study identified patients who underwent surgery for ruptured abdominal aortic aneurysm in a tertiary vascular centre over a 2-year period. Data on demographics and originating unit were recorded. Outcomes assessed included 30-day mortality, operative mortality and postoperative morbidity.

RESULTS We identified 70 patients who underwent surgery for ruptured abdominal aortic aneurysm in the 2-year period; 36 presented directly to the vascular unit (VU), 14 to referral unit 1 (RU1) and 20 to referral unit 2 (RU2); 30-day mortality rates were 27.7% (VU), 35.5% (RU1) and 30.0% (RU2), respectively. There was no statistical difference in mortality between units. Postoperative complications were seen in 35.9% of VU patients, 78.6% of RU1 patients and 70% of RU2 patients. This was statistically significant between VU and RU1 ($P = 0.006$) and VU and RU2 ($P = 0.02$). Direct operative complications were seen in 9 patients, gastrointestinal complications in 9, limb complications in 6 and systemic complications in 40.

CONCLUSION This study found that site of presentation does not affect mortality but is associated with increased morbidity. This is a complex issue, which will require a prospective multicentre study to investigate further.

KEYWORDS

Abdominal aortic aneurysm – Ruptured aneurysm – Transfer – Complications

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Introduction

Ruptured abdominal aortic aneurysm remains a challenging condition associated with significant morbidity and a mortality of between 30 and 80%.¹ This includes cardiorespiratory complications, gastrointestinal complications such as ischaemic colitis and lower-limb complications, including embolus and compartment syndrome.

The Vascular Services Quality Improvement Programme² has led to the regionalisation of vascular services. This has concentrated specialist surgical, anaesthetic and support services in a single geographic locus for each area. Our vascular unit provides elective and emergency vascular surgery for a population of approximately 1.5 million people and tertiary vascular services for surrounding areas. Referrals are taken from the emergency department on site at the vascular unit as well as two district hospitals, 12.9 miles and 6.4 miles from the vascular unit respectively.

Despite improvements in outcomes for elective abdominal aortic aneurysm (AAA) surgery, both mortality and

morbidity after repair of a ruptured AAA (RAAA) remain high, with little improvement over recent years.³ It has been demonstrated within the literature that survival is similar for those patients presenting directly to the vascular centre compared with those transferred from another unit.¹ This similarity in survival may be as transfer will select out only the fittest patients through a delay in reaching the operating theatre from presentation.^{1,5} Patients who undergo transfer before definitive management of their RAAA have been shown to require longer stays in intensive care,¹ longer overall hospital stays⁴ and to incur greater hospital costs^{1,4} than those who present directly to the vascular unit. The mechanism behind this is unclear, but it may be explained by a prolonged period of cardiovascular shock leading to secondary organ dysfunction,¹ causing sequelae such as ischaemic colitis and extremity complications.

Within our unit, we suspected that patients transferred for definitive care appeared to develop both ischaemic colitis and extremity complications more commonly than those presenting directly to the unit. We set out to review

outcomes of patients undergoing surgery for RAAA to identify any variation between originating unit.

Methods

This project was registered with our clinical governance department as part of a service evaluation assessing transfer of patients with a RAAA. We undertook a retrospective analysis of all patients undergoing laparotomy and open repair of a RAAA over a 2-year period from May 2012 to April 2014. Cases were identified through International Classification of Diseases codes for RAAA (441.3). These lists were cross-referenced with the electronic theatre register to ensure all patients were identified.

Basic demographics including age and gender were retrieved. Data on preoperative chronic disease were captured, including cardiovascular disease, respiratory disease, chronic kidney disease and diabetes mellitus. Definition of cardiovascular disease included hypertension, ischaemic heart disease and cerebrovascular disease. Chronic kidney disease was defined by laboratory values of estimated glomerular filtration rate. Respiratory disease included asthma and chronic obstructive pulmonary disease. We did not record American Society of Anesthesiologists (ASA) status as a RAAA is a life-threatening condition, so all patients would be classed as ASA V.

Outcome data collected included 30-day mortality as well as postoperative complications identified from electronic discharge summaries and further surgical procedures recorded on the electronic theatre register. Extremity complications included lower-limb embolism, thrombosis or compartment syndrome. Gastrointestinal complications included ischaemic colitis and ischaemia of other viscera. Acute kidney injury was defined as an increase in creatinine by 1.5 times above baseline. Data on estimated blood loss and operative time were also retrieved. Variation between groups was assessed using the Z-test for proportions and the Kruskal–Wallis test or Mann–Whitney U-test where appropriate. Data were analysed using GraphPad Prism (GraphPad Software, La Jolla, CA, USA).

Results

Overview

Clinical coding identified 84 operations for RAAA in the 2-year period. Case notes for 2 of these were not available and review found 12 aneurysms incorrectly coded as ruptured. This left 70 cases for analysis. Of the remaining patients, 47 were male and 23 female; 36 patients presented directly to the vascular unit (VU), with 14 initially presenting to referral unit 1 (RU1) and the remaining 20 to referral unit 2 (RU2). Demographics showed similar age and sex distribution for all originating units (Table 1). During the study period, open surgery was the only option offered for management of ruptured aneurysm.

Pre-existing cardiovascular disease was more frequently recorded in patients originating in the vascular unit than those originating in outside units (Table 2). Other chronic conditions showed a similar frequency.

Table 1 Overview of demographics

	Place of presentation		
	Vascular unit	Referral unit 1	Referral unit 2
Male : female ratio	24 : 12	10 : 4	13 : 7
Median age (years)	77.3	78.9	75.3
Age range	58.4–90.4	69.3–88.0	65.9–81.7

Table 2 Description of documented preoperative chronic diseases

	Place of presentation		
	Vascular unit	Referral unit 1	Referral unit 2
Chronic kidney disease (n)	3	0	0
Respiratory disease (n)	1	2	6
Cardiovascular disease (n)	17	3	4
Diabetes mellitus (n)	4	1	1

Operative details

Operative time was similar for VU and RU1, with median operative times of 164 and 157.5 minutes respectively. RU2 had a slightly longer median time at 190 minutes. The longest operation was 247 minutes in RU2. This was associated with a patient who underwent femoral embolectomy and additional lower-limb procedures at index operation. Statistical analysis approached but did not reach statistical significance at 0.051. Estimated blood loss was poorly recorded and this may be in part due to the use of a cell-saver device. Median recorded blood loss ranged from 1350–4000ml and did not reach statistical significance (Table 3).

Mortality

The 30-day mortality (Fig 1) for patients originating in each centre was calculated as 27.7%, 35.7% and 30% for VU, RU1 and RU2 respectively. There was no significant difference between mortality in VU and RU1 ($P = 0.44$, Z-test) or VU and RU2 ($P = 0.68$, Z-test) or the two referral units ($P = 0.72$, Z-test).

The rates of on-table death based on referring unit were also assessed as 11.1% for patients originating the VU, 28.6% for patients originating in RU1 and 10% for patients originating in RU2. There was no statistical difference in proportion of on-table deaths between VU and RU1 ($P = 0.19$, Z-test), VU and RU2 ($P = 0.66$, Z-test) or the two referral units ($P = 0.12$, Z-test).

Table 3 Variation in estimated blood loss and operative time by originating unit

	Place of presentation			<i>P</i> *
	Vascular unit	Referral unit 1	Referral unit 2	
Estimated blood loss (<i>ml</i>)	3200	1350	4000	0.150
Median and interquartile range	1700–5000	900–1875	1300–5000	
Operation time (minutes)	164	157.5	190	0.051
Median and interquartile range	138.0–192.0	133.0–185.5	162.0–247.0	

Analysis of complications

The in-hospital complication rate (Fig 1) for patients presenting directly to VU was 35.9%. This was significantly lower than the complication rate of 78.6% for RU1 ($P = 0.006$, Z-test) and 70.0% for RU2 ($P = 0.02$, Z-test). There was no statistical difference between the referral units ($P = 0.58$, Z-test). Multiple complications affected five patients from the VU, two patients from RU1 and four from RU2. There was no statistical difference in these rates between units. There was no relationship between originating unit and category of complication.

Ischaemic colitis was the most common complication requiring surgical intervention, occurring in eight cases (8.3% VU, 7.1% RU1 and 20% RU2). Lower-limb embolism was the most common extremity complication (2.8% VU, 7.1% RU1 and 15% RU2). Complications directly related to the procedure varied widely from wound dehiscence to re-look laparotomy

for bleeding to hysterectomy, but each was uncommon occurring in only one or two cases.

Acute kidney injury was the most common systemic complication, occurring in 32 cases (36.1% VU, 57.1% RU1 and 55% RU2) with pneumonia and *Clostridium difficile* infection being the second most common (three cases of each). No episodes of acute coronary syndrome were documented in the electronic discharge summaries (Table 4).

Discussion

This study has demonstrated that, in our network, there is no difference in rates of 30-day mortality based on originating unit. There is a higher rate of postoperative morbidity seen in patients transferred from outside units. Notably, many of these problems require surgical intervention.

Much of the literature focuses on time to transfer, as the length of time spent in secondary care prior to definitive intervention is critical. Patients often experience significant delays at the referral unit waiting for imaging and then for the transfer vehicle, leading to both increased mortality and morbidity. We must also consider that patients treated initially in a referral unit may be managed differently from those presenting directly to the vascular unit. Principles such as those of permissive hypotension may be suboptimally applied in a unit with less experience than a vascular centre and this may also affect patient outcomes. Management during transfer is also of significance. These were not factors we set out to assess with this study.

Trial by ambulance transfer as an indicator of fitness for surgery is well established and transfer to a vascular unit is generally accepted not to impact on mortality.¹ There is a growing body of evidence however, which points towards an increase in complications in patients who undergo interfacility transfer in the setting of RAAA. Work from the United States has demonstrated increased length of stay and resource use in patients who are transferred.¹ This literature base includes transfers of up to 100 miles, a distance not relevant to UK practice. Given the relatively smaller distances involved, it is interesting that our data reflects the increased burden seen in transferred patients.

A RAAA leads to profound hypotension. Current practice advocates the use of permissive hypotension in this setting, but more recent evidence from the IMPROVE trial has

Figure 1 Key outcome measures for ruptured abdominal aortic aneurysm surgery by originating unit

Table 4 Summary of in-hospital complications affecting patients undergoing surgery for ruptured aortic aneurysm and their frequency by source of referral			
Complication	Place of presentation n (percentage of cohort)		
	Vascular unit	Referral unit 1	Referral unit 2
<i>Procedure-related complications</i>			
Wound dehiscence	1 (2.8)	0	0
Re-look laparotomy for bleeding	1 (2.8)	1 (7.1)	0
Nephrectomy	1 (2.8)	0	1 (5)
Intra-abdominal hypertension	1 (2.8)	0	1 (5)
Aortocaval fistula	0	0	1 (5)
Hysterectomy	0	0	1 (5)
<i>Gastrointestinal complications</i>			
Ischaemic colitis (operated)	3 (8.3)	1 (7.1)	4 (20)
Gallbladder ischaemia	0	0	1 (5)
<i>Other intra-abdominal complications</i>			
Renal infarction	0	0	1 (5)
<i>Lower-limb extremity complications</i>			
Embolism	1 (2.8)	1 (7.1)	3 (15)
Compartment syndrome	0	0	1 (5)
<i>Systemic complications</i>			
Pneumonia	2 (5.5)	1 (7.1)	0
Pulmonary embolus	0	0	1 (5)
Acute kidney injury	13 (36.1)	8 (57.1)	11 (55)
<i>Clostridium difficile</i> infection	2 (5.5)	1 (7.1)	0
Paraplegia	1 (2.8)	0	0

suggested that our current targets for systolic blood pressure may be too low.⁵ It has been suggested by other trials that patients with preoperative hypotension are in fact less likely to survive.⁵

This study has several limitations. It focuses on operative outcomes and excludes patients who are transferred to the vascular unit who do not undergo an operation after being assessed by a vascular specialist. Owing to the retrospective nature of the study, there is bias inherent in the assessment of clinical information. We recognise that this study has used small numbers of patients, despite reflecting the activity of a single large tertiary vascular unit. Caution should therefore be applied in the interpretation of these results and larger numbers of patients would be required to improve statistical reliability.

This study has demonstrated that there is no difference in mortality regardless of originating unit, but there is significant variation in morbidity. Given the improvement in mortality for elective AAA repair over recent years,² our focus

should now move towards improving morbidity and mortality for RAAAs.

This is a difficult area to assess, owing to the interplay of many factors, including delay in initial presentation, delay in diagnosis, resuscitation and management at the originating unit, time for transfer and time to assessment and theatre at the vascular unit. Further challenges remain in the identification and development of a proactive surveillance strategy in the postoperative period. This was designed as an exploratory study and as such was not intended to tease out this complex relationship. The next step should be a prospective multicentre study with accurate documentation of time intervals between key steps in the pathway, matched with haemodynamic data and outcomes.

Conclusion

Patients who are transferred to our vascular unit for treatment of a ruptured AAA are at higher risk of complications

than those who present directly to the vascular unit. Operative mortality is not related to site of presentation.

Acknowledgements

Data from this project were presented at the Association of Surgeons in Training Conference in Glasgow, 2015 and received the Rouleaux Club prize for best poster presentation in vascular surgery. Data was also presented as a short paper as the 50th Golden Anniversary Congress of the European Society for Surgical Research in Liverpool, 2015.

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