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Outcome of surgery for type A aortic dissection – Twenty year evolution of a single surgeon practice

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Abstract

Background: This study investigated type A aortic dissection repair outcomes in a single surgical practice focusing on surgical, perfusion and anaesthetic techniques.

Methods: Prospectively collected Type A dissection surgery data over a twenty year single surgeon practice analysed. Operations grouped into ten year eras (A and B). Risk calculated using Euro score, Parsonnet and a validated Aortic system.

Results: Ten year study eras included 47 and 45 patients respectively. Era A patients were more likely (91%) to present with good, and era B (35%) moderate, left ventricular function. Incidence of arch replacement, composite root replacement and interposition graft was comparable. Circulatory arrest became less common (91% vs. 82%; p=0.13). Circulatory arrest, CPB and AXC times remained constant. Perfusion strategy shifted from femoral cannulation (89% vs. 24%; p<0.01). Overall mortality was 13% and improved with time (17% vs. 9%; p=0.36). Composite end point of freedom of death, neurological injury and reoperation for bleeding remained similar (66% vs. 69%;p=0.36). Renal complications, tracheostomy, ICU and hospital stay did not alter.

Conclusion: Over twenty years in-hospital mortality dropped by almost 50%. Small sample size hindered statistical evidence. Increased valve conservation, reduced incidence of composite root replacement, circulatory arrest and reoperation for bleeding are encouraging.

Introduction

The clinical setting of Acute Aortic Dissection (AAD) is one of an uncommon and high risk emergency. The incidence worldwide is estimated to be 0.5 to 2.95 per 100,000 per year [1]. Butler et al commented over twenty years ago that increased awareness of acute aortic dissection is necessary to achieve early diagnosis, allowing definitive investigation and surgical repair within the first 24 hours' [2]. Historically untreated patients suffer a mortality rate of 1-2% per hour immediately after symptom onset, [3,4]. but reassuringly, early identification and timely surgery in AAD of the ascending aorta has been shown to be beneficial in this highly lethal condition by reducing early mortality from 55.9% to 26.6% [5]. Survival rates are 52-94% at one year and 45-85% at 5 years in type A patients [6].

Due to the nature of the disease, research in the form of randomised studies has proven difficult. It is now recognised that large registries such as the International Registry of Acute Aortic Dissection (IRAD)[5] and the German Registry for Acute Aortic

Dissection Type A (GERAADA) [7] offer the best prospect of providing information to guide treatment. Nevertheless, there is little information relating to outcomes within the practice of a single surgeon. Evidence exists in both General Surgery and Vascular Surgery that surgical experience does improve long term results [8,9].

Some of the best published results have been achieved by the application of some of the simplest surgical principles [10,11]. In the UK, individual surgeons are likely to have limited first operator experience when starting their independent consultant level practice. Evidence exists to suggest that the higher the annual hospital thoracic aortic surgery volume the better the outcome [12]. Surgery for Type A aortic dissection has been described as 'conceptually simple but practically demanding' [13].

The goals of Type A AAD surgery are to save life by prevention of pericardial tamponade/rupture, to resect the primary entry tear, to correct or prevent any malperfusion and aortic valve regurgitation, and if possible to prevent late dissection-related complications in the proximal and downstream aorta [13].

To date the evidence suggests that surgical (30 day) and long term survival of aortic dissection patients has improved over time [14]. Those centres treating 19 or more cases of Type A dissection per year in the UK have achieved better outcomes, whilst measures such as the development and implementation of a multi-disciplinary team approach at specialised centres have been shown to have the potential to reduce operative mortality rates from 33.9% to 2.8% and improve 5 year survival rates from 55% to 85% ($p<0.01$) [15]. Naturally this has led to efforts to standardize and centralise care of these patients and reinforces the view that although surgical skill is important in relation to outcome the team approach and overall experience of a centre may be the dominant factors.

Other positive steps in surgical approach include the preferential use of an antegrade (right axillary or direct aortic cannulation) perfusion strategy to the true lumen over retrograde (femoral artery) during cardiopulmonary bypass. The right axillary approach is safe, with a low stroke rate (11%) and high midterm survival (73±5% at 1 year; 64±6% at 3 years) [16] Antegrade perfusion improves survival at 10 years (71% vs. 51%; $p<0.05$) whilst conversely retrograde perfusion has been shown to be an independent risk factor for late mortality in multivariate analysis ($p<0.01$) [17]. Ascending aortic cannulation is a safe alternative to femoral improving 30 day mortality rate (14% vs. 23%; $p=0.07$) and offers acceptable long term outcomes [18].

The development of effective surgical glues and pharmacologic therapies, such as recombinant activated factor VIIa [19,20] and aprotinin [21] in concert with thromboelastography targeted therapy have reduced bleeding complications.

The wider management of these patients has also improved, particularly the understanding of cerebral perfusion techniques. Antegrade cerebral perfusion appears to offer the best strategy. In a study comparing the use of Deep Hypothermic Circulatory Arrest (DHCA) at 18^{o}C supported by either retrograde (RCP) or Antegrade Cerebral perfusion (ACP) at 25^{o}C 30 day mortality was lowest in the ACP group (DHCA alone 26% vs. RCP 16% vs. ACP 13%; $p<0.05$), as was permanent neurologic dysfunction (DHCA alone 23% vs. RCP 12% vs. ACP 12%; $p<0.05$) [22].

Newer anaesthetic techniques have included using perioperative transoesophageal echocardiography, monitoring perfusion and aortic valve function and managing deep hypothermic circulatory arrest and pharmacologic adjuncts to neuroprotection [11].

There would therefore seem to be ample reason to hypothesise that the surgical treatment of patients with type A dissection has improved.

The principal aim of this observational study was to examine whether increased operator experience and evolution of surgical techniques in association with improvements in perfusion and perioperative care have improved clinical outcomes in the management of Type A AAD patients over a twenty year career of one surgeon with an increasing portfolio of aortic surgery. The authors acknowledge that the single surgeon model may be considered outdated by some and within our centre the transition to a multi-disciplinary approach to the management of Type A aortic dissection has now been fully implemented. However the change in approach has been relatively recent and merit in the investigation of the single surgeon model remains useful when reviewing practice over a 20 year period.

Materials and methods

Consecutive patients undergoing treatment for Type A aortic dissection by a single surgeon at the Bristol Heart Institute during the period from 12th July 1993 to 11th July 2013 were included. To analyse changes in outcome the experience was divided into two equal 10 year eras: 12th July 1993 to 11th July 2003 (study era A) and 12th July 2003 to 11th July 2013 (study era B).

Demographics, preoperative, intraoperative and postoperative data for procedures before April 1996 were abstracted from the operation notes. From April 1996 data was collected prospectively on all patients undergoing cardiac surgery and entered into a database (Patient Analysis and Tracking System (Dendrite Clinical Systems Inc, London, UK)), deaths after hospital discharge were identified from mortality data provided by the National Health Service Strategic Tracing Service. All patients were successfully matched to the National Health Service Strategic Tracing Service database.

The validated and specialised aortic score devised by Mehta et al. [23] was used to assess risk in addition to both standard Parsonnet and Euroscore systems. These two systems were used consistently throughout the time period.

Arch replacement was defined as operations requiring two or more distal anastomoses, one to the distal aorta and one to one or more aortic arch branches. Thus, if the under surface of the aortic arch was replaced (hemi-arch) with a single distal anastomosis, it was considered to be an ascending aortic operation only. Renal complications included need for frusemide infusion, renal impairment requiring haemofiltration or dialysis. Definitions with respect to operative priority, premorbid conditions and postoperative complications are those defined by the National Adult Cardiac Surgical Database and accepted by the Society for Cardiothoracic Surgeons in Great Britain and Ireland (available at www.scts.org).

The mainstay of surgical treatment was interposition graft replacement of the ascending aorta with valve conservation where possible, but composite root replacement was performed for connective tissue disorders or patients with dilatation or extensive dissection within the sinuses of Valsalva.

During the study period, a range of approaches and developments occurred continually, often without being adopted at a single time point. With respect to the surgical techniques in the second era, more effective biological glues (Bioglue; Cryolife Europa Ltd, Guildford, UK) replaced the Gelatin-Resorcin-Formulin (GRF), and aggressive resection of the primary intimal tear with the use of an open distal anastomotic technique has become routine. The tear in the ascending aorta was replaced to the level of the innominate artery. Spiral tears extending along the under surface of the arch were treated with a bevelled distal anastomosis (hemiarch replacements). In study era B, more resections were performed with a hemiarch replacement. Complete aortic arch replacement was performed only for tears within the aortic arch.

From a perfusion perspective, routine femoral artery cannulation throughout was superseded by the adoption of antegrade reperfusion on completion of the anastomosis via the side arm of the Ante-Flo (Gelweave; Vascutek ltd, Renfrewshire) graft conduit, and more recently axillary artery cannulation has been predominantly used. The right axillary artery was preferentially used unless there was haemodynamic instability, right upper limb malperfusion, tamponade or previous surgery in the axilla.

Additional cerebral protection during deep hypothermic circulatory arrest (cooling to 18^{o}C) has changed from widespread use of retrograde cerebral perfusion to circulatory arrest alone to the use of antegrade cerebral perfusion via the axillary artery (separate line 10ml/kg/min) or endoluminally (left and/or right carotid artery).

With respect to anaesthetic techniques, intraoperative transoesophageal echocardiography has been routine in study era B. Aprotinin was used throughout the study period until it was withdrawn, and cell savers were used more commonly, latterly. Only toward the end of study era B was recombinant factor VIIa used to achieve haemostasis in problematic cases. Thromboelastography has been used exclusively in the latter half (study era B) to guide appropriate use of other blood products.

Data was analysed with statistical package (SPSS 15.0, Chicago, Ill). Categoric or ordinal data were compared by using $\chi 2$ tests or Kendall tau b, respectively. Continuous data are presented as mean±standard deviation. Normally distributed data were compared using independent two-sided t tests. Skewed data were either logarithmically transformed or analysed nonparametrically (Mann-Whitney U test).

Results

A total of 92 consecutive patients were included over a 20 year period. In the former 10 year period (12th July 1993 to 11th July 2003; study era A) there was 47 patients and in the latter period (12th July 2003 to 11th July 2013; study era B) 45 patients were included.

Both study eras were comparable for baseline demographics. (Table 1) Difference was noted in the percentage of patients with good, moderate and poor left ventricular function; proportionally fewer patients had good function in the latter era. There were matched number of patients with the Marfan syndrome in both era (13% vs. 0%; p=0.17).

Details of the surgical procedure are summarized (Table 2). Similar numbers of patients underwent arch replacement, composite root replacement and interposition graft over the two eras. There was a suggestion less patients underwent circulatory arrest in the second era (91% vs. 82%; p=0.13) however the time on circulatory arrest of those who received it was comparable between the groups. The CPB and AXC times remained static. There was no difference in the rate of concomitant procedures (mitral valve/coronary surgery). In the second era perfusion strategy shifted away from femoral cannulation (89% vs. 24%; p<0.01).

There were a total of 12 in-hospital deaths over the twenty year period (13%) and mortality was lower but did not reach statistical significance in the second era (17% vs. 9%; p=0.36), (Table 3) but the composite endpoint of freedom of death, neurological injury and reoperation for bleeding remained similar (66% vs. 69%; p=0.36). Renal complication and tracheostomy incidence along with length of ICU and hospital stay did not alter.

Discussion

This study has shown that in a single surgeon practice, over a twenty year period in hospital mortality reduced from 17% to 9% following Type A dissection repair. Taken in an international context the twenty year mortality of 13% is significantly lower than the real world data published in IRAD of 25.1% [24].

Although the results do not match the best published results, [10,11] caution has been advised when considering small single surgeon series' with low mortalities in providing a likely potential outcome for a patient with type A dissection [25]. Studies collecting outcome from large numbers of patients as registry data, such as IRAD, probably reflect more accurately potential outcome.

The data from this study suggests that the hypothesis that increasing surgical experience improves patient outcome over his/her career is a realistic one. The purported benefit of technological advances in anaesthetic, surgical and perfusion techniques have not been individually analysed to assess impact on outcome in this investigation and we recommend this to be the focus of future research. As these factors have been implemented at differing times and in piecemeal fashion this adds to the challenge of assigning individual benefit in outcome. This evidence adds substance to the arguments presented by the proponents of specialised centres housing expert aortic surgeons to deliver prompt care, in large volumes to those presenting for emergency type A dissection repair. At present centralised care of thoracic aortic surgical patients is patchy and inconsistently delivered within the UK.

In a twenty year career of ninety-two consecutive patients an in-hospital mortality of 13% was achieved, better than those in large series' reported in the literature. It is important to be mindful though of the nature and devastating presentations of this condition and the end-organ ischaemia that results from cerebral, visceral or coronary malperfusion. The surgical community must continue to strive to further improve outcomes.

As this study is limited by its small size, observational approach, risk of publication bias and confounding factors such as the effects of time and improvements in anaesthesia and perioperative care it becomes difficult to ascertain the effects of improvements attributable to surgeon expertise and technical advances. The real strengths lie in its use of prospectively collected data and focus on a single surgeon experience over a prolonged period.

In summary this study has demonstrated that over a 20 year period a surgeon can develop significant measurable expertise, in combination with technological progress in anaesthesia, surgical techniques and perfusion strategy, to reduce observed mortality rates by 50%. There was no observed improvement in neurological events but conservation of the aortic valve, reduction in need for both composite root replacement and circulatory arrest along with a decline in reoperation for bleeding are encouraging signs of significant progress in the management of this condition. Statistically convincing evidence of improvements in outcome have been hampered by the relatively small sample size. Outcomes in the current era conform to contemporary standards.

Tables

Table 1: Baseline demographics

Study era	A	B	p
Number of patients (n=; %)	47(51)	45(49)	-
Age (mean±SD) (years)	58.0±15.1	61.2±13.9	0.39
Mehta Score (mean±SD)	2.6±1.3	2.2±1.0	0.75
Mehta Score (median(IQR1-IQR3))	2.8(1.6-3.7)	2.3(1.5-2.8)	0.75
Age >70yrs (n=; %)	14(30)	12(27)	0.82
Female sex (n=; %)	13(28)	16(36)	0.5
Abrupt onset pain on presentation (n=; %)	37(79)	38(84)	0.97
Abnormal ECG on presentation (n=; %)	21(47)	23(51)	0.83
Any pulse deficit on presentation (n=; %)	12(26)	9(20)	0.46
Kidney failure preop (n=; %)	16(34)	10(22)	0.27
Hypotension/shock/tamponade on presentation (n=; %)	17(36)	12(27)	0.26
Parsonnet Score (mean±SD)	28.9±8.8	28.0±15.0	0.39
Parsonnet Score (median(IQR1-IQR3))	30(23.5-31.8)	24(23-28)	0.39
Euroscore (mean±SD)	9.3±2.7	10.4±2.8	0.14
Euroscore (median(IQR1-IQR3))	9(7-11)	10(8-12)	0.14
Marfan syndrome (n=; %)	6(13)	0(0)	0.17
Hypertension (n=; %)	22(47)	22(49)	0.52
Peripheral vascular disease (n=; %)	6(13)	3(7)	0.73
LV function - good (n=; %)	43(91)	4(8)	
- moderate (n=; %)	3(6)	16(35)	-
- poor (n=; %)	1(2)	2(4)	
Redo (n=; %)	2(4)	5(11)	0.23

Table 2: Operative data

Study era	A	B	p
Number of patients (n=; %)	47(51)	45(49)	-
Arch replacement (n=; %)	6(13)	7(16)	0.54
Composite root replacement (n=; %)	16(34)	10(22)	0.26
Interposition graft (n=; %)	28(60)	36(80)	0.42
AVR - 0=N (n=; %)	13(28)	27(60)	
- 1=Y (n=; %)	17(36)	7(16)	-
- 2=S (n=; %)	17(36)	3(7)	
Circulatory arrest (n=; %)	43(91)	37(82)	0.13
Circulatory arrest time (mins) (mean±SD)	35±11	45±46	0.14

CPB time (mins) (mean±SD)	167±46	182±42	0.32
AXC time (mins) (mean±SD)	91±38	100±39	0.25
Mitral valve surgery (n=; %)	1(2)	0(0)	1.00
CABG (n=; %)	7(15)	7(16)	0.59
Number of grafts (mean±SD)	0.3±0.7	0.3±0.7	0.55
Femoral cannulation (n=; %)	42(89)	11(24)	<0.01

Table 3: In-hospital outcomes

Study era	A	B	p
Number of patients (n=; %)	47(51)	45(49)	-
In-hospital death (n=; %)	8(17)	4(9)	0.36
New neurological events - transient (n=; %)	2(4)	0(0)	0.29
- permanent (n=; %)	4(9)	6(13)	
Reoperation for bleeding (n=; %)	5(11)	4(9)	1.00
Renal complications (n=; %)	2(4)	3(7)	0.36
Tracheostomy (n=; %)	4(9)	6(13)	0.15
ICU stay (median(IQR 1 - IQR3))	3(2-5)	4(2-5)	0.64
Hospital stay (median(IQR 1 - IQR3))	12(9-16)	14(8-20)	0.76
Composite endpoint (freedom death/neuro injury /reop bleed) (n=; %)	31(66)	31(69)	0.36

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