ORIGINAL ARTICLE

Early complications in ascending aortic aneurysm surgery: a single centre experience of 81 patients

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ABSTRACT

Aim: To investigate major in-hospital complications of ascending aorta reconstruction and to identify factors associated with these complications.

Methods All consecutive patients admitted to our clinic for aortic aneurysm repair from June 2005 to June 2009 were enrolled in this retrospective study. Demographic data, details of the surgical procedures and major in-hospital complications were assessed and recorded from the institutional electronic database. Patients were divided into two groups according to the development of major in-hospital complications.

Results The New York Heart Association (NYHA) Class of patients with major in-hospital complications was higher than those without complications. In addition, the number of patients with coronary artery disease (CAD), diabetes, chronic renal disease (CRD), chronic obstructive pulmonary disease (COPD), and previous cardiac surgery was significantly higher in those with major in-hospital complications. Moreover, the requirement for inotropic agents and intra-aortic balloon pump was higher in these patients. Cross-clamp time was significantly higher in patients with major in-hospital complications (107±34 vs. 79±26 ($p<0.001$). Presence of CRD ($r=0.308$; $p=0.005$) and CAD ($r=0.244$; $p=0.028$), previous cardiac surgery ($r=0.266$; $p=0.022$), cross-clamp time ($r=0.349$; $p=0.001$) and IABP requirement ($r=0.308$; $p=0.005$) were significantly correlated with the development of major in-hospital complications.

Conclusion Our results show that presence of underlying CRD and CAD, previous cardiac surgery, length of cross-clamp time and IABP requirement were significantly associated with the development of in-hospital complications in patients undergoing surgical reconstruction for ascending aortic aneurysm.

Key-words: ascending aortic aneurysm, complications, mortality, surgery

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INTRODUCTION

Along with the increase in the aging population the prevalence of thoracic aortic aneurysm (TAA) has increased over the last 3 decades. The actual incidence of TAA is estimated at around 3–4% in individuals over 65 years of age (1). Although aneurysms of the thoracic aorta are generally silent, occasionally they present with catastrophic complications such as dissection or rupture, both occurring at an incidence of approximately 3.5 in 100.000 (2). Therefore, appropriate timing for elective reconstruction of the ascending aorta is of paramount importance to prevent the risk of dissection or rupture by repairing the thoracic aorta (3).

Ascending aortic aneurysms constitute the majority of TAAs. Once the aortic damage is considered to necessitate treatment, there are many alternatives for repair with both complete surgical methods and newer hybrid approaches employing the use of endovascular techniques (4). However surgical reconstruction is still widely employed in the treatment of ascending aortic aneurysms as a consequence of overall experience gained over the years with these techniques. Valve-sparing approaches in the repair of the aortic root, including remodelling of the aortic root or reimplantation of the aortic valve are generally performed in ascending aortic aneurysms without aortic valve involvement, whereas the Bentall procedure is employed when the aortic valve needs to be replaced in addition to the aortic root (5,6). Other methods such as the hemi-arch technique, arch island technique (en bloc), conventional elephant trunk procedure, arch-first technique have also been used in the reconstruction of aortic arch (7-10).

Despite increasing experience and recent advances in the surgical reconstruction of the ascending aorta, early mortality is still reported at 6% and in-hospital complications are seen in 9% of patients undergoing these procedures (11,12). Therefore, identifying risk factors which are associated with early mortality and major in-hospital complications is crucial to improve survival and prevent morbidities in patients undergoing surgery for ascending aortic aneurysms.

The present study aimed to investigate major in-hospital complications and to identify the factors associated with these complications in patients undergoing ascending aorta reconstruction surgery.

PATIENTS AND METHODS

Patients and study design

All consecutive patients admitted to the Clinic of Cardiovascular Surgery, Ankara University Faculty of Medicine, Ankara, Turkey, for aortic aneurysm repair between June 2005 and June 2009 were evaluated retrospectively. Patients with acute aortic dissection and those with size reduction surgery or sole reconstruction of the non-coronary sinus in addition to replacement of the ascending aorta were excluded. Demographic data, details of the surgical procedures and in-hospital complications were assessed and recorded from the institutional electronic database. In-hospital complications were classified as follows: cerebrovascular events including transient ischemic attacks, ischemic and haemorrhagic stroke, acute renal failure (50% increase in postoperative creatinine levels), septicemia and need for revision surgery, and death. Patients were divided into two groups according to the development of in-hospital complications: Group 1 consisted of patients developing in-hospital complications and group 2 consisted of patients without in-hospital complications.

A written informed consent was obtained from all patients. The study was conducted in accordance with the ethical principles for human investigations as outlined by the Declaration of Helsinki.

Methods

Indication for ascending aortic replacement was identified as a diameter of ≥5.5 cm, and ≥5 cm for accompanying Marfan syndrome and bicuspid aortic valves. A standardized anaesthesia protocol was applied to all patients and 0.03 mg/kg of midazolam was administered intravenously for premedication. General anaesthesia was induced with intravenous propofol 2 mg/kg, fentanyl 1mg/kg and 0.8 mg/kg rocuronium and was then maintained with 2–3% sevoflurane. Ventilation was performed in a volume-controlled mode at a tidal volume of 7–9 mL/kg, FiO2 being 60%. Following internal jugular vein catheterization, 500 mg methylprednisolone was administered. Perfusion was maintained with an activated clotting time (ACT) of 400 to 600 seconds. In patients in whom total circulatory arrest (TCA) was not applied rectal temperature was decreased to 28 to 32 °C. Body temperature was decreased to

25 °C in patients receiving anterior cerebral perfusion and to 18-20°C degrees in those receiving TCA. At the end of TCA, antegrade body perfusion was initiated with cerebral perfusion pressure (CPP) being 15 mmHg.

In brief, all patients were operated through a median sternotomy and four different surgical techniques were applied to patients: Bentall Procedure in 51 patients, isolated interpositioning graft in 22 patients, ascending aorta and arcus replacement in 5 patients, and ascending aorta hemiarch replacement in 3 patients. All patients scheduled for surgery were initially evaluated by a heart evaluation team consisting of an experienced anaesthetist, cardiologist, and cardiovascular surgeon. The final decision on which technique was to be used was made intraoperatively by the surgeon after inspection of the aortic valve and root.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD), discrete variables as median (range) and categorical variables as number (n) and percentage (%). The Kolmogorov-Smirnov test was used to assess the distribution of data. For group comparisons, student t-test was used, while $\chi 2$ test was used to compare categorical variables. Pearson and Spearman correlation analyses were performed to identify the variables significantly associated with major in-hospital complications. $p<0.05$ was accepted as statistically significant.

RESULTS

A total of 81 patients (mean age 56±12, 46 male) were eligible for enrolment into the study. Major in-hospital complications developed in 37 (46%) patients including neurological complications (7.4%), acute renal failure (7.4%), septicemia (10%) and bleeding/tamponade (10%). Nine patients (11%) died during in-hospital follow-up.

The two groups were similar with respect to age, gender, and pre-existing Marfan syndrome, hypertension, diabetes, and atrial fibrillation. However, the New York Heart Association (NYHA) class of patients with major in-hospital complications were higher than that of those without complications. In addition, the number of patients with coronary artery disease, diabetes, chronic renal disease (CRD), chronic obstructive pulmonary disease (COPD), and previous cardiac surgery was significantly higher in those with major in-hospital complications (Table 1).

Table 1. Patient characteristics and risk profile

Variable	No (%) of patients		p
	IHMC (-) (n=44)	IHMC (+) (n=37)	
Gender, males	26 (59)	20 (54)	0.649
NYHA Class			
I	32 (73)	23 (62)	0.236
II	7 (16)	4 (11)	0.746
III	2 (5)	9 (24)	0.005
IV	0	4 (11)	0.025
Marfan syndrome	2 (5)	1 (3)	0.662
CAD	18 (41)	27 (73)	0.004
Hypertension	36 (81)	30 (81)	0.972
Diabetes	16 (36)	12 (32)	0.562
CRD	1 (2)	5 (14)	0.006
COPD	6 (14)	14 (38)	0.012
AF	5 (11)	4 (11)	0.937
Previous cardiac surgery	9 (20)	19 (51)	0.004

IHMC, in-hospital major complication; NYHA, New York Heart Association Class; CAD, coronary artery disease; CRD, chronic renal disease; COPD, chronic obstructive pulmonary disease; AF, atrial fibrillation

There were no significant relationships between the type of procedure performed and in-hospital complications. However, in-hospital complications were more frequent in patients receiving deep hypothermic total circulatory arrest (DHTCA). Moreover, the requirement for inotropic agents and intraaortic balloon pump was higher in these patients. Cross-clamp time was also significantly higher in patients with in-hospital complications (107±34 vs. 79±26; $p < 0.001$ (Table 2).

Table 2. Intraoperative and postoperative characteristics

Variable	No (%) of patients		p
	IHMC (-) (n=44)	IHMC (+) (n=37)	
Bentall	27 (61)	24 (65)	0.212
Isolated graft interpositioning	13 (29)	9 (24)	0.883
AA and arcus replacement	3 (7)	2 (5)	0.792
AA and hemiarch replacement	1 (2)	2 (5)	0.457
Combined CABG	6 (14)	7 (16)	0.652
Cross-clamp (mean±SD, minutes)	79 ± 26	107±34	0.001
TCA	8 (18)	14 (38)	0.048
Inotropic agent requirement	13 (30)	27 (61)	0.001
IABP requirement	1 (2)	5 (14)	0.048

IHMC, In-hospital major complications; AA, ascending aorta; CABG, coronary artery bypass grafting; TCA, total circulatory arrest; IABP, intra-aortic balloon pump;

As shown in Table 3, correlation analysis revealed that the presence of underlying CRD (r=0.308; p=0.005), CAD (r=0.244; p=0.028) and previous cardiac surgery (r=0.266; p=0.022), Cross-clamp time (r=0.349; p=0.001) and IABP

requirement (r=0.308; p=0.005) was significantly correlated with the development of major in-hospital complications.

Table 3. Correlation between in-hospital major complications and selected variables

	In-hospital major complications	
	r	p
NYHA class	0.008	0.940
Chronic renal disease	0.308	0.005
Coronary artery disease	0.244	0.028
COPD	0.111	0.326
Previous cardiac surgery	0.266	0.022
Cross-clamp time	0.349	0.001
Inotropic requirement	0.097	0.388
IABP requirement	0.308	0.005

NYHA, New York Heart Association Class; COPD, chronic obstructive pulmonary disease; IABP, intra-aortic balloon pump;

DISCUSSION

The present study aimed to investigate the rate of in-hospital complications in patients undergoing surgical reconstruction for ascending aortic aneurysm and demonstrated a high frequency of early complications and death in this population. Moreover, this study also revealed that the presence of underlying CRD, CAD and previous cardiac surgery, length of cross-clamp time and IABP requirement were significantly associated with the development of major in-hospital complications.

Thoracic aortic aneurysms are a cause of significant mortality and morbidity due to the potential risks of dissection and rupture (13). Therefore, elective reconstruction is recommended when the aortic diameter exceeds 5.5 cm (5 cm for those with Marfan syndrome and bicuspid aortic valve) (14). Despite the advances in endovascular interventions and hybrid techniques, complete surgical repair is still popular as a consequence of the experience in these surgeries that have favourable short-and long-term survival, especially when performed by experienced surgeons (15-17). In addition to valve-sparing aortic root repair techniques such as the David procedure, the Bentall procedure, in which both the valve and aortic root are replaced together with a composite aortic graft, may be the treatment of choice when aortic valve disease accompanies aortic dilatation (1). Unfortunately, aortic repair carries a significant risk of morbidity and mortality due to the complex nature of these procedures (18,19).

In a meta-analysis of 48 studies, Mookhoek et al. reported that pooled early mortality was 6% in individuals undergoing the Bentall procedure, and there was no trend toward reduced operative mortality in recent years (11). In a recent trial conducted in 890 patients, Gaudino et al. found that operative mortality was 0.2% and the incidence of major postoperative complications was less than 0.5%, indicating that aortic root replacement is associated with fewer postoperative major adverse events compared to the Bentall procedure (20). In a previous study investigating the survival of patients who had undergone elective reconstruction of the ascending aorta for degenerative aneurysms, the authors reported a 30-day mortality of 9.7%, which was significantly associated with the presence of COPD and poor functional class (1). A previous study considering the postoperative complications after ascending aortic aneurysm surgery reported a stroke prevalence of 7.8%, acute renal failure prevalence of 14.6%, bleeding/tamponade of 14.6% and in-hospital mortality of 15.6% in patients undergoing aortic root replacement in a major cardiac surgical centre (21).

In our study, the majority of the operations performed were Bentall procedures and consequently, the mortality rate was somewhat higher than that of the previous studies. However, the prevalence of major in-hospital complications was similar to previous reports. Our results also demonstrate that the presence of underlying CRD, CAD and previous cardiac surgery, length of cross-clamp time and IABP requirement were associated with the development of in-hospital complications. These findings are consistent with the results of previous studies (22, 23). Nevertheless, contrary to previous results, we did not observe a significant correlation between complications and factors such as COPD and NYHA class, although both were significantly more frequent in patients experiencing complications. In addition, we also did not find any relationship between age and occurrence of in-hospital complications. This finding however, may be the result of small sample size and limited number of events.

Our findings may somewhat be limited by the retrospective design of the present study. Addi-

tionally, the sample size was relatively low and the data only present the experience from a single centre. Moreover, we could not provide laboratory and imaging data of the study population due to the insufficiency of our database. Nevertheless, we believe that our findings reflecting the experience of a single centre are valuable for defining factors which are potentially associated with major in-hospital complications in patients undergoing ascending aortic surgery.

In conclusion, our results show that presence of underlying CRD, CAD, previous cardiac surgery, length of cross-clamp time and IABP requirement are significantly associated with the development of in-hospital complications in patients undergoing surgical reconstruction for ascending aortic aneurysm. Care should be taken to prevent the development of complications in patients with these risk factors. Further studies with larger sample sizes are required to adequately address the relevant factors for major in-hospital complications in patients undergoing ascending aortic surgery.

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TRANSPARENCY DECLARATION

Conflicts of interest: None to declare.

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