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Surgical Complexity and Outcome of Patients Undergoing Re-do Aortic Valve Surgery

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ABSTRACT

Objectives Re-do aortic valve surgery carries a higher mortality and morbidity compared with first time aortic valve replacement (AVR) and often requires concomitant complex procedures. Transcatheter aortic valve replacement (TAVR) is an option for selective patients. The aim of this study is to present our experience with re-do aortic valve procedures and give an insight into the characteristics of these patients and their outcomes.

Methods Retrospective review of 80 consecutive re-do aortic valve procedures.

Results Mean patients' age was 51.80±18.73 years. Aortic regurgitation (AR) was present in 51 (65.4%) patients and aortic stenosis (AS) in 38 (48.7%). Indications for reoperation were: infective endocarditis (IE) (23.8%), bioprosthetic degeneration (12.5%), mechanical valve dysfunction (5%), paravalvular leak (6.2%), patient–prosthesis mismatch (3.8%), native valve disease (25%), aortic aneurysm, pseudoaneurysm and dissection (35%), aortic root/homograft degeneration (27.5%). Forty-one (51.2%) patients underwent re-do AVR, 39 (48.8%) re-do complex aortic valve surgery (28 root, 23 ascending aorta and 6 hemiarch procedures) and 37.5% concomitant procedures. A bioprosthesis was implanted in 43.8%, a mechanical valve in 37.5%, a composite graft in 2.5%, a Biovalsalva graft in 6.2% and a homograft in 10% of patients. In-hospital mortality was 3.8% and incidence of major complications was low.

Conclusions A significant proportion of patients were young (61%<60 y), required complex aortic procedures (49%) or presented with contraindications for TAVR (mechanical valve, AR, IE, proximal aortic disease, need for concomitant surgery). Re-do aortic surgery remains the only treatment for such challenging cases and can be performed with acceptable mortality and morbidity in a specialised aortic centre.

Key questions

What is already known about this subject?

- Re-do patients requiring aortic valve surgery face higher operative risks compared with the first surgery. In this group of patients, a transcatheter aortic valve implantation may represent an attractive option.

What does this study add?

- Our experience shows that patients undergoing a second aortic valve operation often require extensive and complex surgical procedures and are not suitable for a transcatheter approach. We present our surgical experience and a range of surgical techniques which may help in such high-risk operations.

How might this impact on clinical practice?

- Conventional re-do aortic surgery remains the only treatment for such challenging cases and can be performed with acceptable mortality and morbidity in a specialised aortic centre with a dedicated aortic surgery team.

INTRODUCTION

Re-operations represent a significant proportion of modern cardiac surgery and are often associated with higher mortality and morbidity compared with first time operations.[1]

The largest contemporary series of aortic valve replacement (AVR) reoperations from the STS Adult Cardiac Surgery Database showed that re-do AVRs had higher mortality (4.66% vs 2.2%) and morbidity compared with first time AVR.[2] The RECORD multicentre study reported a mortality of 5.1% for re-do AVR across seven European institutions.[3] Furthermore, data from the Japan Adult Cardiovascular Surgery Database showed a 30-day and operative mortality rates of 5.5% and 8.5% in 2157 patients who underwent AVR for aortic stenosis after cardiovascular surgery or re-do AVR.[4]

Transcatheter aortic valve replacement (TAVR) and valve-in-valve (V-in-V) interventions are an option for high-risk patients requiring re-operation for aortic valve disease.[5] The PARTNER 2 V-in-V Registry showed a 30-day and 1-year all-cause mortality of 2.7% and 12.4% for V-in-V procedures.[6] A meta-analysis of five observational studies, comparing re-do AVR to V-in-V procedures, showed no difference in procedural and 30-day survival, but with a cumulative survival

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analysis and echocardiographic outcomes in favour of the surgical treatment.[7]

However, patients requiring re-do aortic valve surgery often involve more complex procedures than just repeat AVR, including aortic root surgery, treatment of native and prosthetic valve endocarditis, aneurysm and pseudoaneurysm of the proximal aorta. In these patients, complex re-do surgery remains the only possible treatment.

The aim of our study is to present our experience with re-do aortic valve surgery and to analyse the characteristics and clinical outcomes in this population of patients.

MATERIAL AND METHOD

Patients

This retrospective analysis of the data from a single surgeons practice and publication as a case note review was approved by the local National Health Service Research & Development office (case note study was registered with clinical audit ID: 5577).

Eighty consecutive patients underwent re-do surgery for aortic valve procedures, under the care of a single surgeon (MP) between April 2008 and March 2018, 32 operations were performed at the Royal Brompton Hospital, London between April 2008 and October 2011 and 48 at the John Radcliffe Hospital, Oxford between October 2011 and March 2018 Clinical, operative and early outcome data of all patients were collected from the hospital computerised database. All intraoperative details were confirmed by direct review of the surgeon's operative notes and all missing data from direct consultation of the patients' notes.

Data collection was closed on the 1 of March 2018.

We identified two groups: 41 (51.2%) patients who underwent re-do AVR and 39 (48.8%) who had re-do complex aortic valve surgery. We analysed the preoperatory characteristics, the intraoperatory findings and early outcomes in the entire group and in both of the subgroups.

Definitions and endpoints

Re-do complex aortic surgery: any re-do aortic surgery involving more than just AVR of native valve or re-replacement of the prosthetic aortic valve.

Aortic team: a dedicated team composed of experienced consultant aortic surgeon, aortic fellow, anaesthetist, surgical echospecialist, perfusionist, surgical care practitioner and scrub nurse. All members of the team are familiar with aortic procedures and re-do surgery and routinely work together.

The primary endpoint of this study was 30-day mortality rate. This includes any patient who died within the index period of hospitalisation, regardless of the length of hospital stay, as well as any patient who died after being discharged from hospital up to 30 days from the date of the operation.

Intraoperative adverse events were categorised as re-entry injuries (occurring during resternotomy and/or mobilisation of the intrapericardial adhesions), cardiopulmonary bypass (CPB)-related and technical surgical complications.[8]

Postoperative complications included stroke, cardiovascular reoperation irrespective of the reason, mechanical ventilation for more than 48 hours, renal failure and need of permanent pacemaker implant. Stroke was defined as a new neurological deficit persisting for more than 72 hours and/or confirmed by new radiological findings. Postoperative renal failure was defined as a patient requiring renal replacement therapy.

Statistical analysis

Analysis was conducted with SPSS software, V.16.0 for Windows (SPSS).[9] Statistical analyses were calculated by measuring the mean±SD for continuous variables, and frequencies were measured for categorical variables. Differences between groups were analysed by a paired t-test for continuous variables and X^2 test or Fisher's exact test, as appropriated, for categorical variables. A $p<0.05$ was considered significant.

RESULTS

Patients' characteristics

Mean age of the population was 51.80±18.73 years, 30% of the patients were younger than 40, 31.2% were between 40 and 60 years old, 35% between 60 and 80 and 3.8% older than 80 years.s

Eighteen (22.5%) patients were female, 8 (10%) had diagnosis of Marfan syndrome. Twenty-one (26.2%) patients were in class New York Heart Association III/IV and 17 (21.2%) required urgent surgery. Good left ventricular function was present in 54 (67.5%) patients, aortic regurgitation (AR) in 51 (65.4%) and aortic stenosis in 38 (48.7%). Logistic EuroSCORE II was 8.26±10.19. Sixty-four (80%) patients underwent first time re-do, 14 (17.5%) second time and 1 (1.2%) third time re-do. Mean interval between the last cardiac procedure and the reoperation was 11.39±10.54 years.

The preoperatory characteristics were similar between the patients who underwent re-do complex aortic procedures and re-do AVR. The patients in the re-do AVR group were more likely to have an elective procedure and an aortic valve stenosis. More urgent/emergency procedures and patients in cardiogenic shock were in the re-do complex group. The logistic EuroSCORE II was significantly higher in the re-do complex group (12% vs 5% $p<0.000$). Preoperative characteristics are reported in table 1.

Previous surgery

Thirty-eight (47.5%) patients had an isolated aortic valve procedure (12 valve repair and 26 AVR), 32 (40%) a complex aortic surgery (including 26 root procedures, 7 ascending aorta and 1 arch replacement) and 10 (12.5%) a non-aortic procedures (8 coronary artery bypass graft (CABG) and two mitral valve surgery) as previous operation.

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Table 1 Preoperative characteristics

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
Age	51.80±18.73	51.51±16.77	52.07±20.63	NS
<40	24 (30)	10 (55.6)	14 (34.1)	NS
40–60	25 (31.2)	16 (41)	9 (22)	NS
60–80	28 (35)	13 (33.3)	15 (36.6)	NS
>80	3 (3.8)	0 (0)	3 (7.3)	NS
Sex (F)	18 (22.5)	9 (23.1)	9 (22)	NS
Body surface area	1.87±0.27	1.90±0.21	1.84±0.33	NS
Urgent/emergency	17 (21.2)	13 (33.3)	4 (9.8)	0.010
Cardiogenic shock	7 (8.8)	7 (17.9)	0	0.005
NYHA III-IV	21 (26.2)	8 (20.5)	13 (31.7)	NS
Hypertension	37 (46.2)	17 (43.6)	20 (48.8)	NS
Diabetes mellitus	8 (10)	3 (7.7)	5 (12.2)	NS
Smoker	14 (17.5)	7 (17.9)	7 (17.1)	NS
Previous CVA	9 (11.2)	7 (17.9)	2 (4.9)	0.066
Previous MI	3 (3.8.)	2 (5.1)	1 (2.4)	NS
Arrhythmia	12 (15)	6 (15.4)	6 (14.6)	NS
Coronary artery disease	15 (18.8)	5 (12.8)	10 (24.4)	NS
Marfan syndrome	8 (10)	3 (7.7)	5 (12.2)	NS
Good LVEF	54 (67.5)	25 (64.1)	29 (70.7)	NS
Moderate LVEF	20 (25)	12 (30.8)	8 (19.5)	NS
Poor LVEF	6 (7.5)	2 (5.1)	4 (9.8)	NS
Aortic regurgitation	51 (65.4)	25 (65.8)	26 (65)	NS
Aortic stenosis	38 (48.7)	13 (34.2)	25 (62.5)	0.011
Logistic EuroSCORE II	8.26 10.19	11.97 13.15	4.82 4.18	0.000
I re-do	64 (80)	31 (79.5)	33 (80.5)	NS
II re-do	14 (17.5)	7 (17.9)	7 (17.1)	NS
III re-do	1 (1.2)	0	1 (2.4)	NS
Interval re-do (years)	11.39±10.53	10.88±12.59	11.87±8.26	NS

AVR, aortic valve replacement; COPD, chronic obstructive pulmonary disease; CVA, cerebral vascular accident; LVEF, left ventricle ejection function; NS, not stated; NYHA, New York Heart Association.

Patients in the re-do AVR group were more likely to have an isolated aortic valve procedure or a non aortic surgery as previous operation, while the patients in the re-do complex group were more likely to have undergone a previous procedure on the proximal aorta.

A total of 15 (18.8%) bioprostheses, 15 (18.8%) mechanical valves, 11 (13.4%) homografts and 7 (8.8%) bioroots were implanted. A previous bioprosthesis implant was more common in the re-do AVR group, no difference between the groups was found for mechanical valves, while in the re-do complex group previous homograft and bio-root implants were more common. Details of the previous surgery are reported in table 2.

Indication for reoperation

Indication for re-do surgery was: endocarditis in 19 (23.8%) patients (12 root abscess), bioprosthesis degeneration in 10 (12.5%), mechanical valve dysfunction in 4 (5%), paravalvular leak in 5 (6.2%), new aortic valve disease in 20 (25%), patient–prosthesis mismatch in 3 (3.8%) aortic aneurysm in 18 (22.5%), aortic chronic dissection in 3 (3.8%), aortic pseudoaneurysm in 7 (8.8%), root degeneration in 14 (17.5%), including 8 (10%) homograft, 1 BioValsalva degeneration, 1 Ross and 8 valve sparing root replacement failures. Indications for re-do surgery are reported in table 3.

Re-do surgery

Forty-one (51.2%) patients underwent re-do AVR and 39 (48.8%) re-do complex aortic valve surgery including 28 (35%) root procedures, 23 (28.7%) ascending aorta and 6 (7.5%) hemiarch replacements. Thirty patients underwent concomitant additional procedures, including 13

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Table 2 Previous surgery

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
Type of surgery				
Isolated AV surgery	38 (47.5)	11 (28.2)	27 (65.9)	0.001
Repair	12 (15)	3 (7.7)	9 (22)	NS
Replacement	26 (32.5)	8 (2.5)	18 (43.9)	0.022
Complex aortic surgery	32 (40)	26 (66.7)	6 (14.6)	0.000
Root	26 (32.5)	21 (53.8)	5 (12.2)	0.000
Ascending	7 (8.8)	6 (15.4)	1 (2.4)	0.047
Arch	1 (1.2)	1 (2.6)	0	NS
Concomitant procedures	9	4	5	NS
CABG	6	3	3	NS
Mitral valve	3	1	2	NS
Non-aortic surgery	10 (12.5)	2 (5.1)	8 (19.5)	0.052
CABG	8 (10)	1 (2.6)	7 (17.1)	0.034
Mitral	2 (2.5)	1 (2.6)	1 (2.4)	NS
Type of prosthesis				
Bioprosthesis	15 (18.8)	2 (5.1)	13 (31.7)	0.002
Mechanical valve	15 (18.8)	9 (23.1)	6 (14.6)	NS
Homograft	11 (13.4)	11 (28.2)	0	0.000
BioRoot	7 (8.8)	7 (17.9)	0	0.005

AV, Aortic Valve; AVR, aortic valve replacement; CABG, coronary artery bypass graft; NS, not stated.

CABG, 4 mitral, 2 tricuspid valve surgery and 15 other procedures.

A bioprosthesis valve was implanted in 35 (43.8%) patients and a mechanical valve in 30 (37.5%).

Regarding root procedures, root remodelling was used in 13 cases where just the non-coronary sinus was involved in the disease, and 15 root replacements were performed using a composite mechanical conduit in 2

Table 3 Indications for re-operation

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
Endocarditis	19 (23.8)	13 (33.3)	6 (14.6)	0.044
Root abscess	12 (15)	11 (28.2)	1 (2.4)	0.001
Bioprosthesis degeneration	10 (12.5)	1 (2.6)	9 (22)	0.009
Mechanical valve dysfunction	4 (5)	2 (5.1)	2 (4.9)	NS
Paravalvular leak	5 (6.2)	2 (5.1)	3 (7.3)	NS
New AV disease	20 (25)	4 (10.3)	16 (39)	0.003
Aortic aneurysm	18 (22.5)	15 (38.5)	3 (7.3)	0.001
Aortic dissection	3 (3.8)	3 (7.7)	0	NS
Aortic pseudoaneurysm	7 (8.8)	7 (16.9)	0	0.005
Root degeneration	14 (17.5)	10 (25.6)	4 (9.8)	0.057
Homograft	8 (10)	8 (20.5)	0	0.002
VSRR	4 (5)	0	4 (9.7)	NS
BioValsalva	1 (1.2)	1 (2.6)	0	NS
Ross	1 (1.2)	1 (2.6)	0	NS
Patient–prosthesis Mismatch	3 (3.8)	1 (2.6)	2 (4.9)	NS

AV, aortic valve; AVR, aortic valve replacement; NS, not stated; VSRR, valve sparing root replacement.

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Table 4 Re-do surgery

Type of surgery	Total 80
Re-do AVR	41 (51.2)
Resternotomy AVR	7 (8.7)
Re-do AVR	34 (42.5)
Complex aortic surgery	39 (48.8)
Root replacement	15
Root remodelling	13
Ascending aorta	23
Hemiarch	6

AVR, aortic valve replacement.

(2.5%) patients, a biovalsalva conduit in 5 (6.2%) and a homograft in 8 (10%).

When the aortic root was affected by an extensive abscess, the preferred technique was aortic root replacement with homograft in seven patients plus biovalsalva conduit in one patient. When the abscess was less extensive, AVRs were performed along with aortic root reconstruction in one patient or left ventricular outflow tract reconstruction in two patients using bovine pericardial patches or direct abscess closure in one patient.

The implant of a mechanical valve was more common in the re-do AVR group (23 vs 7 patients p<0.000). Surgical details are reported in tables 4 and 5.

Preoperative CT scan was performed in all of the patients to assess the relationship of the heart and great vessels with the sternum and plan specific surgical strategies. Severe intrapericardial adhesions were found in 26 patients (32.5%) and were more common in patients in the re-do complex group. Different strategies have been used in anticipation of re-entry injuries. In five patients, a femoral-femoral bypass associated to deep hypothermic circulatory arrest was required to perform a safe resternotomy and mobilise the adhesions. In one patient, a fifth space right anterior mini-thoracotomy was performed to mobilise the aorta prior to the sternotomy.

Eleven patients (three in the re-do complex and eight in the re-do AVR group) had a patent left internal mammary artery (LIMA). A range of different techniques was used to manage the LIMA graft. The LIMA was identified and clamped in eight patients with one snared, six bulldogs, one soft vascular and one intracoronary balloon clamp placed by the interventional cardiologist team prior to surgery. In one patient, the LIMA was inadvertently injured during the dissection of the adhesions and in another the LIMA graft was kept perfused and systemic hyperkalaemia was used as an adjunct to myocardial protection.

Mean CPB time was 150.93±41.702 min and cross-clamp (XC) time 105.93±41.72 min. Both were significantly longer in patients who underwent complex aortic procedures (CPB 111.40±32.05 vs 190.5±65.36, p=0.036 and XC 79.90±21.82 vs 132.86±40.43 p=0.008). Retrograde cardioplegia myocardial protection was used in 88.8% of the patients. Intraoperative details are reported in table 6.

Intraoperative complications occurred in nine patients. Patients requiring re-do complex procedure showed a trend towards an increased risk of intraoperative complications (seven vs two patients, p=0.066). Intraoperative adverse events included three re-entry injuries, one CPB-related and five technical surgical complications. Details of the intraoperative adverse events are recorded in table 7.

In a young woman with Marfan syndrome, with degeneration of previous homograft and concomitant severe mitral regurgitation, a two stage procedure was planned to reduce the risks correlated to prolonged CPB and she

Table 5 Surgical details

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
Concomitant procedures				
No of patients	30 (37.5)	13 (33.3)	17 (41.5)	NS
CABG	13 (16.2)	6 (15.4)	7 (17.1)	NS
MV surgery	4 (5.1)	0	4 (9.8)	NS
TV surgery	3 (3.8)	2 (5.3)	1 (2.4)	NS
Others	15 (18.8)	6 (15.4)	9 (22)	NS
Type of prosthesis				NS
Bioprosthesis	35 (43.8)	17 (43.6)	18 (43.9)	NS
Mechanical valve	30 (37.5)	7 (17.9)	23 (56.1)	0.000
Composite graft	2 (2.5)	2 (5.1)	0	NS
Homograft	8 (10)	8 (20.5)	0	0.002
Biovalsalva	5 (6.2)	5 (12.8)	0	0.024
Aortic valve size	23.17±2.47	23.00±2.33	23.20±2.56	NS

AVR, aortic valve replacement; CABG, coronary artery bypass graft; MV, mitral valve; NS, not stated; TV, tricuspid valve.

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Table 6 Intraoperative details

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
Severe adhesions	26 (32.5)	19 (48.7)	7 (17.1)	0.002
Femoral cannulation	10 (12.5)	10 (25.6)	0	0.000
Retrograde cardioplegia	71 (88.8)	32 (82.1)	39 (95.1)	0.066
CPB (mins)	150.95±64.77	190.5±65.36	111.40±32.5	0.036
XC (mins)	105.93±41.72	132.86±40.43	79.90±21.82	0.008
DHCA	11 (13.8)	11 (28.2)	0	0.000
ACP	4 (5)	4 (10.3)	0	NS
IABP	3 (3.7)	1 (2.6)	2 (4.9)	NS
Additional mini-thoracotomy	1 (1.2)	1 (2.6)	0	NS
DHCA to release adhesions	5 (6.2)	5 (12.8)	0	0.024
Patent LIMA	11 (13.8)	3 (7.7)	8 (19.5)	NS
Intraoperative complications	9 (11.2)	7 (17.9)	2 (4.9)	0.066

ACP, antegrade cerebral perfusion; AVR, aortic valve replacement; CPB, cardiopulmonary bypass; DHCA, deep hypothermic circulatory arrest; IABP, intra-aortic balloon pump; LIMA, left internal mammary artery; NS, not stated; XC, cross clamp.

underwent re-do root replacement followed by mitral valve repair 13 days later.

Postoperative outcomes

Postoperative clinical outcomes are reported in table 8. In-hospital mortality was 3.8%, all the three deaths occurred in re-do complex cases, with no statistically significant difference between the two groups (0% vs 7.7%, p=0.111). One patient died in theatre due to multiple intraoperative complications and intractable biventricular failure. A second high-risk patient died of a massive pulmonary embolism on day 25 postoperatively. A third high-risk case died of respiratory complication after a prolonged (>3 months) hospital stay.

Two (2.5%) patients, both in the re-do complex group, suffered a postoperative stroke and 7 (8.8%) transient neurological symptoms. Four (5%) patients required re-exploration for bleeding, 3 (3.8%) renal replacement therapy and 8 (10%) a permanent pacemaker implant. Forty-four patients (55%) had at least one blood transfusion and 59 (73.8%) had blood products during the hospital stay. Transfusion requirement was significantly higher in patients who had re-do complex procedures.

Mean intensive care length of stay was 5.43±13.34 days, with 31 (39.7%) patients requiring more than 72 hours stay and 15 (18.8%) prolonged (>48 hours) mechanical respiratory support. Total hospital length of stay was 12.17±13.65 days. Patients who underwent complex re-do had a prolonged hospital LOS and a trend towards a prolonged intensive therapy unit stay, compared with those who underwent re-do AVR.

Table 7 Intraoperatory adverse events

	Intraoperatory adverse events
Re-entry injury	LIMA adherent to the sternum
	Injury of right lung
	Injury of right atrium
CPB-related complications	Incessant fine VF activity despite 7 L of cardioplegia (patent LIMA occluded with bulldog)
Technical surgical complications	Tearing of friable aortic root wall and RCA ostium disintegration - Expeditious bypass grafting of the RCA for cardioplegia delivery. Severe RV failure, RVAD, intraoperative death
	Disintegration of homograft NCS from the brittle nature of the calcium treated with a double layer of bovine pericardium remodelling patch
	TOE assessment showed an interference of one of the valve suture with mechanical valve hemidisc excursion. II round of CPB.
	Residual supra-aortic stenosis post-AVR. II round of CPB and remodelling of the seno-tubular junction with pericardial patch
	Kinking post proximal reimplantation of previous SVG-RCA. TTFM assessment confirmed impaired flow, additional CABG was performed.

AVR, aortic valve replacement; CABG, coronary artery bypass graft; CPB, cardiopulmonary bypass; LIMA, left internal mammary artery; NCS, non-coronary sinus; RCA, right coronary artery; RV, right ventricular; RVAD, right ventricular assist devce; SVG, saphenous venus graft; TOE, transoesophageal echocardiogram; TTFM, transit time flow measurements; VF, Ventricular Fibrillation.

DISCUSSION

Data from three large registers have been recently published to review current outcomes of re-do AVRs, with the intention of setting a benchmark for TAVR and V-in-V procedures and guide multi-disciplinary team (MDT) decision.[2–4]

The data from the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database on 3380 patients, who underwent isolated re-AVRs (75% previous isolated AVR

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Table 8 Postoperative outcome

	Total 80	Re-do complex surgery 39	Re-do AVR 41	P value
ITU LOS (days)	5.43±13.34	6.94±17.87	4.07±7.17	NS
Hospital LOS (days)	12.17±13.65	15.06±18.05	9.65±7.46	0.029
IH mortality	3 (3.8)	3 (7.7)	0	NS
Complications (N of patients)	22 (27.5)	12 (30.8)	10 (24.4)	NS
Stroke	2 (2.5)	2 (5.1)	0	NS
Transient neurological symptoms	7 (8.8)	4 (10.3)	3 (7.3)	NS
Reoperation	4 (5)	2 (5.1)	2 (4.9)	NS
Renal replacement therapy	3 (3.8)	1 (2.6)	2 (4.9)	NS
PPM dependency	8 (10)	6 (15.4)	2 (4.9)	NS
Ventilatory support >48 hours	15 (18.8)	11 (28.2)	4 (9.8)	0.033
ITU stay >72 hours	31 (39.7)	18 (47.4)	13 (32.5)	NS
Red cells (patients)	44 (55)	28 (71.8)	16 (39)	0.003
Clotting factors (patients)	59 (73.8)	35 (89.7)	24 (58.5)	0.001

AVR, aortic valve replacement; IH, in-hospital mortality; ITU, intensive therapy unit; LOS, length of stay; NS, not stated; PPM, permanent pace maker.

and 25% AVR +CABG), confirmed excellent outcomes with an in-hospital mortality of 4.66%. Even in this larger and more homogeneous group (all reoperations for AVR), many patients presented with contraindications for transcatheter procedures: 37.5% had severe AR, 13% active infective endocarditis and 18% a previous mechanical aortic valve prosthesis. When compared with 54.183 first time, AVR procedures form the STS database, re-do AVRs were associated with higher mortality (4.66% vs 2.2%), morbidity, incidence of postoperative blood transfusions and longer postoperative hospital length of stay.[2]

Data from the multicentre European RECORD study (7 European institutions, 711 patients) showed a 5.1% hospital mortality for re-do aortic valve procedures (4.5% for isolated re-do AVR) and low incidence of postoperative complications. From a more detailed reading of the results, it emerged that even in the RECORD population 36.3% of patients were younger than 65 years old, 21.7% presented with endocarditis aetiology, 41.4% implanted a mechanical valve and 27.9% required concomitant procedures.[3]

A review of the national Japanese database of 2157 patients who underwent AVR for aortic stenosis after cardiovascular surgery showed a raw 30-day and operative mortality rates of 5.5% and 8.5%, respectively. The background of prior surgery included CABG in 31.9%, valve in 67.5% and thoracic aorta in 9% of the patients. Significant AR was present in 42.2% of the cases. Concomitant procedures were performed in 40.5% (CABG 14.5%; mitral valve surgery 29.9% and aortic surgery 5.9%) and a mechanical valve was implanted in 48.7% of the patients.[4]

In our experience, 61% of the patients was younger than 60 years old and 37.5% chose a mechanical valve prosthesis. Only 12.5% of the patients presented with bioprosthesis degeneration, in contrast 18.8% who had a mechanical valve implanted as result of the previous surgery. A large number of patients presented with contraindications for TAVR such as significant AR (65.4%), infective endocarditis (23.8%), paravalvular leak (6.2%), patient–prosthesis mismatch (3.8%), proximal aortic disease (35%) including aortic aneurysm, chronic aortic dissection and pseudoaneurysm. Fifty-six per cent of the patients who underwent re-do AVR implanted a mechanical valve and 37.5% had concomitant surgery.

Patients were equally distributed between those who underwent re-do AVRs (51.2%) and those (48.8%) who required more complex procedures such as root procedures (35%), ascending aorta (28.7%) and hemiarch (7.5%) replacement.

It is well established that re-do proximal aortic reoperations are challenging procedures.[10–13] Silva *et al* reported a significantly higher in-hospital mortality rate for patients undergoing re-do ascending aortic and aortic root procedures compared with similar primary procedures (12.1% vs 6.8%).[10] Data from the STS Database (122 cases, 2004–2010) confirmed a 11.5% mortality for re-do proximal aortic surgery.[11]

Bavaria's group reported their experience with the 'true' re-do aortic root replacement. In the absence of infection, aortic root reoperations had outcomes similar to first-time aortic root replacement (4% in-hospital mortality in the de novo group vs 5% in the re-do group). Only patients who underwent re-do for infection had higher morbidity compared with the de novo group. An additional interesting finding of the study was that the number of reoperations performed per year increased during the study period (32% during the first chronologically half of the study vs 86% during the latter half), while the total number of aortic root replacements remained constant.[14]

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In our experience, the mortality in patients who underwent re-do complex aortic procedures was 7.7%. No deaths occurred in the re-do AVR group. Patients who underwent proximal aortic procedures received more urgent/emergency procedures and had higher EuroSCORE II compared with those who required isolated re-do AVR (12% vs 5% p<0.000). As expected, complex procedures required prolonged CPB time, higher transfusion requirement and prolonged postoperative length of stay. There was a trend towards an increased risk of intraoperative adverse events. Overall postoperative outcomes showed a low rate of complications for both groups of patients.

In our experience, key points for safe re-do aortic surgery were: a familiar 'complex aortic surgery team', preoperative CT scanning, complex aortic MDT discussion, advanced intraoperative transoesophageal echocardiogram support, prompt management of intraoperative adverse events and blood conserving strategies.[15] The role of an experienced surgical echospecialist in the operating theatre is of paramount importance in planning surgical correction, monitoring the cardioplegia delivery, optimising the deairing and early recognition of intraoperative complications.

As suggested from the Bavaria group study, the number of referrals for complex proximal aortic re-do procedures is increasing in the current practice and consequently calls for the need for highly specialised aortic teams and centres with experience in managing such complex aortic valve and root pathologies.[14]

CONCLUSION

Re-do aortic valve and proximal aortic procedures can be performed with acceptably low mortality and morbidity in expert centres with a familiar 'complex aortic surgery team'. TAVR and V-in-V procedures are a very attractive alternative to conventional high-risk re-do aortic surgery, but the number of patients that would be eligible for such procedures is probably overestimated. Re-do aortic surgery currently remains the only realistic treatment option for such challenging cases.

Limitations

This is a relatively small retrospective observational study of an heterogeneous group of patients.

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