Outcome after homograft redo operation in aortic position
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Abstract

OBJECTIVE: Since 1992, homografts have been implanted in our institution. After initial sub-coronary implantation of the homograft, our preferred technique for aortic-valve replacement with homografts became root replacement, which poses a surgical challenge whenever redo procedures are necessary. The aim of the present study was to evaluate the outcome after homograft redo surgery, based on prospective data from the biggest patient cohort in Germany for this procedure.

METHODS: Between May 1992 and August 2009, 363 adult patients underwent aortic-valve replacement with homografts in our cardiac surgery department. Homograft replacement was indicated in 90 of these 363 patients due to degenerative or infective conditions, and these were analysed.

RESULTS: In these 73 male and 17 female patients (mean age at redo operation 62.0 years), homograft explantation was necessary due to infection (n = 14) or degeneration (stenosis n = 19, regurgitation > II° n = 57). Mean time between homograft implantation and redo operation was 8.4 ± 3.6 years (range 0.0-15.5 years). Redo valve replacement through the aorta/homograft was done in 86 cases (valve into homograft wall = 80, total replacement of the homograft = 6) and trans-apical homograft replacement with an Edwards Sapien® Trans-catheter valve in four. Thirteen additional procedures were performed: bypass surgery (n = 1), mitral-valve repair (n = 6), replacement of the ascending aorta (n = 5) and tricuspid-valve repair (n = 1). Thirty-day mortality was 8.9% (n = 8, all of these patients presented with a homograft infection; five patients had a homograft reinfection). Survival rates after 1 and 5 years were 86.0% and 77.4%, respectively.

CONCLUSIONS: The risk for a redo procedure after aortic-valve replacement with a homograft seems to be acceptable when compared with other prostheses. Mortality was, however, elevated in patients with a homograft infection. Trans-apical procedures are safe and feasible and might be our preferred technique for the future. Valve infections still remain a contraindication for trans-apical procedures.

Keywords: Aortic homograft • Redo operation • Valve disease • Aortic valve

INTRODUCTION

Since the first sub-coronary implantation of an aortic-valve homograft (AVH) in 1962 by Ross [1], variations of the implantation technique have been described [2, 3]. The sub-coronary implantation technique is suspected to lead to complex host pathologic processes [4], often associated with asymmetry of the aortic root and valve annulus, and aortic-root replacement and reimplantation of the coronaries therefore evolved as the preferred technique, as it is relatively simple and easy to do [5]. Besides AVHs, a few pulmonary-valve homografts (PVHs) were used for aortic-valve replacement (AVR), until the incidence of graft failure proved to be higher.

However, the root-replacement technique might pose a higher risk for the redo procedure compared with other implantation techniques and other prosthetic types [6-8]. It is hypothesised that it is mainly degenerative tissue failure with extensive calcification of the homograft (HG) wall and infections that lead to a higher risk for the redo operation [8, 9]. The data presented here show the outcome after HG replacement in our institution, based on the largest patient cohort in Germany.

MATERIALS AND METHODS

Patients

Between May 1992 and August 2009, 363 adult patients underwent AVR with HGs in our department. All patients underwent prospective follow-up on an annual basis, including investigation of medical history, clinical examination and echocardiography in the outpatient clinic. HG replacement was indicated in 90 of the 363 patients (24.8%) due to degenerative or infective conditions, and these were analysed and compared statistically in this study.

Homografts

The implanted HGs were harvested from cardiac transplant recipients after informed consent and treated with an antibiotic cocktail containing amikacin, ciprofloxacin, vancomycin, amphotericin B and metronidazole. The tissues were stored in our own in-house HG bank, according to the standard regulation, in liquid nitrogen at −197 °C, using dimethyl sulphoxide as a
cryoprotectant [10]. Matching of blood groups or human leucocyte antigen (HLA) class was not attempted. Due to the restricted availability of aortic HGs, some pulmonary HGs were used [11].

**Surgical HG implantation techniques**

Between 1992 and 1995, all HGs \((n = 75)\) were implanted using a sub-coronary technique. After May 1995, the root-replacement method was used, which necessitated reimplantation of the coronary arteries \((n = 288)\). All operations were performed via a median sternotomy using cardiopulmonary bypass and moderate hypothermia \((30 \pm 2 ^{\circ}C)\). Both aortic \((n = 315)\) and pulmonary \((n = 48)\) HGs were used for AVR.

**Techniques for HG replacement**

Most redo operations were performed through a median sternotomy using cardiopulmonary bypass. In cases where the HG wall was still flexible, only the HG leaflets were excised and a new mechanical or biological valve prosthesis was implanted into the HG annulus \((n = 80)\). Some of these patients underwent an additional aortic-root enlargement \((n = 9)\). In patients with major calcifications of the HG wall and valve, the HG was dissected and removed ‘en bloc’ sparing the coronary buttons. Afterwards, total replacement of the aortic root was performed using the Bentall—De Bono [12] technique \((n = 6,\) all HGs were implanted using the root-replacement technique). In recent times, trans-catheter techniques have been available to our group, and four redo operations were performed via a trans-apical approach. These patients presented with a severely calcified aortic annulus and wall on the one hand but showed thin and friable leaflets on the other hand. We opted for trans-apical HG replacement with an Edwards Sapien® Trans-catheter valve (THV) \((n = 4)\).

**Statistical analysis**

Surgical results and follow-up data were reported in accordance with the recommendations of the Ad Hoc Liaison Committee in ‘Guidelines for Reporting Morbidity and Mortality After Cardiac Valve Interventions’ [13]. All recorded data were compared statistically using analysis of variance, \(t\)-tests and chi-square tests. Survival rate, freedom from redo surgery and absence of valve-related events were calculated as cumulative events according to the Kaplan—Meier and log-rank tests, with documentation of the patients at risk. All \(p\)-values were two-tailed; results were considered to be statistically significant if the \(p\)-value was <0.05. The software package Statistical Package for Social Sciences (SPSS) 17.0 for Windows was used to calculate these data.

**RESULTS**

**Patient characteristics**

As many as 73 patients were male (81%) and 17 were female (19%). Mean age at redo operation was 62.0 ± 12.9 years (Fig. 1). Mean time between HG implantation and redo operation was 8.4 ± 3.6 years (range 0.0—15.5). During the re-operation, 39 patients received stented xenografts, 44 patients mechanical prostheses, six patients a second homograft and one patient underwent a Ross operation. Secondary to the HG replacement, nine patients underwent coronary artery bypass surgery; additional mitral-valve reconstruction was needed in four patients, and tricuspid-valve repair was needed in one patient as a concomitant procedure. Additional replacement of the ascending aorta was necessary in only one patient. The reasons for intervention were regurgitation >II° \((n = 57)\), calcification \((n = 19)\) and graft infection \((n = 14)\) (Table 1). Nine redo patients suffered from a new HG infection and underwent reoperation (2% out of 363 initial HG patients). Early and late recurrent endocarditis was found in five redo patients (9% of the 55 patients who suffered from an endocarditis prior to HG implantation) (Fig. 2). In 13 out of the 14 endocarditis patients, only the infected cusps were excised and just one patient showed a second endocarditis 7 years later. After excision of the cusps, a classical transaortic valve-in-valveless-HG procedure (mechanical or biological) was done in 86 cases and trans-apical HG replacement with an Edwards. Sapien® THV in four cases (Fig. 3). Regarding the necessity for redo AVR, no differences were found between the two implantation techniques and the two graft types (Table 2).

**Survival**

The 30-day mortality was 8.9%. All of these patients \((n = 8)\) presented exclusively with infection of the graft. Later survival rates
were 84.5% (AVH) and 90.5% (PVH) after 1 year and 75.1% (AVH) versus 83.5% (PVH) after 5 years (n.s.). A comparison of the two primary implantation techniques showed early mortality of 8.0% in patients with sub-coronary implantation and 9.0% in patients with root replacement. The 5-year survival was 81.5% after sub-coronary implantation versus 77.0% for root replacement (n.s.).

Late death occurred in 11 patients and was valve-related in two of these cases, both due to primary HG infection (Fig. 4).

**Perioperative valve/procedure-related complications**

Nine patients had early repeat thoracotomy due to bleeding complications after redo procedure.

In one operation, the ostium of the right coronary artery was dissected and found to be occluded, and a venous bypass was performed in consequence. Total atrioventricular block and subsequent permanent pacemaker implantation was seen in four patients (4.4%). During the observation period, there was no incidence of stroke and myocardial infarction. There were three transient ischaemic attacks (TIAs). No major or prolonged case of other thrombo-embolism was reported.

**Redo after redo operation**

Prosthetic infection after redo operation was found in five patients (5.6%), and graft replacement was performed in consequence.

**DISCUSSION**

The aim of this study was to evaluate the outcome after HG redo surgery in the aortic position, based on data from our department in Germany. Out of 363 HGs implanted since 1992, 90 patients presented with an indication for redo AVR, necessitating HG explantation.

Despite the excellent haemodynamic performance of HGs, their long-term durability was thought to improve after enhanced preservation methods, as numerous authors have hypothesised [14, 15]. However, it has been apparent in recent years, as our article has shown, that the long-term durability does not seem to be superior compared with biological xenoprotheses [16, 17], due to chronic degeneration of the HGs, leading to fibrosis and calcification along with intense root calcification (Fig. 5). The leading cause for reoperation in most of our patients was significant aortic regurgitation due to retraction of the leaflets or dilation of the native aortic bulb (Fig. 6). The calcification of the HG wall was expected to present a higher risk for the redo procedure, in particular for those patients where the HG was implanted using the root-replacement technique. However, our analysis revealed no difference between the two implantation techniques. In the majority of our patients, isolated replacement of the aortic valve was possible via dissection of the flexible wall of the HG, and the critical complete removal of the HG could be avoided. A prosthesis—patient mismatch was not expected because the implanted HG root had the same diameter as the patients’ aortic root.
HG infections warrant attention. Although we had a very low infection rate, the mortality at the redo operation was markedly elevated in patients with a HG infection. Whereas the rate of reinfection after the initial AVR with a HG was really low, as numerous authors have reported before [23–25], the 30-day mortality after the redo operation was considerably elevated when HG infection was present. Strict endocarditis prophylaxis should be mandatory in view of this postoperative outcome.

As many of our HG patients present with more advanced age and many concomitant morbidities, operative techniques have been broadened towards less invasive operations.

These circumstances make trans-apical placement of a stented valve attractive. Based on our experience, trans-apical procedures are safe and feasible and they might be our preferred technique for the future. Valve infections still remain a contraindication for trans-apical procedures.

CONCLUSIONS

A higher risk for redo AVR with explantation of the HG has been hypothesised on account of the complex implantation technique and the calcification of the HG root cylinder. Due to our tissue preserving valve-in-valveless-HG technique, the survival rates and procedure-related complications seem to be comparable to other prostheses. However, mortality was elevated in patients with a HG infection. In patients with infective endocarditis, the incidence of HG infection and reinfection is remarkably low when compared with other prostheses. Long-term durability of HGs is not superior to other biological substitutes. Trans-apical procedures are safe and feasible, and they might be our preferred technique for the future. Valve infections still remain a contraindication for trans-apical procedures.

ABBREVIATIONS


Conflict of interest: none declared.

REFERENCES


