Abstract

Cardiac transplantation is limited by donor availability and carries a considerable perioperative mortality in addition to continuing morbidity and mortality post-transplant. Some patients referred for transplantation may benefit from non-transplant cardiac surgery. This study assessed the results of non-transplant cardiac surgery in this high-risk group of patients over the 5-year period 1996–2001. Twenty-five such patients underwent conventional cardiac surgery and these were highly symptomatic, with angina and dyspnoea. All had impaired left ventricular function, 20 having left ventricular ejection fraction (LVEF) < 30% and five an LVEF of 30–50%. Twelve of these patients had undergone previous cardiac surgery, nine patients required LV aneurysm surgery in addition to revascularization, and three had valve replacement plus coronary artery bypass grafting. There was one death (4% mortality). Mortality predicted by Parsonnet was 11.3% and by EuroSCORE 5.56%. Compared with all cardiac surgery patients, these high-risk patients had a prolonged intensive therapy unit stay (median 1 day, \( P = 0.013 \)) and hospital stay (median 12 vs. 8 days, \( P < 0.001 \)). Although patients referred for cardiac transplantation constitute a high-risk group for conventional cardiac surgery, the operative mortality compares favourably with that of cardiac transplantation.

1. Introduction

Cardiac transplantation is a well-established treatment option for cardiac failure. Results have improved with refinements in donor management, surgical technique and postoperative care. Nonetheless, cardiac transplantation still carries a substantial perioperative mortality risk. In our institution the 30-day mortality for cardiac transplantation over the last 5 years has been 7.0%. Additionally, transplant recipients are prone to allograft rejection and the complications of immunosuppression. The estimated 1-, 3- and 5-year survival rates for cardiac transplant recipients in the United Kingdom are 80, 76 and 63%, respectively [1]. One of the main limiting factors in cadaveric transplantation is donor availability, as reflected in the steady decline in United Kingdom intrathoracic transplants from 461 in 1995 to only 286 in 2001 [1]. As a consequence, a number of patients referred for transplantation and accepted onto the waiting list die while waiting for a graft.

Patients referred to our institution for consideration of cardiac transplantation are always fully assessed, including review of their coronary angiography. Any individuals considered suitable for conventional, non-transplant surgery would then be offered coronary revascularization and/or valve surgery. The Parsonnet [2] and EuroSCORE [3] scoring systems were used to estimate the mortality risk for individual patients undergoing conventional cardiac surgery.

In this study, we investigated the outcome of conventional cardiac surgery in those patients who were considered unsuitable for such surgery at other cardiothoracic centres and were referred for transplantation. These were high-risk patients and important endpoints were surgical mortality and morbidity, as well as resource consumption in terms of intensive care (in the intensive therapy unit; ITU) and hospital stay.

2. Materials and methods

We studied patients undergoing conventional cardiac surgery at Papworth Hospital, Cambridge, as a result of
referral from other regions for consideration of cardiac transplantation, during the 5-year period April 1996 to March 2001. Data were collected from the hospital database and medical records to study preoperative factors, the details of surgery and the outcomes, including length of stay in intensive care and hospital as well as mortality and complications.

The surgical technique aimed at complete myocardial revascularization with careful myocardial protection. Normothermic cardiopulmonary bypass was employed and myocardial protection comprised antegrade warm blood cardioplegia for induction, followed by cold St. Thomas’s crystalloid cardioplegia, epicardial cooling and aortic root suction for venting. The conduits used for revascularization were left or bilateral internal thoracic artery pedicles and long saphenous vein, with frequent use of sequential grafting. Surgical reverse remodelling to the left ventricle was performed with a modified Dor technique [4]. Postoperative management involved careful weaning from any inotropic support, regular diuretics and early introduction of an angiotensin-converting enzyme (ACE) inhibitor when tolerated.

The resource utilization by these patients was compared to that for all patients undergoing cardiac surgery at the same institution over the financial year April 2000 to March 2001 (n = 1583). Length of stay data were categorized for the purpose of illustration, since the median value does not well represent the impact upon resources of a minority of patients requiring prolonged care. The exact length of stay was compared between groups using a Mann–Whitney U-test (SPSS 10.0, SPSS, Chicago, IL). The 95% confidence intervals around the observed mortality rate were determined from Poisson distribution tables.

3. Results

Four hundred and forty-six patients were referred to Papworth Hospital for consideration of cardiac transplantation during the 5-year period studied. Of these, 25 (5.6%) were judged to be amenable to conventional, non-transplant cardiac surgery. Two hundred and thirty-nine of the patients were judged to be amenable to conventional, non-transplant cardiac surgery. Two hundred and thirty-nine of the patients were accepted onto the waiting list for transplantation, 205 subsequently receiving a heart. Twenty patients (4.5%) died while waiting for transplantation.

The 25 quaternary referral patients undergoing non-transplant surgery comprised 19 men and six women, with a median age of 55 years. All patients had ischaemic heart disease, nine patients requiring left ventricular (LV) aneurysm surgery in addition to revascularization, three valve replacement plus coronary artery bypass grafting (CABG), and 13 CABG alone. Characteristically, the coronary artery morphology was unfavourable in this group, although the median number of coronary grafts was four. All had impaired left ventricular function, 20 having left ventricular ejection fraction (LVEF) < 30% and five having LVEF 30–50%. More precise definition of the ventricular function is not helpful in the context of a high proportion of left ventricular aneurysms. Twelve of these patients had undergone previous cardiac surgery. The patients were highly symptomatic, with angina (median Canadian Cardiovascular Society grade 3) and dyspnoea (median New York Heart Association grade 3). Importantly, all but three of the patients had a substantial degree of angina, implying the presence of ischaemic viable myocardium. Consistent with referral for transplantation, this group of patients did not have many comorbid conditions, although two had chronic pulmonary disease.

There was one death, corresponding to a 4% mortality rate (95% confidence interval 0.1–22.3%). This was a 51-year-old man who underwent redo CABG × 4. He came off bypass well, but suffered repeated ventricular fibrillation later on the day of surgery, from which he could not be resuscitated. Overall mortality predicted by Parsonnet was 11.3%, by standard EuroSCORE 5.56% and by logistic EuroSCORE 6.32%. By comparison, the mortality rate for all non-transplant cardiac surgery at the same institution for the financial year 2000–2001 (n = 1583) was 3.8% (EuroSCORE prediction 4.55%). Two patients subsequently underwent cardiac transplantation, 16 and 17 months post-surgery.

Postoperatively, 11 of the 25 patients required inotropic support and intra-aortic balloon counterpulsation was used in five patients (20%). Haemofiltration was required for renal support in one patient and another needed a tracheostomy to facilitate weaning from the ventilator. One patient suffered a cerebrovascular accident, two had ventricular dysrhythmias, two postoperative bleeding, four sternal wound infection and three atrial fibrillation.

As a measure of resource utilization, we assessed the length of stay in intensive care (ITU) and hospital. Although the median ITU stay was 1 day (interquartile range 1–4 days), 40% of this group stayed for 3 days or more (Fig. 1). By comparison, the median ITU stay for all cardiac surgery patients in the last financial year was 1 day (interquartile range 1–1 day) and only 10% stayed for 3 or more days. The ITU stay was significantly prolonged in this group of high-risk patients (P = 0.013). The median hospital stay was 12 days (8.5–22 days) and 36% of patients studied required more than 14 days in hospital (Fig. 2). This was significantly longer than the control group, amongst whom the median hospital stay was 8 days (7–12 days, P < 0.001).

4. Discussion

Conventional cardiac surgery clearly offers effective treatment to some of those patients initially deemed inoperable due to the state of their native coronary arteries or the degree of left ventricular impairment. Complete revascularization was attainable, as shown by the number of bypass grafts (median 4) and the good symptomatic results...
achieved. This group of patients are at relatively high risk of perioperative death, but the observed mortality rate was not greater than that predicted by either standard or logistic EuroSCORE. The predicted mortality was not very high since patients referred for transplantation are relatively young and do not have multiple comorbidities. Furthermore, there was not an unduly high burden of perioperative morbidity. It seems appropriate to offer cardiac surgery to such high-risk patients, after careful discussion of the risks and benefits entailed.

The important factors in achieving a successful outcome in this high-risk group of patients are preoperative assessment, operative strategy and meticulous postoperative care. When assessing the patients, the severity of angina can give a good indication of viable myocardium. At angiography, the suitability of target vessels must be determined and the potential for left ventricular remodelling in the context of LV aneurysm assessed. Dobutamine stress echocardiography was used to assess myocardial viability. At operation, the emphasis was on optimal myocardial protection and complete revascularization.

Compared with the outcome of primary cardiac transplantation, conventional surgery entailed a lower perioperative mortality risk for this group of quaternary referral patients. In our institution, cardiac transplantation is currently associated with a 7.0% 30-day mortality and the International Society for Heart and Lung Transplantation Registry (http://www.ishlt.org) indicates a 1-year survival rate of 85.6% for the period 1996-1999. Transplant recipients are also prone to allograft rejection, complications of immunosuppression and chronic graft vasculopathy, resulting in the continuing mortality rate following transplantation. In addition to these limitations of transplantation, conventional surgery is not dependent upon donor availability. The waiting list mortality rate of 4.5% should be subtracted from the transplantation survival figures to give a more accurate representation of the overall outcome of transplantation based upon intention to treat, since these heart failure patients are still subject to a 92% 2-year mortality risk while waiting [5]. Although some patients undergoing conventional surgery may subsequently become transplant candidates, a large proportion of patients treated in this way may never require transplantation. The longer-term outcome of non-transplant surgery in this setting is uncertain [6] and requires further study.

An increasing array of investigations is becoming available to assess myocardial viability preoperatively. These include dobutamine stress echocardiography [7], nuclear...
imaging techniques such as single-photon emission computed tomography (SPECT) or technetium sestamibi scanning to detect myocardial perfusion [8], and cardiac magnetic resonance imaging [9]. Revascularization of patients with ischaemic heart failure in the presence of viable myocardium, as identified by dobutamine stress echo, has been shown to confer a survival advantage compared to medical therapy [7]. Such investigations provide important adjuncts to the assessment of patients referred for transplantation, in terms of their potential benefit from conventional surgery.

The increasing public scrutiny of surgical results, especially in cardiac surgery, has important implications for this group of patients. Treatment of high-risk cardiac surgical patients such as these will have an impact on the overall results of a surgical centre, whether they are treated at their local tertiary referral centre or at a quaternary centre, as described here. This study also raises important issues in terms of the use of resources. The increased length of stay in ITU and hospital has major financial implications. Additionally, there is an opportunity cost in terms of the reduced availability of resources to lower risk local patients who are awaiting surgery.

Nonetheless, conventional surgery remains an important option for some of the patients referred for transplantation. In the context of declining donor numbers, all patients with ischaemic heart disease referred for transplantation should be carefully assessed with a view to potential coronary revascularization or surgical reverse remodelling to the left ventricle. Treatment is not dependent upon donor availability and the EuroSCORE system appears to offer an appropriate prediction of the perioperative mortality risk. Further work is needed to identify which patients may benefit most from this approach in the medium and long term.

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References


Appendix A. Conference discussion

Dr F. Mohr (Leipzig, Germany): I am a little bit surprised about the low number of patients you selected for surgery, only 5% out of the referrals. The question is, how do you evaluate by diagnostic tools who are the good candidates who go for surgery? Do you use MR, do you use PET scan to find out? You didn’t mention mitral valve insufficiency in your patient cohort as another alternative. Does that play a role in your diagnosis? You didn’t show anything about that.

Mr Billing: If I could perhaps answer in sections, firstly, the incidence, the 5% rate is relatively low. This is probably because all of the patients have already been assessed at a tertiary center, a cardiothoracic center, and felt to be unsuitable for conventional surgery.

In terms of our assessment, we are looking at all the viable angiographic targets, and we are looking at the left ventricular function with dobutamine stress echo, and also a clinical assessment, looking at their vo2 max, and how severe their angina symptoms are. we feel that is quite a useful predictor, although it is subjective.

In terms of the mitral surgery, you have seen that only three of the patients required valve surgery in addition to coronary artery surgery. In this selective group mitral insufficiency was not a large issue.