Symposium: Review Article

Non-transplant surgical alternatives for heart failure

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Abstract Although surgical options exist, treatment for heart failure remains dominated by medical therapy. Even with optimal medical therapy, the mortality of heart failure continues to be high. Conventional wisdom in heart failure treatment leads many practitioners to believe that the patient is “too sick” for further operative procedures such as revascularization, valve repair or replacement and ventricular reconstruction. Improvements in intra and peri-operative care over the last 20 years have allowed for more complex procedures to be performed, and have improved the mortality rates of the more traditional surgeries. As the complexity of the operative procedure and morbidity of the patient has elevated so has the importance of a multidisciplinary approach in choosing treatment plans for patients. As the age of the population increases and acute management of ischemic heart disease improves, the prevalence of heart failure will likely increase. Improving access and changing treatment algorithms to include operative procedures can improve the treatment of heart failure patients. (J Geriatr Cardiol 2006;3:222-226.)

Key Words heart failure; therapy; surgery

Introduction

Heart Failure remains a burden on society and the healthcare system. Five million Americans are affected by heart failure with over 500,000 cases that are diagnosed annually.1 Almost 300,000 deaths are linked to heart failure as either a primary or contributory cause. One year mortality for medically treated NYHA class IV or Stage D heart failure is 50%.

Heart transplantation is the gold standard surgical therapy against which all other treatments for heart failure are measured. The survival rates for heart transplantation continue to improve with one, five, and ten-year survival rates of > 80%, 65%, and 45%, respectively.2 A limited pool of suitable donors has caused the number of heart transplants performed annually in the U.S. to be fairly static at just over 2000/year though. This shortfall in donors contributes to the 500-1,000 patients that die each year while waiting on the United Network for Organ Sharing (UNOS) list.3 End-stage heart failure patients also may be at advanced age or have co-morbidities that don’t allow for transplantation or they may develop complications from their heart failure causing removal from the waiting list. Development of alternative surgical therapies for advanced heart failure patients has increased during the last several decades due to this “donor-limited” number of transplant procedures performed annually, the mortality on the waiting list, and ineligibility of some end-stage heart failure patients for transplantation.

Advances in myocardial protection, operative techniques, and peri-operative care now make it possible for procedures such as coronary bypass, ventricular reconstruction, and valve repair to be offered to many patients with advanced heart failure with good short and long term results. In 2006 few patients are inoperable. Surgical therapy may delay the need for listing a patient for heart transplant or negate the need for transplantation altogether. This article will discuss these non-transplant surgical options for treatment of advanced heart failure.

Coronary revascularization

The leading cause of congestive heart failure in the U.S. and developed world remains ischemic heart disease which accounts for 40-70% of congestive heart failure cases.4,5 Even with state of the art pharmacotherapy, survival is poor for medically treated patients with ischemic cardiomyopathy.6-12 The Assessment of Treatment with Lisinopril and Survival (ATLAS) trial reviewed the effect of Lisinopril in high and low doses in 2,035 patients with ischemic cardiomyopathy. In the high dose group there was an 8% decrease in mortality after four years relative to the low dose group but mortality was 44%.13 In ATLAS, 54% of patients died of acute coronary events. The Studies of Left Ventricular Dysfunction (SOLVD) database examined Enalapril's ef-
Surgical coronary revascularization improves mortality in patients with ischemic cardiomyopathy. The Coronary Artery Surgery Study (CASS) and VA trials included patients with left ventricular (LV) dysfunction. Both demonstrated improved survival in surgical patients with coronary artery disease and LV dysfunction relative to those treated with medical therapy. Another randomized VA study of patients with unstable angina demonstrated improved survival for patients with LV dysfunction who underwent surgical revascularization. In addition, the CASS registry, a nonrandomized arm of the CASS trial, demonstrated a lower rate of sudden cardiac death in patients who had been revascularized after being diagnosed with Left Ventricular dysfunction. It is important to note that these studies did not include patients with a left ventricular ejection fraction (LVEF) <35% as they were felt to be too high risk to undergo coronary revascularization.

Numerous retrospective studies have shown that coronary artery bypass in patients with LVEF < 25% can be accomplished with operative mortality rates ranging from 2-8% with a subsequent improvement in LVEF. Myocardial viability testing discriminates which patients with multivessel coronary artery disease and LV dysfunction will benefit from revascularization. A meta-analysis of 24 studies examined the impact of viability on survival after revascularization for ischemic cardiomyopathy. This analysis showed revascularization gave a clear benefit for patients with viability. The analysis included 3,022 patients with an average LVEF of 32%. Follow-up was 25 months. Revascularized patients with viability had a 3.2% annual mortality rate as compared to a 16% annual mortality rate in patients with viability that did not undergo revascularization. This effect did not cross over to those patients without viability who underwent revascularization. These patients fared no better than those who were managed medically with annual mortalities of 7.7% and 6.2%, respectively. LV dysfunction is a risk factor for coronary artery bypass. The operative arm of the randomized Should We Revascularize Occluded Coronaries in Cardiogenic Shock (SHOCK) trial had a 30-day and 1-year mortality rate of 42% and 56%, respectively. This study demonstrated that individuals who have uncompensated heart failure have a very high operative mortality. No completed randomized trial exists comparing outcomes of medical and surgical therapy for ischemic cardiomyopathy, but most people with ischemic cardiomyopathy die from ischemia and there is ample evidence supporting the beneficial effect of surgery. In individuals with compensated heart failure and viability, revascularization leads to improved survival and can be safely performed in the face of severely compromised ventricular function.

Left ventricular reconstruction

Remodeling a dyskinetic aneurysm or akinetic scar to create a more effective ventricle is referred to as left ventricular reconstruction (LVR). After aneurysm reconstruction there is improvement in both myocardial oxygen consumption and myocardial efficiency. A resulting improvement in the neurohormonal milieu of heart failure ensues. Remodeling also leads directly to a net reduction of ventricular wall stress. Traditionally, aneurysms were repaired in a "linear" fashion by removing the thin walled scar lateral to the left anterior descending artery, with more complete reconstructions being developed in the 1980's by Cooley, Jatene, and Dor that include the infarcted septum.

The Reconstructive Endoventricular Surgery returning Torsion Original Radius Elliptical shape to the left ventricle (RESTORE) is a multicenter registry that looked at the results of 1,198 post infarction patients who underwent left ventricular reconstruction. Thirty day mortality was 5.3%. Ninety-five percent of the patients underwent concomitant coronary artery bypass surgery (CABG) and 22% underwent concomitant mitral valve repair. Sixty-six percent of patients had LVR due to akinetic segments with 34% undergoing LVR for a dyskinetic segment. Five year survival was 65% for those with akinetic segments versus 80% for patients who underwent LVR for dyskinetic segment. The average preoperative LVEF was 29% which improved to 39% after LVR. Mean NYHA functional class improved from 3.0 to 1.9, and the 5 year readmission rate for heart failure was 15%.

The Surgical Treatment of Ischemic Heart Failure (STITCH) trial is a multicenter prospective randomized trial designed to study the effect of ventricular reconstruction on survival. Patients enrolled in this trial have ischemic cardiomyopathy, LVEF < 35%, NYHA class III or IV, and have an akinetic or dyskinetic segment. They are randomized to either optimal medical therapy or surgery. The patients in the surgical arm are subsequently randomized to revascularization alone or revascularization plus LVR. The estimated date of study completion is 2008.

Valve repair / replacement

Mitral

Historically, operative mortality of mitral valve surgery in patients with a LVEF <40% was thought to be prohibitive. 3+ or 4+ mitral regurgitation is present in nearly 50% of patients with an LVEF <35%. Mortality is increased in patients with significant mitral regurgitation compared to those without mitral regurgitation following medical therapy, post-myocardial infarction, or post percutaneous coronary intervention. The increased operative mortality in mitral valve surgery was felt to be due to the removal of a "pop off" mechanism which allowed the LV to decompress into the low pressure left atrium reducing LV stress. However, this high mortality was more likely related to the status of...
operative and perioperative care of the cardiac surgery pa-
tient in the 1970s and 80s.

There are two mechanisms that typically lead to mitral regurgitation in heart failure patients. Annular dilatation (Carpentier type I) predominates in dilated cardiomyopathy and posterior leaflet restriction secondary to papillary muscle tethering (Carpentier type IIIb) predominates in ischemic cardiomyopathy. In advanced ischemic disease, often a mixture of annular dilatation and posterior leaflet restriction coexists. It is important to understand that in both mechanisms the underlying valvular and subvalvular apparatuses retain normal architecture amid their failing surroundings.

It is possible to repair the valve using a severely undersized ring to improve leaflet coaptation. Bolling et al. first showed that mitral valve repair in this population could be performed with a low operative mortality in patients with severe LV dysfunction and mitral regurgitation. Other authors have demonstrated similar low operative mortality in patients undergoing mitral valve surgery. Intermediate survival, functional class, and ventricular functional changes (improved LVEF fraction, decrease sphericity, and decrease ventricular volumes) can all be improved after undergoing mitral valve repair.

Some groups still support treating patients with chronic ischemic mitral regurgitation by coronary revascularization alone. In contrast, other groups have shown that mitral regurgitation in patients undergoing coronary artery bypass does not resolve following coronary bypass alone and the regurgitation may reduce survival of patients compared to those without it. Still other investigators have indicated that adding mitral valve repair to patients with 2+ - 3+ mitral regurgitation will improve late survival. The reports of adding mitral valve surgery to coronary artery bypass to improve survival and late functional class are controversial, as some reports have failed to show any benefit.

The question then remains if mitral valve repair extends the lives of patients with severe LV dysfunction. No randomized trials have yet been performed. Several studies have indicated an improved NYHA functional class, LV volume and function, and a lower need for rehospitalization. One retrospective study indicated no difference in five year survival. As with all retrospective studies, there were inequities at base line in the groups. For instance, the medically treated group was almost twice as likely to receive defibrillators, and was more likely to have been on beta blockers, both of which have been shown to decrease late mortality in patients with heart failure and a low ejection fraction. Ideally a prospective randomized trial of mitral valve repair in patients with low ejection fraction needs to be performed to support the idea that it is safe with contemporary techniques and effective in the short term.

Aortic valve

Aortic stenosis is a highly correctable cause of heart failure with a very predictable natural history. The decision for replacement in symptomatic patients and for asymptomatic individuals with evidence of severe aortic stenosis is straightforward. Patients with low cardiac output and aortic stenosis are described as having "low gradient" aortic stenosis as their ventricles are too compromised to generate a pressure gradient across the aortic valve. The severity of aortic stenosis can be difficult to quantify in these patients using echocardiographic techniques. Right and left heart catheterization and dobutamine echocardiography are useful tests for confirming the severity of aortic stenosis in this setting.

With current myocardial protection strategies, aortic valve replacement can be done with low risk in even patients who until recently were felt to be inoperable. A study out of the Cleveland Clinic from 1990-1998 reported outcomes of three groups of patients with aortic stenosis. Group I (n=68) underwent aortic valve replacement for aortic valve area < 0.75 cm², LVEF < 35%, and mean gradient < 30mmHg. Group II had aortic valve replacement for an aortic valve area <0.75 cm², LVEF < 50%, and mean gradient = 35mmHg. Group III (n=89) were not operated on and had an aortic valve area, 75cm²; gradient < 30mmHg and LVEF < 35%. Operative mortality was 5.9% and 4.0% for groups I and II respectively. One and four year survivals were 82%/75% and 92%/82% for groups I and II respectively. One year survival for the medically managed Group III was 20%.

A similar approach can also be utilized when dealing with aortic insufficiency. As with aortic stenosis, modern myocardial protection strategies and improved operative and perioperative care has extended the limits of who can benefit from valve replacement. A series from the Cleveland Clinic looked at patients with aortic insufficiency and LV depression (LVEF <30%), a group previously thought of as inoperable. For the group that underwent aortic valve replacement after 1990 thirty day mortality was 0% and 5 year survival was 84%. 

Tricuspid valve

Until recently, the tricuspid valve has been largely untreated in individuals with heart failure. Consistent repair of the tricuspid valve has been elusive. Numerous suture annuloplasties have been described, but long term durability is lacking. A recent report from the Cleveland Clinic described the outcomes of 790 tricuspid repairs performed from 1990-1999. Eighty-nine patients had a concomitant mitral valve procedure. Operative mortality was 8% and 5 year survival was 65%. Repair with a rigid ring provided the best long-term freedom from recurrent tricuspid regurgitation. The authors concluded that formal ring annuloplasty of the tricuspid valve should be undertaken for tricuspid regurgitation deemed to be greater than 2+. By preoperative transthoracic echocardiogram. Other groups have had similar encouraging results. Kuwaki et al. reported a hospital mortality of 8.9% and 10 year survival of 84% in their series of 260 patients (97% NYHA class III or IV) undergoing tricuspid repair. Improvement in right ventricular function has also been demonstrated after tricuspid repair.
Atrial fibrillation

Atrial fibrillation commonly coexists with mitral valvular pathology and heart failure. It has been shown to be an independent predictor of mortality in patients undergoing coronary artery bypass.54,55 The Cox Maze III operation is the gold standard therapy for atrial fibrillation. Ninety percent of patients who undergo the Cox-Maze III are cured.56 Some groups have demonstrated an overall improvement in LVEF in patients who have undergone the Maze procedure.57 Patients with atrial fibrillation can have a tachycardia induced cardiomyopathy which can improve when the causative tachycardia is treated. The classic Maze has failed to become established in cardiac surgery likely due to its complexity. A recent influx of new technologies can create a full thickness atrial lesion and precludes the need for the surgical incisions and subsequent suture repair of a Maze.57 The simplest lesion set consists of pulmonary vein isolation and stapling of the left atrial appendage. This can be done quickly, is highly effective, and can be done safely in the sickest of patients.57

Conclusion

After ACE inhibitors, beta blockade, and resynchronization therapy have been utilized in advanced heart failure patients, many patients may be helped by conventional surgical procedures such as coronary revascularization, ventricular reconstruction and valve repair or replacement.

Severe uncompensated, inotrope dependent heart failure is a usually a contraindication for conventional surgery. If major co-morbidities do not exist our feeling is that these patients are better served by transplantation or ventricular assistance as destination therapy. Obviously there are patients that fall into a grey zone. It is difficult to tell if these individuals will tolerate or improve with surgery. Mechanical assistance as a backup strategy in case difficulty is encountered weaning from cardiopulmonary bypass is necessary when managing these patients with conventional surgery. A recent paper from the Cleveland Clinic foundation reported the results of cardiac surgery in patients that had been initially referred for cardiac transplantation.58 It is noteworthy that this series demonstrated equivalent intermediate survival in patients undergoing conventional surgery or transplantation.

Heart failure does not have to be a death sentence. There are many therapies, both medical and surgical, that exist for patients with this disabling condition. The decision of what the best treatment is for any particular patient is not always straight forward. A multidisciplinary team led by cardiologists and surgeons who have specific interest and training in the management of heart failure, and that individualizes treatment for each patient will bring the best outcomes. A state-of-the-art center must be able to place contemporary surgical treatments alongside medical therapy in battling what will only be a more frequent disease in our aging population.

References

1. American Heart Association Heart Disease and Stroke Statistics — 2005 Update.