A case for minimally invasive coronary surgery as primary treatment for left anterior descending coronary artery disease

Robert W. Emery*, Kit V. Arom, Thomas F. Flavin, Ann M. Emery

Cardiac Surgical Associates, P.A. 920 East 28th Street, Suite 420, Minneapolis, MN 55407, USA

Abstract

Objective: The introduction of minimally invasive coronary bypass surgery has allowed the application of multiple approaches to coronary artery disease. Methods: Technologic developments have resolved patency and myocardial ischemic issues and increased surgical experience and training have combined to make more coronary bypass surgeons facile in minimally invasive surgical techniques. Results: These advances, along with the decreased invasiveness, shortened recovery and lower cost, suggest the application of these techniques to the primary treatment of disease of the anterior descending artery. Conclusion: In selected circumstances such as these in which patient co-morbid risk factors would suggest high recurrence rates in complex lesions or total occlusion of the anterior descending coronary artery and present in cases of in-stent restenosis, primary application of minimally invasive bypass techniques may create long-term benefits for patients. © 1999 Elsevier Science B.V. All rights reserved.

Keywords: Minimally invasive coronary surgery; Interventional cardiology

1. Introduction

Following the first report in 1995, [1] minimally invasive bypass surgery opened the door to multiple novel surgical approaches to coronary artery disease (CAD). The lay press and patients enthusiastically received these procedures, but there was controversy within the surgical and medical community, to the extreme, that some surgeons indicated that minimally invasive off-pump coronary artery bypass techniques should never be utilized [2,3]. The use of such procedures as institutional marketing tools further complicated the evaluation and acceptance of these newer and varied techniques. Interestingly, some of the surgical approaches for CAD proclaimed novel were originally used to initiate the field of coronary artery surgery decades ago and have been revitalized [4]. While the definition of what constitutes minimally invasive cardiac surgery is controversial, for current discussion, the LAST procedure as described by Calafiore et al. is taken as the prototype for the surgical treatment of single vessel disease involving the left anterior descending coronary artery (LAD) [5,6].

Data has indicated that arterial revascularization is the only interventional procedure that has been shown to extend the patient’s life and that survival benefits of internal mammary grafting increase with time [7]. Loop et al. initially demonstrated improved survival when an internal mammary artery (IMA) anastomosis was constructed to the LAD [8]. Further long-term results indicate continued patency, decreased incidence of reoperation and re-intervention, and increased symptom-free intervals [9]. No such long-term data, however, has accumulated for other procedures. This process of arterial utilization is an evolution in the treatment of coronary artery disease. The revolution in cardiac surgery has been the advent of minimally invasive cardiac surgery (MICS) offering the opportunity to tailor the operation to the patient rather than the patient to the operation and to effectively treat disease of the LAD for decades. It must be remembered that the objective of intervention whether it be catheter based or surgical is to achieve complete revascularization with the lowest mortality, lowest morbidity, most rapid return to activity and the best long-term results possible. In order to determine where MICS lies in the spectrum of treatment for coronary artery disease, several factors (Table 1) must be reviewed to determine differences and similarities between interventional and MICS procedures.

2. Invasiveness of the procedure

Dr Ralph Damiano, Chief of Cardiovascular Surgery at Penn State University, Hershey, PA, has issued a mandate
for surgeons participating in MICS: ‘as surgeons, we must develop procedures that maintain the superior outcomes of open-chest coronary artery bypass grafting with the minimally invasive trauma of angioplasty’. Certainly, a small groin incision with dilatation and/or stenting of the arteries is as minimal as a surgical procedure can get. Like angioplasty of the 1980s, however, MICS is in its formative years and will become more minimal as improved instrumentation and technologies develop. Interventional procedures are minimal, but a significant incidence of recurrence still exists [10]. Anterior descending arterial revascularization surgery on the other hand has proven long-term patency results and advances are making the process less invasive [9]. Currently, the 6–8 cm left anterior thoracotomy with harvesting of the internal mammary artery for single or double bypass to the anterior descending system provides the aforementioned benefits of internal mammary artery grafting and a minimally invasive approach. MICS is not yet as minimally invasive as angioplasty and issues of general anesthesia and surgical healing are apparent, although operative time and interventional time may be similar. A significant portion of pain that occurs following surgical thoracotomy is due to retraction on the chest wall for harvesting of the internal mammary artery and spreading of the ribs to create an area large enough to perform the bypass surgery after IMA retrieval. Increasingly, surgeons are utilizing thoracoscopy through 3–5 mm ports to harvest the IMA [11]. This substantially decreases post-operative pain and allows localization of the thoracotomy incision to a more lateral approach directly over the LAD necessitating less rib retraction. In procedures such as this, patient recovery is substantively faster and same day admission and discharge protocols are possible. The development of robotic-enabling technology has progressed to the point that the first internal mammary to anterior descending artery revascularization has been accomplished through port access alone (R. Daminano, personal communication). These developmental milestones are bringing the invasiveness of MICS closer to that of angioplasty and providing the proven longevity of IMA grafting in the face of an adequately constructed anastomosis. Certainly, as angioplasty has become more complex and costly with the utilization of multiple stents and intravascular ultrasound along with investigational issues of radiation and/or vascular endothelial growth factor augmentation, coronary artery surgery to treat anterior descending artery disease has been simplified and become more economical. Hospital stay for MICS is currently about 2 days, and most patients returned to full activity by 2 weeks.

3. Patency

Coronary bypass surgery is the most studied surgical procedure in the history of medicine and the patency and import of arterial revascularization is well documented [9]. As minimally invasive bypass surgery has developed, the question of anastomotic patency when surgery is performed on the beating heart has been the subject of intense scrutiny. Recent reports obviate these concerns when the procedure is performed by surgeons experienced in minimally invasive techniques [6,13–15]. These data indicate that patency of the anastomosis is greater than 95% in surgical procedures performed on the beating heart. Results have further improved with the use of stabilizing devices as ongoing development continues [12,16]. This is equivalent or better than previous data reported on patency of the mammary artery performed on the still heart [15]. Acute patency of MICS bypass can thus be compared with the success of interventional therapy, and long-term results can be expected to be improved.

4. Cost

MICS has diminished the cost in the delivery of coronary artery surgery [17–19]. Two distinct groups of patients having MICS have been identified, those with significant co-morbid risk factors for surgery and those with few such factors [18]. Cost savings are not as clearly identified in patients at high risk for coronary surgery, but more importantly they are able to be operated on safely and effectively via MICS approaches, even though co-morbid risk factors add to cost and hospital stay [17–19]. In patients without such risk factors and single vessel disease, the cost of MICS approaches that of angioplasty. Stenosis following angioplasty over 6 months has been noted to be as high as 55% [20]. Even with stent application, restenosis can be as high as 20% and the interventional treatment of in-stent re-stenosis carries further high recurrence rates [21,22]. The anastomosis of the LIMA to the LAD is occluded than 3% acutely and less than 5% total by 6 months requiring further intervention [12,15]. The cost differential for recurrent stenosis in intervention has not been recorded, but is substantial and such cost factors amortized over time would appear to favor surgery. Many patients can be selected for high risk of recurrence and may initially be best managed by MICS [23]. Further, the use of expensive new pharmacologic agents (i.e. IIB/IIIa platelet inhibitors) and multiple stents will increase interventional cost and complications in a manner as yet to be determined.
5. Long-term results

The long-term results of beating heart surgery are not known. Intermediate term results would indicate that surgery on the beating heart is equivalent to that on the still heart in terms of anginal-free intervals [24,25]. Further, these reports were completed prior to the introduction of modern stabilization devices. Gundry et al. disagrees with this view, citing an earlier recurrence of coronary disease in patients having surgery on the beating heart if distal vessel snares were utilized [26]. For this reason, distal snaring is now used less often. The surgical community is expectantly waiting the availability of more intermediate-term results from beating heart bypass surgery. Long-term results of angioplasty for stable or unstable angina indicate event free survival of only 32% after 10 years, which is substantively less than that for surgery [8,9,27]. Others have also noted decreased rates of reintervention after surgery when compared to angioplasty [28]. After a 4-year experience, Calafiore has noted a 2% reoperative rate and a 0.7% reintervention rate following the LAST operation [29]. These patients have a 97.3% freedom from complications related to the LAD artery and 97.1% survival. Over a similar time frame, Subramanian has noted a 93% freedom for all cardiac-related events [16]. In terms of the general utilization since approval by the FDA, the time frame for the

Fig. 1. This complex lesion of the LAD is capable of being managed by either MICS or intervention. Short-term versus long-term advantages, the co-morbid risk factors involved in the process, and the desires of the patient need to be considered in the decision making process.
availability of stents has been almost similar to that of minimally invasive bypass surgery. Most in-stent restenosis is noted by 6 months and 5-year patency, data is not available. We do know, however, that certain subsets of coronary lesions have been associated with a higher rate of repeat intervention following angioplasty [23]. Such lesions may be more amendable to primary surgery. Patient related risk factors, such as the size of the vessel and the presence of diabetes, negatively impact the long-term outcomes of interventional therapy and yet do not impact the patency of artery to artery bypass. These factors need to be considered in the decision making process for choice of therapy [9,30,31]. It will be a decade before we will know with assurance the long-term incidence of recurrent symptoms and cardiac mortality in patients undergoing minimally invasive procedures as well as those of patient need for re-intervention or surgery in the case of stenting to the anterior descending coronary artery. In spite of the limited time frame of MICS reports, once healed the LIMA-LAD anastomosis is known for long-term patency and the development of distal disease is limited [7,8,9].

6. Hybrid procedures

Certainly, intervention and MICS are not mutually exclusive. As shown in Table 2, there are instances in which patients have contraindications to standard approaches for coronary artery surgery or for cardiopulmonary bypass or have significant co-morbid risk factors [32,33]. Left main coronary disease in appropriate candidates may also be treated in such fashion [34]. In such high-risk patients, the availability of minimally invasive bypass surgery with angioplasty/stenting of disease in the remaining vessels allows patients a post-interventional course minimizing the mortality and morbidity from major surgical procedures. Experience with hybrid procedures has been limited and follow-up is unknown, but certainly this approach is a cooperative and compatible approach for complete revascularization in patients with significant disease and risk factors.

In summary, minimally invasive coronary bypass surgery offers an alternative to the treatment of disease of the anterior descending coronary artery. Simple lesions of the anterior descending artery are best managed by the truly minimally invasive interventional procedures of stenting and angioplasty. However, recurrent disease following angioplasty or stenting, complex lesions, patient co-morbid risk factors that can be predictive of high recurrence, or lesions that are totally occlusive to the anterior descending coronary artery may well be better managed over the long term by the application of minimally invasive coronary surgery with or without angioplasty and stenting of other vessels. Fig. 1 represents a complex lesion that may be managed by intervention or surgery. MICS has virtually equalized the cost and stabilization devices have resolved the acute patency issue. Angioplasty offers less invasion but a greater rate of untoward cardiac events. Compared to standard operative procedures, MICS has decreased surgical trauma and recovery yet offers predictable long-term results.

The appropriate conduct of myocardial revascularization for the individual patient will be determined by the physician who combines thoughtful risk factor analysis coupled with a knowledge of pertinent clinical data, and the experience of the surgical team integrating patient preference creating ‘designer’ myocardial revascularization for the individual patient.

References


