Minimally Invasive Surgical Treatment of Valvular Heart Disease

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Cardiac surgery is in the midst of a practice revolution. Traditionally, surgery for valvular heart disease consisted of valve replacement via conventional sternotomy using cardiopulmonary bypass. However, over the past 20 years, the increasing popularity of less-invasive procedures, accompanied by advancements in imaging, surgical instrumentation, and robotic technology, has motivated and enabled surgeons to develop and perform complex cardiac surgical procedures through small incisions, often eliminating the need for sternotomy or cardiopulmonary bypass. In addition to the benefits of improved cosmesis, minimally invasive mitral valve surgery was pioneered with the intent of reducing morbidity, postoperative pain, blood loss, hospital length of stay, and time to return to normal activity. This article reviews the current state-of-the-art of minimally invasive approaches to the surgical treatment of valvular heart disease.

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INTRODUCTION

Over the past 20 years, the increasing popularity of less-invasive procedures has affected nearly every surgical specialty, including cardiac surgery. Consequently, patients requiring surgery frequently seek minimally invasive operations that promise smaller and ideally better tolerated incisions. With the recent approval of percutaneous valve replacement and repair technologies, it is clear that many patients prefer less-invasive therapies instead of proven traditional surgical approaches, despite an absence of mid- or long-term efficacy data. Thus, those who treat valvular heart disease are faced with a particular challenge that is revolutionizing current surgical practice—reform valve interventions to minimize the burden of surgery without compromising overall cardiovascular care. Advancements in imaging, surgical instrumentation, and robotic technology have enabled surgeons to perform complex cardiac surgical procedures through small incisions, often eliminating the need for sternotomy or cardiopulmonary bypass. The excellent outcomes of these contemporary minimally invasive valve surgery platforms provide benchmarks against which fledgling percutaneous technologies should be compared.

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SURGICAL TREATMENT OF THE MITRAL VALVE

Degenerative mitral valve disease, typically characterized by leaflet prolapse secondary to chordal rupture or elongation, is the most common cause of chronic isolated mitral regurgitation in the United States.[1] In general, patients with degenerative mitral regurgitation benefit in terms of event-free and overall survival if the mitral valve is repaired instead of replaced. The increased morbidity and mortality associated with mitral replacement is generally from higher reoperation rates due to prosthesis failure or complications of obligatory anticoagulation. Furthermore, increasing evidence supports early surgical repair of patients with severe degenerative mitral regurgitation, prior to the development of adverse sequelae of longstanding disease (eg, ventricular remodeling and dysfunction, pulmonary hypertension, and atrial fibrillation).[2,3] As younger and healthier patients are referred for surgery, the

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demand for effective and cosmetically favorable approaches to mitral valve repair has increased.

Operative Technique

Although initial reports of less-invasive mitral valve surgery used parasternal[4,5] or lower hemisternotomy[6] approaches for mediastinal access, the right anterolateral minithoracotomy has become the minimally invasive approach of choice for correcting mitral valve disease.[7-9] Compared with lower partial sternotomy, this approach provides a more en face view of the mitral valve and avoids surgery in the xiphisternal region, the area most prone to wound breakdown and infection following sternotomy. The right thoracotomy approach is considerably more resistant to infection owing to overlying pectoralis muscle and soft tissue to seal the surgical site.[10] Robotic and port access mitral valve surgery are thus carried out through an incision of 3-4 cm in the inframammary crease, and the thoracic cavity is entered through the third or fourth interspace. Additional 1-cm ports facilitate introduction of a camera, left atrial retractor, suction, and in the case of robotic surgery, working arms (Fig. 1). Peripheral cannulation for cardiopulmonary bypass via the femoral arterial and venous vessels, as well as the internal jugular vein, facilitates smaller working incisions and less clutter of the surgical field. However, the ascending aorta and right atrium may be directly cannulated via Seldinger technique if a contraindication precludes direct femoral cannulation. Aortic cross clamping is achieved with a transthoracic Chitwood clamp or endovascularly with an endoaortic balloon occlusion device. Although beating- or fibrillating-heart strategies are employed in some centers, concerns for higher stroke rates have led many surgeons to advocate using these techniques with caution.[11,12] As robotic and thoracoscopic port access approaches facilitate all the standard resectional and nonresectional valve repair techniques, the procedure of mitral valve repair is akin to the operation performed through conventional sternotomy[13-16] (Fig. 2).

Clinical Efficacy

A minimally invasive approach to valve surgery must permit performance of a procedure equal or superior to that of the reference standard median sternotomy approach. Therefore, minimally invasive mitral valve surgery must be as safe, effective, and durable as the traditional "open" approach. To date, no comparison study has shown a significant difference in operative mortality when comparing minimally invasive mitral valve surgery with median sternotomy.[8,17-22] Although reports of initial experiences with port access mitral valve surgery documented mortality rates of approximately 10%,[23] more recent studies, including our own, reproducibly demonstrate mortality rates less than 1%, particularly in the case of degenerative mitral valve disease.[8,17,18,24] Intermediate and long-term results are also encouraging. Propensity score-matched comparisons of minimally invasive and sternotomy approaches with mitral valve surgery reveal similar survival up to a decade after surgery.[8,18,19] In our analysis of 402 well-matched patient pairs with mitral regurgitation of any etiology, 1-, 5-, and 9-year survival rates were 96%, 96%, and 96% after minimally invasive mitral valve repair, and 97%, 92%, and 89% following the conventional approach ($P = 0.8$), respectively.[8] Operative approach does not appear to significantly affect the likelihood of

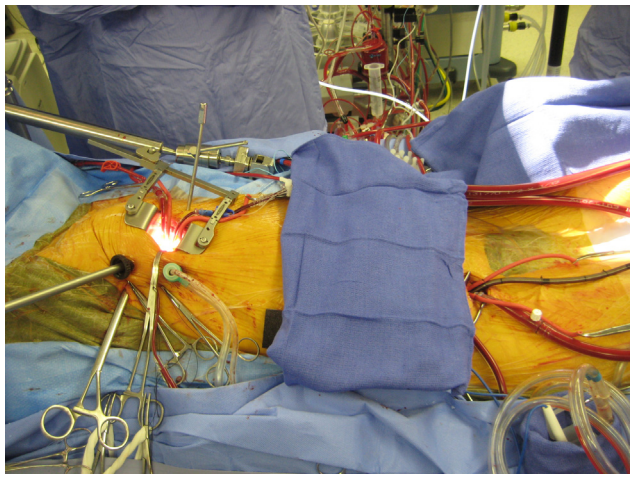

Figure 1. Exposure and cannulation technique employed for minimally invasive mitral valve surgery.