Robotic Mitral Valve Repair

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Background: Mitral valve repair is the standard therapy for patients with severe mitral regurgitation. Currently, robotic mitral valve repair is the least invasive surgical approach and an alternative to the traditional sternotomy. Recent studies and newer guidelines on mitral valve repair advocate for earlier referral to surgery, resulting in better long-term outcomes of valve function and decreased left ventricular remodeling. Purpose: Robotic mitral valve repair outcomes were compared with nonrobotic mitral repair outcomes through analysis of 4 recent studies, one of which was the Food and Drug Administration trial that granted approval of robotic cardiac surgery. Two studies included their own nonrobotic groups for comparison, with one comparing the robotic approach with complete sternotomy, partial sternotomy, and mini–anterolateral thoracotomy to assess all currently available techniques.

Conclusions: All 4 studies showed positive outcomes including decreased need for postoperative mechanical ventilation, intensive care unit length of stay, and hospital length of stay. The studies also showed that postrepair mitral regurgitation was equivalent to that of traditional open repairs at multiple different periods after surgery. Clinical Implications: Patients should be given the option for minimally invasive robotic mitral valve repair if they have no other risk factors such as peripheral vascular disease that prevent femoral cannulation for cardiopulmonary bypass or the need for concomitant cardiac surgery such as coronary artery bypass. With the equality of robotic outcomes compared with full sternotomy valve surgery comes the need for more research into what kind of complex valve repairs can be done, which methods of repair work best with robotic techniques, whether the learning curve for robotic surgery can be shortened with more widespread use, and what outcomes can be improved upon from this standpoint. Healthcare professionals need to be aware of all choices for patients who need surgical intervention for their mitral regurgitation.

KEY WORDS: cardiac surgical procedures, computer-assisted surgery, literature review, mitral valve insufficiency, mitral valve prolapse, robotics

Manipulation of the mitral valve has been attempted as early as the 1920s. In 1956, C. Walton Lillehei was one of the first to develop mitral valve repair using the concept of annuloplasty. Then, in 1960, Dwight McGoon developed a technique for resceting the prolapsing segment of the mitral leaflet caused by a ruptured chordae tendineae. Finally, in 1983, Carpentier published an article describing what he called the French correction,” which introduced several mitral valve repair techniques and provided classification for assessing the lesions on the leaflets. With this background, the groundwork for the modern mitral valve repair surgery was born.

The mitral valve’s function is dependent on 5 components: the leaflets, the annulus, the chordae tendineae, the papillary muscles, and the subjacent myocardium. Mitral regurgitation can result from an abnormality or disease process affecting one of the components. Chronic regurgitation can be the end result of rheumatic disease, mitral valve prolapse, mitral annular calcification, congenital valve defects, hypertrophic obstructive cardiomyopathy, and dilated cardiomyopathy. Usually, the cause of mitral valve prolapse is unknown, but it can encompass a wide spectrum of severity. In many cases, anterior or posterior leaflet prolapse can progress to bileaflet prolapse, flail leaflet, chordal rupture, or severe mitral regurgitation. Chronic mitral regurgitation can lead to a decrease in ejection fraction and ventricular remodeling, which can, in turn, lead to heart failure. No matter what the initial cause, chronic severe mitral regurgitation is progressive without intervention.

Echocardiography can help determine the ejection fraction and end-systolic dimension and diagnose the severity of the patient’s regurgitation or prolapse. The need for surgical intervention is recommended after echocardiographic analysis is conducted. Mitral valve repair is recommended over replacement for mitral regurgitation or prolapse whenever possible because of the better outcomes reported in a variety of clinical studies. Recently, research studying the effects of mitral valve repair early in the disease process, often before the patient is having any symptoms, has been conducted. Although there is no current guideline definitively advocating...
early repair, there are new data to support referral for early surgical repair at an advanced repair institution.\textsuperscript{6,7} In the early 1990s, minimally invasive surgery became a realistic option for a variety of surgical specialties, including cardiac. By 1998, the technology had advanced to robotics, and the first mitral valve repairs were done with 3-dimensional video and robotic assistance.\textsuperscript{8} With the developed technology available now, there are multiple ways to approach surgical repair of the mitral valve: full sternotomy, partial sternotomy, full thoracotomy or minithoracotomy with or without video assistance, and robotically assisted.\textsuperscript{8} The changes in surgical approach also affect the cannulation for cardiopulmonary bypass and perfusion, as well as the instrumentation needed to cross clamp the aorta and work on the valve itself. These options require additional training by the surgeons and the teams assisting them throughout the process, creating a learning curve for this kind of specialized surgery.

It is currently estimated that up to 3\% of the US population has mitral valve prolapse.\textsuperscript{9} With the combination of advised early intervention and less invasive options available, mitral valve repair surgeries have been increasing, as compared with mitral valve replacements. The purposes of this article were to determine whether robotic mitral valve repair has similar outcomes to traditional methods and to clarify what kinds of criteria were used to select patients for this surgery on the basis of 4 recent studies. By determining outcomes of robotic mitral valve repairs and comparing them with established results from traditional mitral valve repairs, healthcare professionals can better advise patients on repair options and their advantages. With such a minimally invasive approach available, earlier intervention may not seem like such a drastic undertaking to the patients who would benefit most from it.

Methods

A search of the literature between the years of 2008 and 2013 was done using the key words \textit{robotic mitral valve}. The initial Food and Drug Administration (FDA) study from 2005 was included on the basis of its landmark status that allowed all other studies to be performed. A search was conducted through PubMed, MEDLINE, sciencedirect.com, the entire catalogs of both the \textit{Journal of Thoracic and Cardiovascular Surgery} and the \textit{Annals of Thoracic Surgery}, and the references of all articles found there. Studies were selected on the basis of the similarities of their hypotheses, the outcomes analyzed, the date of their published results, and their contribution to this field of study. The studies included here examine intensive care unit length of stay, hospital length of stay, postrepair regurgitation, and both cardiopulmonary bypass and aortic cross-clamp times; all 4 looked at robotic mitral valve repair outcomes for efficacy, with 3 hypothesizing that robotic results would be comparable with traditional surgical methods (see Table 1).

Data and Analysis

The 4 studies reviewed each had the similar purpose of looking at the outcomes of mitral valve repair. Each used the da Vinci Surgical System from Intuitive Surgical, Inc, in Sunnyvale, California. The oldest study included is an FDA phase II clinical trial by Nifong et al,\textsuperscript{10} with results published in 2005. The results from this trial gave FDA clearance for robotic mitral valve repair surgery in the United States. This was a multicenter trial with 10 different institutions around the United States. Their combined initiative was to evaluate the safety and efficacy of robotic mitral valve repair in a variety of institutional environments.

Between February 2001 and July 2002, a total of 112 patients were enrolled and signed both FDA-approved and institutional review board–approved consents. The patients were between the ages of 37 and 81 years and had confirmed moderate or severe mitral regurgitation based on their echocardiograms. Patients were excluded if they were younger than 18 years; were older than 80 years; had a previous right thoracotomy; were in renal failure; and had liver dysfunction, a bleeding disorder, pulmonary hypertension, mitral stenosis, anterior mitral valve leaflet disease, significant aortic or tricuspid valve disease, coronary artery disease requiring surgery, myocardial ischemia in the previous 30 days, a stroke in the previous 30 days, a calcified mitral annulus, or a body mass index greater than 35 kg/m$^2$. The mean (SD) age for all patients was 56.4 (10.2) years, 77 of the enrolled were men, and 102 were white. Preoperative comorbid conditions consisted of 59 having coronary artery disease, 39 who smoked, 33 having cardiac arrhythmias, 39 having hypertension, 22 having congestive heart failure, and 5 having peripheral vascular disease. These investigators did not find any statistically significant differences in any of the demographic characteristics.

All clinical information for the enrolled patients was collected and verified by trained study monitors, abstracted onto an FDA case report form, and entered into a database. Case reports were completed before surgery, during surgery, after surgery, at discharge, and 1 month after surgery. The endpoints analyzed from this study were cardiopulmonary bypass time, cross-clamp time, total operation time, ventilation time, intensive care unit length of stay, hospital length of stay, and the comparison of prerepair with postrepair grades of regurgitation from echocardiography, separated by institution. All echocardiograms, including the before and after surgery studies as well as the 1-month follow-up, were reviewed by an independent laboratory that was blinded to which site it was reading.\textsuperscript{10}

Another study looked at 300 patients who underwent robotic mitral valve repair at the University Health

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System of Eastern Carolina and East Carolina University between May 2000 and November 2006. This was the largest single-center series to date of robotic mitral valve repairs. Their purpose was to describe the clinical outcomes of this kind of robotic repair. The results were then discussed in comparison with other current studies available that used traditional repair approaches. Institutional review board informed consent was obtained from each patient. All patients with degenerative mitral valve disease were considered candidates except patients with the following: extensively calcified mitral valve annulus, preoperative planning for a mitral valve replacement, severe pulmonary hypertension with pulmonary artery systolic pressure of higher than 50 mm Hg, and active endocarditis. The results were then discussed in comparison with other current studies available that used traditional repair approaches.

### TABLE 1 Comorbid Conditions, Exclusion Criteria, and Outcomes by Study

<table>
<thead>
<tr>
<th>Study</th>
<th>Comorbid Conditions</th>
<th>Exclusion criteria</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Nifong et al, 2005</td>
<td>Coronary artery disease (CAD), smoking status, hypertension (HTN), congestive heart failure (CHF), peripheral vascular disease (PVD)</td>
<td>&lt;18 or &gt;80 years old, prior right thoracotomy, renal failure, liver dysfunction, bleeding disorder, pulmonary HTN, mitral stenosis, anterior mitral leaflet disease, CAD requiring surgery, MI/CVA within 30 d, calcified mitral annulus, BMI &gt;35 kg/m²</td>
<td>CPB time, cross-clamp time, total operation time, intubation time, ICU LOS, hospital LOS, comparison of pre- and postoperative outcomes</td>
</tr>
<tr>
<td>Chitwood et al, 2008</td>
<td>Coronary artery disease (CAD), smoking status, atrial fibrillation, hypertension (HTN), congestive heart failure (CHF), peripheral vascular disease (PVD)</td>
<td>Calcified mitral valve annulus, preoperative plan for mitral valve replacement, severe pulmonary HTN, EF &lt;20%, CAD requiring multivessel bypass grafting</td>
<td>CPB time, cross-clamp time, early/late mortality, ICU LOS, intubation time, hospital LOS, postoperative MR grade, follow-up ECHO, MR grade, freedom from reoperation</td>
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<tr>
<td>Suri et al, 2011</td>
<td>Coronary artery disease (CAD), atrial fibrillation, hypertension (HTN), congestive heart failure (CHF), peripheral vascular disease (PVD), diabetes, renal insufficiency, pulmonary HTN, CVA, mitral insufficiency, prior cardiac surgery</td>
<td>Mitral valve pathology from congenital, rheumatic, or ischemic disease, active endocarditis, PVD, significant CAD, CAD requiring revascularization, need for concomitant cardiac surgery (other than ASD, PFO, or Maze), PVD preventing groin cannulation, prior median sternotomy or right thoracotomy</td>
<td>CPB time, cross-clamp time, intubation time, ICU LOS, hospital LOS, pre-discharge MR grade</td>
</tr>
<tr>
<td>Mihaljevic et al, 2011</td>
<td>Smoking status, atrial fibrillation, hypertension (HTN), congestive heart failure (CHF), peripheral arterial disease, diabetes, CVA, COPD, prior MI, carotid disease</td>
<td>Concomitant surgical need other than PFO repair, ASD repair, or ablation</td>
<td>CPB time, cross-clamp time, intubation time, hospital LOS, pre-discharge ECHO, MR grade, STS database morbidity and mortality</td>
</tr>
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Abbreviations: ASD, atrial septal defect; BMI, body mass index; CAD, coronary artery disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; CPB, cardiopulmonary bypass; CVA, cerebrovascular accident; ECHO, echocardiography; EF, ejection fraction; HTN, hypertension; ICU, intensive care unit; LOS, length of stay; MI, myocardial infarction; MR, mitral valve regurgitation; PFO, patent foramen ovale; PVD, peripheral vascular disease; STS, Society of Thoracic Surgeons.

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than 70 mm Hg, poor left ventricular function with an ejection fraction of less than 20%, and significant coronary artery disease necessitating multivessel bypass grafting.

Preoperative echocardiograms were performed to confirm the plan for mitral valve repair and to have comparisons for after surgery. The surgeons in this study specifically used standard open-repair techniques for resection, reconstruction, chordal transfer, and neoachordal construction. Preoperative demographics were collected, and the mean (SD) age was 56.5 (12.8) years with a range of 19 to 80, and 107 were women. Identified preoperative patient comorbidities were 242 with congestive heart failure, 120 with hypertension, 102 smokers, 19 with diabetes, 1 with renal insufficiency, 49 with pulmonary hypertension, 54 with atrial fibrillation, 26 with coronary artery disease, 3 with peripheral vascular disease, 8 with previous strokes, 2 with previous cardiac surgery, and 272 with severe mitral insufficiency.

The end results evaluated were cardiopulmonary bypass time, cross-clamp time, early and late mortality, intensive care unit length of stay, time to extubation, hospital length of stay, postrepair mitral regurgitation, follow-up echocardiogram regeneration, and freedom from reoperation. All patients who survived were examined 6 weeks after surgery, with recommended echocardiogram follow-ups between 3 and 6 months after surgical intervention and then annually. All data, both perioperative and postoperative outcomes, were collected contemporaneously into a clinical cardiovascular information system.

Suri et al compared early safety and efficacy of transsternal versus robot-assisted mitral valve repair using identical, standard, and proven repair techniques. They wanted their information to serve as contemporary data for judgment against which percutaneous maneuvers could be compared. Between July 1, 2007, and January 1, 2010, a total of 301 patients consented for their data to be used. The study was approved by the Mayo Clinic institutional review board. Patients were excluded from this study if they had mitral valve pathology due to congenital, rheumatic, or ischemic disease; active endocarditis; peripheral vascular disease; and significant coronary disease, and also excluded were those needing concomitant cardiac surgical procedures other than atrial septal defect or patent foramen ovale closure or a Maze or modified Maze procedure. Robotic mitral valve repair is presented as an option, although candidates were excluded if they had coronary artery disease requiring revascularization, severe peripheral vascular disease preventing safe groin cannulation, or prior median sternotomy or right thoracotomy.

From the group of patients not excluded, 95 propensity-matched pairs were identified and received preoperative echocardiogram studies. The patients in the open and robotic groups were propensity matched on the basis of 15 demographic and preoperative variables including age, sex, body mass index, creatinine, and ejection fraction and presence of cerebrovascular disease, chronic lung disease, congestive heart failure, nonsevere coronary artery disease, diabetes, dyslipidemia, hypertension, prior myocardial infarction, and preoperative atrial fibrillation. In the matched groups, the mean age was 55.69 years in the open group and 54.88 years in the robotic group. Ejection fraction for the open and robotic groups was 65.34. The outcomes compared were median perfusion time, cross-clamp time, intensive care unit length of stay, postoperative ventilation, length of hospital stay, and dismissal mitral regurgitation.

In the last study, Mihaljevic et al wanted to compare the safety and efficacy of robotic posterior leaflet mitral valve repair with those that were repaired through complete sternotomy, partial sternotomy, or mini–anterolateral thoracotomy for myxomatous mitral valve disease. From January 1, 2006, to January 1, 2009, a total of 759 patients had their posterior mitral leaflet repaired at the Cleveland Clinic. Complete sternotomy was done on 114 patients; partial sternotomy, on 270 patients; mini–anterolateral thoracotomy, on 114 patients; and robotically, on 261 patients. Patients were excluded if they had concomitant procedures other than patent foramen ovale or atrial septal defect closure or if they had left-sided ablation for atrial fibrillation. All patients had severe mitral regurgitation verified by transesophageal echocardiograms. The institutional review board waived consent because all databases used for gathering information were approved for research. Preoperative and operative variable information was from the Cardiovascular Information Registry. Data were also retrieved from echocardiographic, cardiac anesthesia, laboratory medicine, and operating room databases.

To approximate a randomized trial, the researchers used propensity matching. The focus was on the robotic repairs, so they created 3 propensity models for comparison: robotic versus complete sternotomy, robotic versus partial sternotomy, and robotic versus mini–anterolateral thoracotomy. To identify factors associated with robotic surgery versus the other methods, a propensity score was constructed. Some of the variables considered were age; sex; body mass index; ejection fraction; smoking status; creatinine; and comorbid conditions such as atrial fibrillation, previous myocardial infarction, carotid disease, previous stroke, peripheral arterial disease, hypertension, diabetes, and chronic obstructive pulmonary disease. A propensity score was calculated for each patient to see the probability of receiving robotic mitral repair. Robotic cases were then matched to nonrobotic cases.

Outcomes compared and discussed were divided into effectiveness and safety. Effective outcomes examined were cardiopulmonary bypass time, myocardial ischemia time (cross-clamp time), postoperative intubation time, and hospital length of stay. Effectiveness of the
valve repair itself was based on predischarge echocardiography in comparison with the preoperative studies. Safety was assessed by comparing mortality and morbidity as defined by the Society of Thoracic Surgeons National Database.12

Results

In the multicenter FDA study, results were calculated as totals for all the participants and separated by institution. The mean total operation time was 266.4 minutes, with a range of 150 to 463 minutes. The mean cardiopulmonary bypass time was 168.8 minutes, with a range of 82 to 316 minutes. The mean aortic cross-clamp time was 124.1 minutes, with a range of 60 to 227 minutes.

Chitwood et al11 found their mean cardiopulmonary bypass time to be 158.7 (41.8) minutes. Their mean (SD) cross-clamp time was 122.1 (33.3) minutes.

Suri et al7 found a median cardiopulmonary bypass time of 101 minutes for the robotic group, with 40 minutes for their full sternotomy comparison group. Their median aortic cross-clamp time was 75 minutes in the robotic group compared with 31 minutes for the sternotomy.

When looking at changes in the robotic group for the second half of the study, they found that the median bypass time was 86 minutes compared with 122 minutes for the first half. The cross-clamp time decreased to 63 minutes from 85 minutes in the first half. Mihaljevic et al12 also found that the robotic group had longer median bypass and cross-clamp times compared with the other studied approaches. The robotic group had a median bypass time of 116 minutes and cross-clamp time of 85 minutes. When looking at the individual surgeries during the duration of the study, they also found a learning curve that decreased the bypass and cross-clamp times.12

Nifong et al10 found a mean (SD) intubation time of 9.1 (12.6) hours, with a mean (SD) intensive care unit length of stay of 36.6 (24.7) hours. The mean (SD) length of stay in the hospital for all patients was 4.7 (3) days. Chitwood et al11 found that 286 patients, or 95.3%, were extubated within 24 hours of surgery. Their mean (SD) intensive care unit stay was 32.4 (67.3) hours, and their hospital length of stay was 5.2 (4.2) days. They had 58.3% of their patients discharged by postoperative day 4.11 Suri et al7 found that the robotic group had a shorter postoperative intubation time of 4 hours compared with 6.4 for the sternotomy group. During the second half of the study, the robotic group decreased down to 0 hours, with patients being extubated in the operating room. Their median intensive care unit stay was 18.5 hours for the robotic group and 22.5 hours for the sternotomy group, decreasing to 13.1 hours in the second half of the study for the robotic group. The total hospital stay was a median of 3 days for robotic patients and 5 days for sternotomy patients7 (see Table 2).

Mihaljevic et al12 showed how many patients in each propensity group were kept intubated longer than 24 hours postoperatively. In the complete sternotomy–robotic group, 3 sternotomy patients and 2 robotic patients were kept intubated. In the partial sternotomy–robotic group, 5 sternotomy and 11 robotic patients were kept intubated. In the thoracotomy–robotic group, 1 thoracotomy patient and 4 robotic patients were kept intubated. Among the matched groups, the robotic patients had the shortest hospital stay, with a median of 4.2 days. The sternotomy group had a median of 5.2 days, the partial sternotomy group had a median of 5.8 days, and the thoracotomy group had a median of 5.1 days.12

Nifong et al10 compared their patients’ preoperative echocardiograms with those done immediately after repair and a follow-up echocardiogram done 1 month postoperatively. Preoperatively, 68 patients had moderate regurgitation and 36 had severe regurgitation. Immediately after repair, 78 had none, 29 had trace, and 1 had mild regurgitation. At the 1-month follow up, 103 patients, or 92%, had none or trace regurgitation. Seven, or 6.3%, had mild and 2 had either moderate or severe regurgitation. It was noted that, of these 9 patients, 6 patients (5.3%) had surgery again and 4 underwent a mitral valve replacement with a mechanical valve. There were no operative deaths and no conversions to open approaches from robotic.10

Chitwood et al11 had 2 (0.7%) early deaths within 30 days postoperatively. One was related to a protamine...
reaction and one was due to right ventricular failure. There were also 6 (2.0%) late mortalities, 4 of which were non–cardiac related. The other 2 died after mitral valve reoperations. A total of 16 patients (5.3%) had reoperations at a mean (SD) of 319 (327) days from their original operation. Of these 16 patients, 13 had a prosthetic valve placed and 3 were repaired again. The patients had their preoperative echocardiograms compared with ones done immediately after repair as well as ones done at follow-up visits. The mean (SD) of these follow-ups was 815 (459) days. Before repair, 28 patients had moderate regurgitation and 272 had severe regurgitation. Immediately after repair, 280 had none, 12 had trace, 5 had mild, and 3 had moderate regurgitation. Of the 279 patients who followed up, 125 had none, 67 had trace, 66 had mild, 15 had moderate, and 6 had severe regurgitation. All of the patients who had severe regurgitation during their follow-up had another operation. Kaplan-Meier survival rate was 96.6% (1.5%) at 5 years, and freedom from reoperation rate was 93.8% (1.6%).

Suri et al7 looked at echocardiograms preoperatively as well as after bypass and at hospital discharge. The robotic patients also had studies done 30 days after their surgery. Immediately after bypass, all patients in both sternotomy and robotic groups had less than mild regurgitation. At discharge, the robotic and sternotomy groups had 78 patients each with none to trace regurgitation. The sternotomy group had 16 with mild and 1 with moderate regurgitation, whereas the robotic group had 17 with mild regurgitation. It was noted that regurgitation was indistinguishable between groups at discharge. At the 30-day follow-up, all patients in the robotic group had less than or equal to mild regurgitation.

Mihaljevic et al assessed the efficacy of their mitral valve repairs on the basis of routine predischarge echocardiography. Their quality across matched groups was similar because more than 95% of patients had none or mild regurgitation before discharge. When compared with sternotomy, the robotic group had 98% with none to mild regurgitation; compared with partial sternotomy, the robotic group had 97% with none to mild regurgitation; and compared with thoracotomy, the robotic group had 96% with none to mild regurgitation. In each of the comparisons, the alternative approach had 99% with none to mild regurgitation. The robotic approach was found to be safe because there were no operative deaths. Complications were defined by the Society of Thoracic Surgeons and were similar among all groups. It was noted that the robotic group had the lowest prevalence of new postoperative atrial fibrillation.

Limitations

The FDA study was a fairly homogeneous population but otherwise lacking only in longer-term follow-up data and results. This study also had what each of the other studies lacked: multiple institutions. All 3 of the other studies, although with larger populations, were done at only 1 hospital each. Chitwood et al compared their robotic data with historical data for only sternotomy-repaired mitral valves. The 2 studies that had good comparative data for alternative approaches to robotically assisted repairs were the most lacking in long-term follow-up.7,12 The main limitation in all studies was follow-up and long-term evidence to compare because 5- to 20-year follow-up data are not yet available. This is still a newer technology, having been approved for intracardiac surgery only in 2002.

Discussion and Opinion

The results from these studies show the promise of robotic mitral valve repair as a safe and efficient option for patients with mitral valve prolapse or regurgitation. The outcomes of all 4 studies demonstrate that robotic repair is a viable option for appropriate candidates. Only Mihaljevic et al and Suri et al looked at their own data for alternative surgical approaches other than robotic. Each came up with their own results, indicating benefits such as decreased postoperative intubation times, decreased intensive care unit lengths of stay, and decreased length of hospital stay when patients who underwent robotic surgery were compared with those treated with invasive surgical repair. Although randomized trials would most likely meet with difficulty finding patients willing to participate, on the basis of the major difference in invasiveness, both studies used propensity matching to mimic randomization and further validate their findings.

The progressive decline of cross-clamp, bypass, and total operative times make it evident that a learning curve exists within this specialty, as can be seen in the individual studies themselves, as well as during the time frame between the oldest and newest studies. The end result of similar postoperative outcomes to conventional techniques means that nurse practitioners and registered nurses serving as patient advocates need to be made aware that robotic surgery is a realistic option. Mitral valve repair has benefits of its own when compared with replacement, including increased survival and decreased mortality rates. When robotic surgery is considered, the patient benefits are not only equal outcomes but also reduced trauma, shorter hospital length of stay, and fewer reoperations. As guidelines move toward advocating early repair for degenerative mitral disease, asymptomatic or minimally symptomatic patients will benefit most as they seek to avoid traditional surgical incisions when given less invasive options, in hopes of minimizing the temporary postoperative disability.7

Robotic benefits to the surgeons consist of 3-dimensional visualization with digital and analog camera zoom, wrist-like articulations with 7 degrees of ergonomic freedom,
Clinical Pearls

- Evidence shows that robotic mitral valve repair has similar postoperative outcomes when compared with conventional techniques.
- Healthcare providers must be aware of the criteria used to select the appropriate candidate for whom robotic mitral valve surgery is a realistic option.
- Benefits of robotic mitral valve repair include equal reduction in mitral regurgitation grades postoperatively, reduced trauma, shorter hospital stays, and fewer reoperations compared with traditional repair methods.

Tremor filtration, and ambidexterity. With these enhancing capabilities at the surgeons’ disposal, there is an opening in the field to determine which categories of mitral prolapse can and/or should be repaired robotically. One study examining both anterior leaflet and bileaflet prolapse repairs shows that more complex diseases can be robotically repaired, but further study is needed. In addition, when considering a patient for robotic surgery, there should be some research into those who have had a previous sternotomy and/or mitral repair. The less invasive robotic approach means that a surgeon does not need to transect the sternum again, preventing a variety of complications that could arise. Lastly, the methods through which the repair is done, either traditional as an open repair or modified with mitral clips or other suturing techniques, should be studied to see which works better with robotic assistance. With further research can come the adoption of standardized and reproducible techniques that can improve the safety, efficacy, and durability of the robotic approach to surgical mitral valve repair.

REFERENCES