Minimally Invasive Mitral Valve Surgery with or without Robotics: Examining the Evidence

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Abstract

Minimally invasive mitral valve surgery can be performed with or without robotic assistance. In this issue of the journal Zheng et al compare between these two approaches in a propensity matched study over a 5 year period and show that the two techniques have similar successful short and mid term outcomes. Although we are proponents of the robotic approach, we agree with their conclusions and discuss in this commentary some of the previously published studies that have shown similar findings.

JOCS Commentary

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Commentary

In this issue of the Journal of Cardiac Surgery, Zheng et al. demonstrate that robotic mitral valve repair provided comparable short- and mid-term survival and freedom from mitral valve reoperation when compared to mini-thoracotomy approach in a propensity matched cohort [1]. Minimally invasive mitral valve surgery (MIMVS) with a mini-thoracotomy approach was first described in 1998 [2], followed by the first robotic assisted MIMVS performed by the same group [3]. In the United States, after the da Vinci surgical system was approved in 2002 following FDA trials lead by Chitwood, Nifong and colleagues [4, 5], the number of both mini-thoracotomy and robotic assisted MIMVS has dramatically increased over the last 20 years [6]. This trend has been encouraged by favorable short-term outcomes of both MIMVS approaches reported in several meta-analysis and retrospective studies in high-volume centers. Almost all the studies comparing sternotomy versus mini-thoracotomy [7-11], or sternotomy versus robotic assisted MIMVS [12-18], demonstrated similar findings in that both MIMVS approaches provided better short-term outcomes including shorter hospital stay, less need for blood transfusions, lower incidence of postoperative atrial fibrillation, and earlier return to normal activity despite the longer procedure time compared to sternotomy. Mid-term outcomes of mini-thoracotomy [8] and robotic assisted MIMVS [13] were also equivalent to a sternotomy approach. Although, the safety and feasibility of the two MIMVS approaches have been verified, as the authors mentioned, there has been a paucity of data directly comparing mini thoracotomy versus a robotic assisted approach in the literature. One study investigating these two MIMVS approaches was a propensity matched analysis conducted by Mihaljevic et al. who found that robotic assisted MIMVS resulted in longer procedure times, but lower rates of atrial fibrillation resulting in shorter length of hospital stay compared to mini-thoracotomy MIMVS [19]. Hawking et al. compared 295 propensity matched patients who underwent MIMVS with either mini-thoracotomy or robotic assisted approach and concluded that robotic assisted MIMVS had higher rate of atrial fibrillation, more need for blood transfusions and longer length of hospital stay [20]. Regarding long-term outcome comparisons, a propensity matched study by Barac et al. demonstrated 5-year mortality of 3 % and incidence of mitral valve reoperation of 3 %, which did not differ between robotic assisted MIMVS and mini-thoracotomy MIMVS [21]. Although further studies including randomized controlled trials would be warranted on this topic, most surgeons and institutions focus on one or the other of these techniques making it difficult to achieve meaningful randomization. In addition, the current evidence points to the fact that both mini-thoracotomy and robotic assisted MIMVS provide similar short- and long-term outcomes in terms of morbidity and mortality.

Even with equivalent clinical outcomes seen in the two MIMVS approaches, we think that the most crucial advantage of using robotic technology is the excellent visualization afforded by the high-definition three-dimensional camera in current robotic systems. In addition to that, wristed instruments and the dynamic manipulability of a left atrial retractor facilitate excellent exposure of mitral valve and the meticulous execution of complex repair techniques (e.g., neo-chord implantation, leaflet resection, and patch reconstruction) all while using a port only approach. With the aid of these technologies, several centers have recently reported excellent clinical outcomes of robotic assisted MIMVS. The largest series of robotic assisted MIMVS to date was published by Murphy et al in 2015, who reviewed outcomes of 1257 patients with short-term mortality of 0.9% and incidence of mitral valve reoperation of 3.8 % at a mean follow-up of 50 months [22]. The Cleveland Clinic group reported outcomes of 1000 robotic assisted MIMVS cases and showed excellent short-term mortality of 0.1 % [23]. Other centers also reported similar short-term results of their series of hundreds of patients undergoing robotic MIMVS [24, 25]. Chitwood et al. reported long-term outcomes of robotic assisted MIMVS with a 5-year mortality of 3.4 % and incidence of mitral valve reoperation of 6.2 % [26]. Mayo Clinic reviewed 487 robotic assisted MIMVS cases and found that the 5-year mortality was 0.5 % and the incidence of reoperation was 2.3 % [27]. The same institution published 10-year outcomes of 843 patients with a mortality of 7 % and incidence of mitral valve reoperation of 7.4 % in 2021 [28]. These long-term outcomes were comparable to the sternotomy data published in previous reports [29, 30]. Some centers have assessed the feasibility of robotic assisted MIMVS in a wide range of mitral pathologies with more complex repair techniques (e.g., bileaflet repair, mitral annular calcification excision) [31-33]. Fujita et al. reported that patients who underwent robotic assisted MIMVS had a higher complexity score requiring more complex repairs than patients undergoing mini-thoracotomy MIMVS [32]. Neo-chord implantation was attempted more in robotic assisted MIMVS though procedure times did not differ between the two groups. Regarding complexity, Rowe et al. conducted robotic MIMVS for Barlow type mitral disease with 5-year freedom from greater than moderate mitral regurgitation of 92 %, which was similar to non-Barlow disease [33].

In our own practice the senior author has been performing sternal sparing mitral valve surgery since 2003 which began as a mini-thoracotomy approach and gradually transitioned to an all-robotic approach around 2010. The impetus to moving to a robotic approach was to minimize the size of the ports and transition to a truly endoscopic procedure, while adding the benefits of dexterity and improved visualization. In our current practice we perform endoscopic robotic MIMVS as a standard treatment for both simple and complex mitral valve disease. Based on our experience, the key to safely perform robotic MIMVS for a wide range of patients with various types of mitral pathology is to have a dedicated robotic team for whom the robot is a routine addition in the operating room. Another key factor is a thorough understanding of peripheral perfusion techniques and myocardial protection options. In particular, having several cardiac arrest options is important. We routinely utilize 3 modalities which are transthoracic aortic clamp, endoaortic balloon occlusion and ventricular fibrillatory arrest based on patient and technical factors. In general, transthoracic aortic clamp is the most used in mini-thoracotomy MIMVS and is the easiest to master. The endoballoon however may be more attractive in re-operative procedures and to avoid the need for a separate aortic antegrade catheter puncture site. On the other hand, if the patient has a competent aortic valve and a patent IMA graft, moderate hypothermic ventricular fibrillatory arrest can be an option in less complex repairs.

These considerations are obviously important in non-robotic approaches to MIMVS as well.

Finally, cost considerations have forced many programs interested in MIMVS to adopt a non-robotic platform. Recent advances in non-robotic 3D visualization have helped enhance this approach. As can be seen by this study from Zheng et al and from prior publications in the literature, excellent outcomes can and should be expected in MIMVS whether or not a robotic platform is used.

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