

Should a Video-Assisted Mini-Thoracotomy be the Approach of Choice for Reoperative Mitral Valve Surgery?

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Background and aim of the study: Reoperative cardiac surgery carries a greater morbidity and mortality than primary cardiac surgery. The study aim was to compare perioperative outcomes in patients undergoing mitral valve surgery who had already undergone a previous cardiac operation using either a minimally invasive video-assisted (MIVA) mini-thoracotomy or a redo median sternotomy (MS).

Methods: Between January 1996 and June 2003, 71 consecutive patients with prior cardiac surgery underwent mitral valve surgery. Of these operations, 38 were MIVA procedures, performed through a 5-cm right anterior thoracotomy using voice-activated robotic camera control (AESOP 3000™). Outcome was compared with results in 33 consecutive patients who underwent a standard redo MS.

Results: The MIVA and redo MS cohorts differed in preoperative ejection fraction ($46 \pm 2\%$ versus $55 \pm 2\%$; $p = 0.004$) and percentage of urgent operations (33 versus 8.3%; $p = 0.01$). Operative mortality was

similar in both groups (5.7% and 5.9% respectively; $p = 0.976$), as were cardiopulmonary bypass, operating room, and ICU times. Postoperative intubation time was shorter in the MIVA group than in the redo MS group (29.1 ± 8.9 versus 38.0 ± 9.9 h; $p = 0.008$), and blood transfusion requirements were also reduced (2.9 ± 0.6 versus 5.5 ± 0.7 units; $p = 0.001$) respectively. Length of hospital stay was significantly less in the MIVA group (7.1 ± 1.3 versus 11.2 ± 1.1 days; $p = 0.001$).

Conclusion: Minimally invasive video-assisted mitral valve operations may be performed safely and efficiently in patients with prior cardiac surgery. Demonstrated advantages include fewer red blood cell and blood product transfusions, as well as decreased intubation time and length of hospital stay.

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Although the first mitral valve commissurotomies performed by Harken and Bailey were carried out through a right thoracotomy, the traditional modern mitral valve surgery approach has been via a median sternotomy (1,2). During the 1980s, several authors utilized the right thoracotomy as an alternative approach for mitral valve surgery in a redo setting (3,4). The introduction of modern perfusion cannulae, minimally invasive surgical instruments, and video-assisted surgery has created a new alternative approach for patients undergoing mitral surgery (5). The study aim

was to compare operative outcomes, using either a minimally invasive video-assisted (MIVA) mini-thoracotomy or a redo median sternotomy (MS), in mitral valve surgery patients who had undergone prior cardiac surgery.

Clinical material and methods

Patients

Between January 1996 and June 2003, 71 consecutive patients who had undergone prior cardiac surgery underwent mitral valve repair or replacement. Among these operations, 38 were MIVA procedures, performed through a 5-cm right anterior thoracotomy. Voice-activated robotic camera control (AESOP 3000™) was employed. Outcome was compared to results obtained in 33 consecutive patients who underwent a standard redo MS. Emergency, second-time redos or more, and combined procedures were excluded from this study.

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There was a trend toward a higher mean age in the MIVA group (67.9 ± 1.5 years) than in the redo MS group (62.9 ± 2.0 years) ($p = 0.090$), and preoperative ejection fractions were lower in the MIVA group ($46 \pm 2\%$) than in the redo MS group ($55 \pm 2\%$) ($p = 0.004$). There were more urgent surgeries in the redo MS group than in the MIVA group (33 versus 8.3%; $p = 0.01$), but the degree of congestive heart failure in both groups was similar (Fig. 1).

Operative technique (minimally invasive)

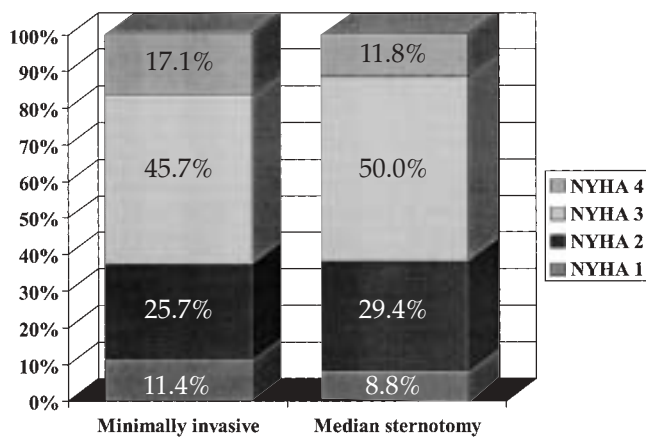
Patients were intubated with a double-lumen endotracheal tube for single-lung ventilation, and positioned with the right chest elevated at 45°. Cardiopulmonary bypass (CPB) was established at 26°C using femoral arterial inflow (17 Fr; Medtronic, Bio-Medicus, USA), femoral venous drainage (22-25 Fr; Cardioventions, Ethicon, USA), and right internal jugular venous drainage (17 Fr; Medtronic). All cannulations were performed under transesophageal echo guidance. All cases utilized suction-assisted venous drainage with a vortex pump. A 5-cm right submammary incision was performed, and the chest entered via the 4th-intercostal space. Once appropriate dissection was achieved, fibrillatory arrest was induced, and the left atrium opened. Exposure of the valve was achieved with a transthoracic atrial retractor (Cardioventions) placed through a small left atriotomy. A left atrial sump sucker maintained a dry operative field, and intrathoracic carbon dioxide was insufflated continuously to displace intracardiac air. A 5-mm, two-dimensional (0° or 30° view) thoracoscope (Linvatec, Inc., Largo, FL, USA) was placed parallel to the right superior pulmonary vein. A voice-activated AESOP 3000 system (Computer Motion, Inc., Santa Barbara,

CA, USA) was attached to the thoracoscope for camera control. Long-shafted instruments, passed through the incision, provided tissue removal, leaflet remodeling, suture placement, chordal transfers and replacements, annuloplasty ring implantation, and knot tying. Annuloplasty bands or rings were sized using standard sizers. Excision of the leaflets, placement of valve sutures, knot tying, and prosthesis seating were carried out using a combination of direct vision and video-assistance. Left atriotomy closure was performed under direct vision without video assistance.

St. Jude Medical prostheses (St. Jude Medical, Inc., St. Paul, MN, USA) were used for valve replacements with chordal preservation techniques. For annuloplasties, either the Cosgrove-Edwards band (Edwards Life Sciences, Inc., Irvine, CA, USA) or the Carpentier-Edwards Physio Ring were used. Ti-Cron sutures (US Surgical, Norwalk, CT, USA) were used to secure the prosthetic valves, rings, or bands to the annulus. A 4-0 Cardionyl monofilament suture (Peters, Inc., Paris, France) was used for leaflet repairs, and a 4-0 Gore-Tex suture (WL Gore and Associates, Scottsdale, AZ, USA) was used for prosthetic chordal replacements.

Statistical analysis

Statistical comparison included a ranks-based, non-parametric Mann-Whitney test and chi-square test, as indicated. Data were reported as mean \pm SEM.



P=0.611

Figure 1: Comparison of NYHA functional class of the two patient groups.

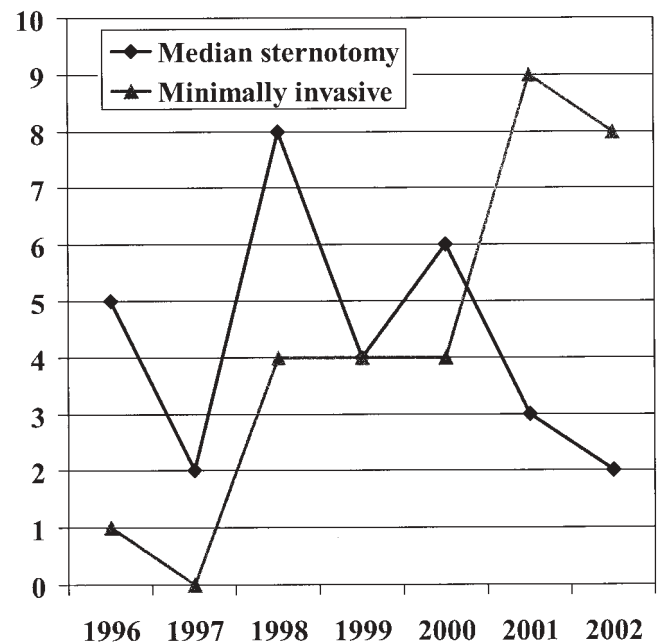


Figure 2: Numbers of minimally invasive video-assisted (MIVA) or redo median sternotomy (MS) approaches for repeat mitral surgery in East Carolina University, 1996-2002.

Table I: Intraoperative and postoperative patient parameters.

Parameter	Surgical approach	Mean	Median	Minimum	Maximum	SEM	p-value
Surgery time (h)	MIVA	4.5	4.3	1.6	8.6	0.25	0.297
	MS	4.9	4.4	2.7	8.4	0.32	
CPB time (min)	MIVA	160	155	78	371	10.5	0.985
	MS	157	150	80	264	9.4	
Ventilation time (h)	MIVA	29.1	11.4	5.6	230	8.9	0.008
	MS	38.0	18.3	7.0	288	9.9	
ICU time (days)	MIVA	2.44	1.0	1	25	0.7	0.266
	MS	2.71	1.5	1	12	0.5	
Hospital LOS (days)	MIVA	7.1	5.0	3	47	1.3	0.001
	MS	11.2	8.0	3	34	1.1	
Bleeding (ml)	MIVA	1,178	630	100	4,234	183	0.850
	MS	1,112	810	110	4,985	132	
Transfusion of RBC (units)	MIVA	2.86	2.0	0	17	0.6	0.001
	MS	5.5	4.0	0	15	0.5	
Transfusion of blood products (units)	MIVA	5.4	0	0	58	1.8	<0.001
	MS	16.6	15.5	0	38	1.6	

Results

There were no retrograde aortic dissections or other complications of peripheral cannulation in the MIVA group. There were no incision conversions from the MIVA group to redo MS. Significantly more mitral valve repairs were carried out in the MIVA group (42%) than in the redo MS group (8.8%) ($p = 0.003$).

No group differences were found in the overall duration of the procedure, CPB time or intensive care length of stay (Table I). Postoperative ventilation time was less in MIVA patients (29.1 ± 8.9 h) than in redo MS patients (38.0 ± 9.9 h) ($p = 0.008$).

Hospital length of stay was shorter in the MIVA group (7.1 ± 1.3 days) compared to the MS group (11.2 ± 1.1 days) ($p = 0.001$).

There was no difference in bleeding between the two groups; however, there were significantly fewer red cell transfusions in the MIVA group, as well as overall less use of blood products in the MIVA patients (Table I).

The intraoperative and 30-day mortality rates were similar in both groups (5.7% after MIVA; 5.9% after MS) ($p = 0.976$).

At the present authors' institute, the proportion of mini-mitral re-do operations increased to 80% in the year 2002 (Fig. 2).

Discussion

Mitral valve surgery, in the setting of prior cardiac surgery, represents a continuing challenge to offer patients a safe and effective repair or replacement. The right anterior thoracotomy for repeat cardiac surgery has been shown effective in avoiding a repeat median

sternotomy and its associated potential complications, such as injury to the heart, phrenic nerve, great vessel and patent internal thoracic coronary artery graft (6,7).

The combination of video-assisted robotic technology and modern bypass techniques now allows superb visualization to be achieved in redo cardiac operations performed through a small right anterior thoracotomy. The relative high percentage of repairs versus replacements in the MIVA group represents the degree of accessibility and visualization of the mitral valve through this approach. The combination of internal jugular and femoral venous suction drainage with femoral arterial inflow, as well as transthoracic suction, CO₂ insufflations and robotic-controlled vision, allows a reduction in the size of the incision, without compromising surgical results (8,9).

In the present study, there was no difference between the two groups regarding the length of the procedure or CPB time. Tribble et al. (3) demonstrated shorter bypass times in the thoracotomy group, probably due mainly to 100% valve replacements as compared to 42% in the present study, and on the basis that mitral valve repair takes longer than replacement. A similar duration of CPB time in patients who had a higher percentage of repairs was shown by Steimle and Bolling (6). In the present study, comparable chest tube drainage between the two groups, with significantly less use of red blood cells in the MIVA group, may represent a more conservative approach in these patients. However, the need for fewer blood products probably represents less coagulopathy at the end of the procedure, which has been demonstrated in previous studies (10).

The reductions in postoperative ventilation time and hospital length of stay in the MIVA group seemed to be related to the minimally invasive nature of the procedure, with earlier recovery of this patient population. The consistent increase in use of the MIVA approach for re-do patients at the present authors' institution represents a growing confidence in the procedure's advantages, as well as the patients' demands.

Study limitations

The present study was not a prospective and randomized trial, and therefore some differences between the two study groups were detected. Specifically, there was a trend towards older patients and a significantly lower preoperative ejection fraction in the MIVA group. Although more urgent operations were performed in the redo MS group, careful assessment of the NYHA heart failure class revealed no difference between the two groups.

In conclusion, minimally invasive video-assisted mitral valve operations may be performed safely and efficiently in patients with prior cardiac surgery. Demonstrated advantages include fewer red blood cell and blood product transfusions, as well as shorter ventilation times and lengths of hospital stay.

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Meeting discussion

DR. PROBAL GHOSH (Salzburg, Austria): I am not clear how your cases were selected for the MIVA group - what criteria were used? And what was the reason for the different uses of blood products?

DR. GIL BOLOTIN (Greenville, North Carolina, USA): The first minimally invasive operations were carried out in 1996, but both approaches were used during the years. The decision of which approach to use is largely down to surgeon confidence. In recent years, most patients underwent minimally invasive operation. This is not a randomized trial, so there is a difference between the groups. Regarding the lack of differences in bleeding and use of less blood products and red blood cells, it is possible that the surgeons and hospital staff try to give less blood products to the minimally invasive group, but it more likely represents less coagulopathy after the operation. Usually, we treat the patient with factors because of bleeding in the operating room, or immediately after surgery if bleeding has occurred.

DR. GHOSH: What was the reason for redo surgery in both groups?

DR. BOLOTIN: There was no significant difference between groups regarding the reason for the reoperation. There were about 70 patients in total - perhaps not enough patients to see a statistically significant difference - but there was no difference between the groups.

DR. GHOSH: One last question - you must have performed some reoperations through the right thoracotomy. Do you have any information comparing the MIVA with the standard right thoracotomy redos?

DR. W. RANDOLPH CHITWOOD (Greenville, North Carolina, USA): We have not used the right thoracotomy for a long time. Before 1996, we used a larger right thoracotomy and then just reduced the size. You cannot randomize this group.

DR. OLIVIER JEGADEN (Lyon, France): Why do you prefer ventricular fibrillation rather than the endoaortic clamp?

DR. BOLOTIN: You have to do less dissection and the preservation of the heart is very good. So I think fibrillatory arrest is a good option and it saves time.