

Robotic-assisted mitral valve surgery without aortic cross-clamping: A safe and feasible technique

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ABSTRACT

BACKGROUND: The primary objective of this study was to evaluate the safety and feasibility of robotic-assisted mitral valve surgery without aortic cross-clamping.

METHODS: From January 2010 to September 2022, 28 patients underwent robotic-assisted mitral valve surgery without aortic cross-clamping in our center using Da Vinci Robotic Systems. Perioperative variables and early clinical outcomes were recorded.

RESULTS: Most patients were in New York Heart Association (NYHA) class II and III. Mean age and EuroScore II of the patients were 71.5 ± 13.5 and 8.4 ± 3.7 respectively. The patients underwent either mitral valve replacement (n=16, 57.1%) or mitral valve repair (n=12, 42.9%). Concomitant procedures were performed including tricuspid valve repair, tricuspid valve replacement, PFO closure, left atrial appendage ligation, left atrial appendage thrombectomy and cryoablation for atrial fibrillation. Mean CPB times were 140.9 ± 44.6 and mean fibrillatory arrest duration was 76.6 ± 18.4. Mean duration of ICU stay was 32.5 ± 28.8 hours and mean duration of hospital stay 9.8 ± 8.3 days. One patient (3.6%) underwent revision due to bleeding. New onset renal failure was observed in one (3.6%) patient and postoperative stroke in one (3.6%) patient .

CONCLUSIONS: Robotic-assisted mitral valve surgery without cross-clamping is a safe and feasible technique in high-risk patients undergoing redo mitral surgery with severe adhesions as well as in primary mitral valve cases that are complicated with ascending aortic calcification.

INTRODUCTION

Myocardial protection is usually achieved by placing an aortic cross-clamp and delivering cardioplegia in conventional cardiac surgery as well as in robotic-assisted intracardiac repairs. However, this technique represents a clinical challenge in patients undergoing redo cardiac surgery due to adhesions surrounding the heart and the great vessels and also in patients who present with extensive aortic calcification which increases the risk of cerebrovascular accidents and further complications during cross-clamping. The primary objective of this study was to evaluate the safety and feasibility of robotic-assisted mitral valve surgery without aortic cross-clamping.

Table 2: Operative data

Variables	Patients (n=28)
Mitral Surgery	
Mitral valve repair	12 (42.9)
Mitral valve replacement	16 (57.1)
Mitral prosthesis	
Mechanical valve	8 (50)
Biological valve	8 (50)
Concomitant Procedures:	
Tricuspid valve replacement	1 (3.6)
Tricuspid valve repair	10 (35.7)
PFO Closure	2 (7.1)
LAA Ligation	7 (25)
Cryoablation	6 (21.4)
LAA Thrombectomy	1 (3.6)
Operative duration (min):	
Fibrillatory arrest	76.6 ± 18.4
Cardiopulmonary bypass	140.9 ± 44.6

Data are expressed as mean ± standard deviation or number (%). PFO, patent foramen ovale; LAA, left atrial appendage.

Table 1: Preoperative characteristics of patients

Demographics	n= 28
Age (years)	71.5 ± 13.5
Female gender	12 (42.9)
EuroScore II	8.4 ± 3.7
NYHA Class 2	14 (50)
NYHA Class 3	13 (46.4)
BMI	27 ± 4
Diabetes Mellitus	12 (42.8)
Hypertension	22 (78.6)
Hypercholesterolemia	9 (32.1)
Preoperative AF	10 (35.7)
EF (%)	55.3 ± 9.3
LVEDD (cm)	5.2 ± 0.6
LVESD (cm)	3.5 ± 0.6
Pulmonary artery systolic pressure (mmHg)	56.9 ± 19.2
Creatinine (mg/dL)	1.1 ± 0.4
Previous cardiac procedures	15 (53.6)
Ethiology of Mitral Valve Pathology	
Myxomatous/degenerative mitral valve disease	14 (50)
Rheumatic mitral valve disease	6 (21.4)
Infective endocarditis	2 (7.1)
Ischemic mitral valve disease	1 (3.6)
Prosthetic valve dysfunction	5 (17.9)

Data are expressed as mean ± standard deviation or number (%). NYHA, New York Heart Association; BMI, Body Mass Index; AF, atrial fibrillation; EF, ejection fraction; LVEDD, left ventricular end diastolic diameter; LVESD, left ventricular end systolic diameter.

METHODS

From January 2010 to September 2022, 301 patients underwent robotic-assisted mitral valve surgery in our center using Da Vinci Systems and in 28 of these patients (9.3%), the operation was completed without cross-clamping and on the fibrillating heart. Myocardial protection was achieved with moderate hypothermia and ventricular fibrillatory arrest. Severe pericardial adhesions due to previous cardiac operations or existence of highly calcified ascending aorta were the indications for fibrillatory arrest during robotic-assisted surgery.

The classical set-up for the robotic mitral operations in our center was as described previously (1). A mini thoracotomy is performed after the anesthetic preparation is completed, usually at the right 4th intercostal space and of 4 cm length. Left and right working ports are inserted through the 3rd and 5th intercostal spaces, respectively. The camera is sent through the soft tissue retractor and cardiopulmonary bypass (CPB) is started.

Our technique for robotic assisted cardiac surgery without aortic cross clamping was described elsewhere (2). The fibrillator cable which was delivered through the service port was used to fibrillate the heart. The patients were cooled down to 28°C, and the aim was to keep this level of hypothermia throughout the procedure to prevent any spontaneous conversion to sinus rhythm during surgery. Carbon dioxide was continuously insufflated (5L/min) to displace intracardiac air and vacuum assist via venous cannulas was used in case of need. Additionally, the left ventricular catheter helps in avoiding distention of the left ventricle. The rest of the operation was continued in conventional fashion via robotic arms. Deairing is one of the most essential and important parts of the procedure. For this purpose, two suction catheters are used, one of them being kept in the left atrium and the other in the left ventricle via mitral valve. Both catheters are kept in place until the end of CPB and are not removed until no air is visible in transesophageal echocardiogram.

RESULTS

Mean CPB times were 140.9 ± 44.6 and mean fibrillatory arrest duration was 76.6 ± 18.4. The mean mechanical ventilation time was 8.3 ± 5.3 h, mean duration of ICU stay was 32.5 ± 28.8 hours and mean duration of hospital stay 9.8 ± 8.3 days. Mean drainage in ICU was 334.6 ± 270.2 ml, and one patient (3.6%) underwent revision due to bleeding. New onset renal failure was observed in one (3.6%) patient in the postoperative period. Autotransfusion was used in all patients. There was no case of conversion to open thoracotomy or sternotomy. Transient or permanent AV block was not observed in any of the patients.Postoperative early mortality was observed in two (7.1%) patients, the first due to a pulmonary infection and the second due to a cerebrovascular accident alongside GI ischemia causing multiorgan failure.

CONCLUSIONS

Robotic-assisted mitral valve surgery without cross-clamping and under fibrillation represents a good alternative to conventional mitral valve surgery with cross-clamping and cardioplegic arrest. Our results suggest that the technique is safe and feasible in high-risk patients undergoing redo mitral surgery with adhesions as well as in primary mitral valve cases that are complicated with ascending aortic calcification.

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Table 3: Postoperative Outcomes

Outcomes	n=28
Mechanical ventilation time (h)	8.3 ± 5.3
ICU Stay (h)	32.5 ± 28.8
Inotrope Support	
None	22 (78.6)
Low Dose	1 (3.6)
High Dose	5 (17.9)
Blood transfusion requirement	3 (10.8)
Postoperative atrial fibrillation	6 (21.4)
Transient AV Block	0 (0)
Permanent AV Block	0 (0)
Postoperative stroke	1 (3.6)
Postoperative dialysis	1 (3.6)
Infection	
Pneumonia	1 (3.6)
Urosepsis	1 (3.6)
Chest tube drainage in ICU (mL)	334.6 ± 270.2
Reoperation	1 (3.6)
Hospital stay (days)	9.8 ± 8.3
Reintubation	4 (14.3)
30-day mortality	2 (7.1)

Data are expressed as mean ± standard deviation or number (%). ICU, intensive care unit.

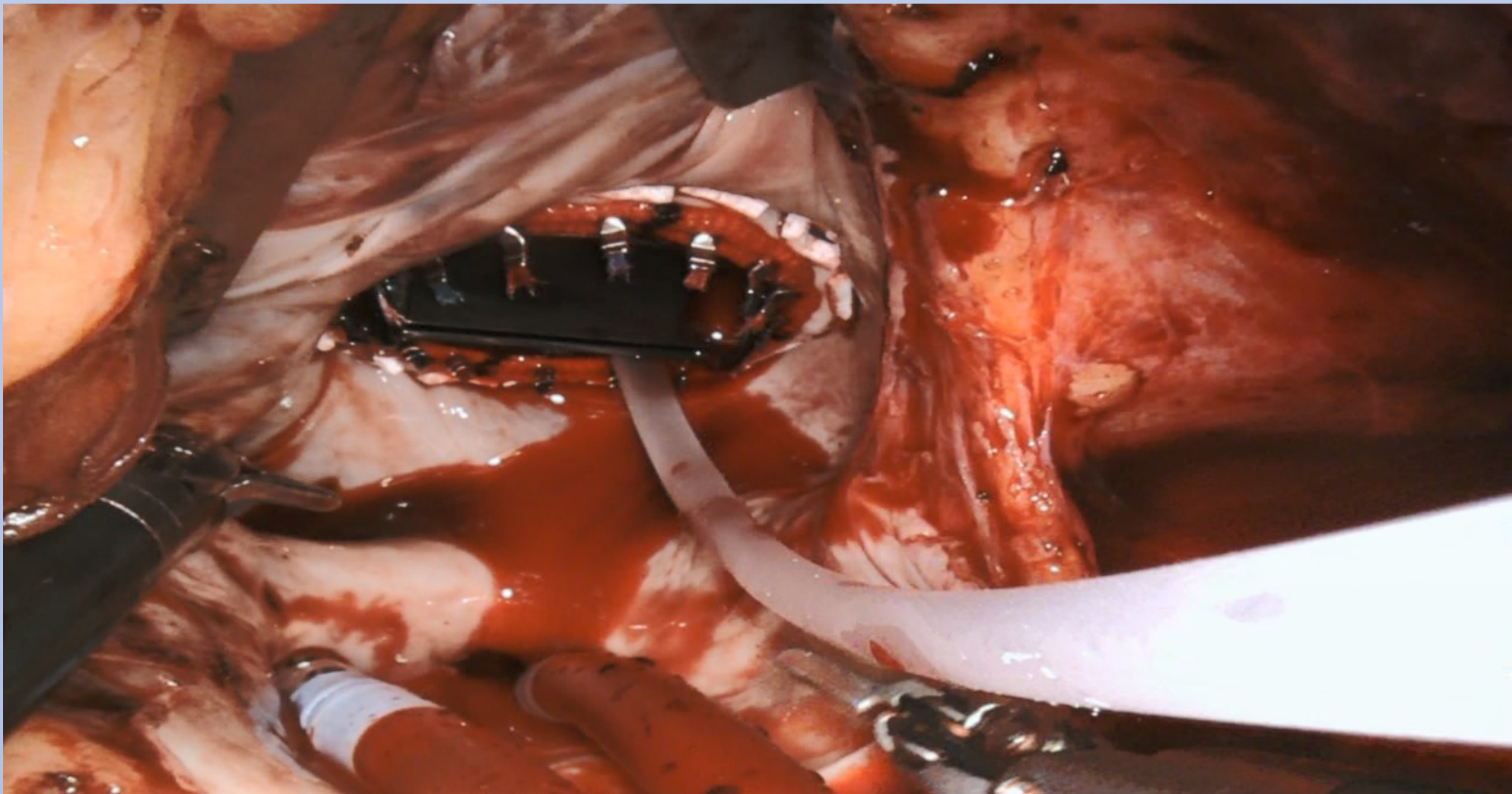


Figure 1: Placing a sump into the left ventricle through a mechanic mitral valve



Figure 2: Placing a sump into the left ventricle through a biological mitral valve