



Robotic assisted minimally invasive surgery for atrial septal defect correction

Cirurgia minimamente invasiva robô assistida na correção da comunicação interatrial

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CHARACTERIZATION OF PATIENT

The characteristics of the patient are: female, 24 years old, 55 kg. She came to our department with complaints of fatigue and palpitations. She denied any associated disease or medication use. On physical examination, the patient was eutrophic, eupneic at rest, without edema. No alterations of pulmonary auscultation and cardiac auscultation revealed a sinus rhythm, with pulmonary systolic murmur with fixed splitting of 2nd heart sound. Resting blood pressure (BP) was: 100/70 millimeters of mercury (mmHg).

The chest radiograph showed normal heart size and increased pulmonary vasculature. Echocardiography revealed a normal left atrial dimension (LA) of 2.9 centimeters (cm) and left ventricular (LV) diameter within normality (LV Systolic Diameter: 2.5 cm - LV Diastolic Diameter: 4.2 cm) and normal myocardial thickness. The other cavities were also normal. The presence of interatrial communication (IAC) *secundum ostium* type showed the Doppler that the shunt with unidirectional flow of LA to the right. The ejection fraction was estimated at 72% (Simpson). The pulmonary

artery pressure was estimated at 40 mmHg and increased pulmonary blood flow: 1.5 cm /second (cm/s).

The electrocardiogram showed sinus rhythm with right bundle branch block.

After discussing the clinical case, the surgery to repair the IAC was indicated. In a conversation with the patient after the explanation of the techniques type available to the IAC and also signed informed consent, she chose the robot-assisted minimally invasive approach [1].

Surgical correction consisted of atrial septal defect with a bovine pericardial patch. The duration of extracorporeal circulation (EC) was 63 minutes (min) and aortic clamping, 38 min.

The patient was extubated in the operating room; the postoperative bleeding was 340 milliliters (ml), length of ICU stay of 14 hours, had a great postoperative evolution and was discharged on the 2nd day after surgery. On the discharge day, the echocardiogram showed a normal ventricular function and an intact atrial septum, with well positioned patch without residual shunt.

THE VIDEO PERTINENT TO THE TEXT IS PUBLISHED ON THE JOURNAL WEBSITE: <http://www.rbccv.org.br/video/v27n3>

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There is no conflict of interest in this work.

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Abbreviations, Acronyms & Symbols	
LA	Left Atrium
IAC	Interatrial Communication
EC	Extracorporeal Circulation
cm	Centimeters
cm/s	Centimeters/seconds
RICS	Right Intercostal Space
Fr	French
l/min	Liters/minute
AAL	Anterior Axillary Line
MAL	Midaxillary Line
RML	Right Midclavicular Line
min	Minutes
ml	Milliliters
mmHg	Millimeters of Mercury
BP	Blood Pressure
PTFE	Polytetrafluoroethylene

DESCRIPTION OF SURGICAL TECHNIQUE

The patient was intubated using Robert Shaw probe intubation, for selective lung ventilation and positioned with the right chest elevated at 20°, with the arm alongside the body. Disposable pads for external cardiac defibrillation were placed in the region of the right scapula and anterolateral hemithorax. We performed the passage of nasopharyngeal thermometer and transesophageal transducer [2].

After central venous puncture through the right internal jugular vein and placement of double-lumen catheter, the same jugular vein was punctured in its proximal portion, and, through the Seldinger technique, a Bio-Medicus® arterial cannula (Medtronic, Inc.) No. 17 French (Fr) was introduced. The puncture was guided by ultrasound in right internal jugular vein and the cannula located in the region of the superior vena cava.

Initially the markings were made for surgical access (Figure 1). After preparing the skin, sterile transparent plastic adhesive was applied across the exposed area (3M Steri Drape®). Following the markings, three incisions were made in the right mammary groove: (1) a more anterior one of 0.8 cm to place an 8mm trocar to the right atrial retractor located between right midclavicular (RML) and the anterior axillary lines (AAL), (2) the second one measuring 1.2 cm for the introduction of a 12 mm trocar to the optics located 1 cm above the AAL and the third incision (3) for the working trocar measuring 2 cm, located after the AAL. The trocar into the right atrial retractor was introduced into the chest through the 5th right intercostal space (RICS) and the other two entered the chest cavity through the 4th RICS. Then, two more 0.8 cm incisions were made for the trocars and 8mm for the robot arms, the first (4) into two RICS near the

AAL, and another (5) at the 6th RICS, 2 cm after the AAL. A sixth incision (C) of 0.5 cm was made at the midaxillary line for introducing the transthoracic aortic clamp. CO₂ was continuously blown into the operative field at a rate of 3 liters / minute (l / min) through the trocar to the optic, which had a side entrance.

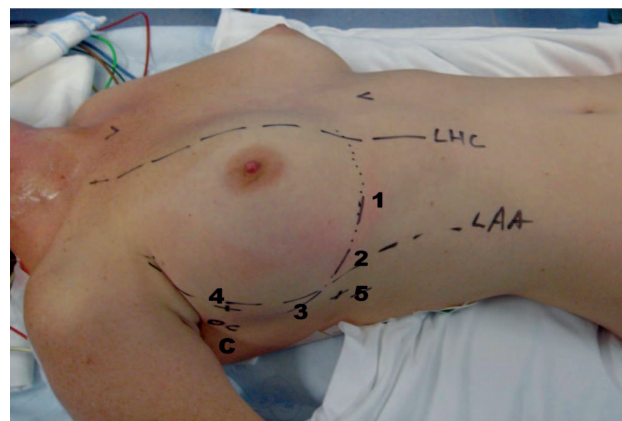


Fig. 1 - Preoperative Marking and locations for introduction: 1. Right atrial retractor 2. Optics, 3. Working trocar 4. Left arm of the robot 5. Right-arm of the robot, C. transthoracic aortic clamp. HL: Hemiclavicular line, AAL: anterior axillary line

After systemic heparinization, EC was established by cannulation of the femoral vessels, and the skin was incised in the right inguinal groove and the femoral vessels were cannulated using the Seldinger technique under direct vision. For arterial cannulation, Bio-Medicus cannula® No 19 Fr (Medtronic, Inc.) was used, and for venous line, Bio-Medicus® multistage femoral cannula N°. 21 Fr (Medtronic, Inc). For perfect positioning of the cannulas, we used transesophageal echocardiography. It was then initiated EC. Vacuum-assisted venous drainage was used. The patient was maintained at 32°C.

Before the introduction of the trocars, the right lung was selectivated. The trocar was located to the optics and a micro-camera was introduced. The right hemithorax was inspected and, subsequently, other trocars were inserted. Approximation was conducted with DaVinci robotic system (Intuitive Surgical Inc., Sunnyvale, CA) and connected to the trocars (Figure 2). The clamps used in the surgical procedure were specific for this robotic system and consisted of: large needlecases, Cardiere tweezers, DeBakey tweezers, scissors and dynamic atrial retractor. Under optical vision, the pericardium was opened 2 cm parallelly and anteriorly to the phrenic nerve. This incision extended from the superior to the inferior vena cava. The pericardium was pulled by two stiches, which were exteriorized through the chest wall using a retractor / hook. Both vena cava were dissected and tied with heart ribbon.



Fig. 2 - External aspect of the operative field: DaVinci® robotic system connected to trocars

Through the second RICS, transthoracic aortic clamp (Chitwood clamp - Fehling, Inc.) was introduced in the midaxillary line (MAL). By using thoracoscopy, the ascending aorta was clamped and punctured with a 30cm metal needle(Geister, Inc.) for administration of hypothermic antegrade cardioplegia (6°C) with (Custodiol ®)HTK solution. At the puncture site, a purse-string suture was performed with polytetrafluoroethylene (PTFE) (Gore-tex ® - CV-3) wire. The opening of the right atrium was performed parallelly to the atrial septum and removal done with the aid of a specific robotic surgical retractor.

From the opening of the right atrium until its closure, the CO₂ insufflation flow rate of 3 liters / min was maintained, with the goal of reducing the possibility of air embolism [3].

With the introduction of optics in the right atrium, IAC *ostium secundum* type was visualized with some remnants membranes, which was resected. Using measurements acquired by three-dimensional echocardiography, a compatible pericardial patch was made to fit the hole. The suture patch on IAC edges was performed continuously with PTFE (Gore-tex ® - CV-4) wire. Deaeration maneuvers of left chamberwere performed before completing suturing the pericardial patch with lung inflation. The right atrium was also closed through continuous suture in two layers of PTFE (Gore-tex ® - CV-4) wire. Both vena cava were untied. The purse-string suture in the ascending aorta was left open in the puncture site for cardioplegia, so that residual air of the ascending aorta could be evacuated. After appropriate deaeration, and checked by transesophageal echocardiography, the aorta was unclamped and the patient rewarmed.

After weaning from EC, another transesophageal echocardiogram was performed to demonstrate that the

bovine pericardium was well located and absence of residual shunt. The femoral vessels were decannulated and heparin reversed. Concomitantly, the right internal jugular vein was decannulated and achieved hemostasis by compression. After review of hemostasis, the pericardium was closed by 2-0 braided polyester sutures. The chest drain was exteriorized through the trocar orifice of the right arm of the robot and placed inside the pericardial sac. It was kept in negative aspiration of 20 mmH₂O.

The accesses were closed in layers, first the muscle and then the subcutaneous tissue with poligalactina 910 (Vicryl Plus ® - Ethicon) 2-0 and 3-0 wires. Intradermal stiches were used for skin sutures with polyglycolic acid (PGA Monocryl ® - Ethicon) 4-0 colorless cutting needle. The remaining holes with less than 1 cm were closed using simple stitches made by nylon 5-0 (Figure 3). The dressings were performed with Opsite (Smith & Nephew Plc ®).



Fig. 3 - Final surgical aspect of the operative field

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