Periareolar Access for Minimally Invasive Cardiac Surgery
The Brazilian Technique

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Abstract: The periareolar access has been the preferred technique used at our institution for minimally invasive cardiac surgery since 2006. The surgical approach consists of video-assisted minithoracotomy in the 4th right intercostal space, through a periareolar incision. Initially, the technique was restricted to minimally invasive mitral valve surgeries but, due to its feasibility and safety, was soon incorporated as an ideal access for other cardiac pathologies such as tricuspid valve disease, atrial septal defect, atrial fibrillation, and pacemaker leads endocarditis. The technique was performed in 214 patients, and it is associated with excellent aesthetic and functional results, with low morbimortality and no reoperations at long-term follow-up. Here, we describe and support the use of periareolar access as a routine surgical technique for correction of several cardiac pathologies, especially in women.

Key Words: Minimally invasive cardiac surgery, Mitral valve repair, Congenital heart defects, Atrial fibrillation.

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With the constant evolution of heart surgery, new surgical techniques and adjunct technologies have been used for safer and less invasive procedures. In the mid 1990s, several reports of video-assisted techniques emerged in medical literature, and since then, large centers worldwide have shown a growing involvement with minimally invasive cardiac surgery (MICS).[1,2]

The potential benefits of minimally invasive procedures are reduced surgical trauma, less pain, decreased blood loss with minimal use of blood components, shorter hospital stays, faster return to social and professional activities, superior cosmesis, and greater patient satisfaction.[1–3] Cost reductions may also play a role in decision-making.[1,2]

Here, we describe an unprecedented approach for video-assisted MICS, which combines the effectiveness of conventional procedures with an optimized manipulation of the cardiac structures through small periareolar skin incision, with excellent functional and aesthetic results. The periareolar access[3,4] has been used for mitral and tricuspid valve surgery, atrial septal defect closure, atrial fibrillation ablation, and pacemaker leads extraction. It is our preferred access especially in women.

SURGICAL TECHNIQUE

Under general anesthesia, patients were intubated using a Robert Shaw double-lumen endotracheal cannula for selective pulmonary ventilation. Disposable paddles for external cardiac defibrillation were placed in the right scapula and anterolateral region of the left hemithorax. A nasopharyngeal thermometer for body temperature control and a three-dimensional transducer for intraoperative transesophageal echocardiography (TEE) were placed.

Before positioning the patient, the right breast was carefully examined. Significant pre-existing asymmetries or chest wall deformities were recognized, because these might difficult the nipple cut and the access to the mediastinum. After positioning the patient with the right hemithorax elevated at 20 degrees, markings were made on the thorax surface using a surgical pen (Fig. 1). Then, sterile plastic field was applied across the exposed area.

A solution of 200 mL of saline, 20 mL of ropivacaine 0.75%, and 1 mg of epinephrine was prepared, and 20 mL were infiltrated at the deep dermis before incision for postoperative pain relief and local vasoconstriction. After 3 minutes, a right angle skin incision was performed using a 15 blade 2-mm inside the edge of the nipple-areolar complex, on its lower half circumference (4–10 hours position), after the previous marking.

Mammary glandular tissue was then sectioned with scissors through the entire length of the incision, reaching the major pectoralis at the 4th right intercostal space (RICS) between the anterior axillary line (AAL) and right hemiclavicular line. Layer hemostasis was performed accurately. To enlarge the work space and protect wound margins, Alexis (Applied Medical, Rancho Santa Margarita, CA USA) wound retractor/protector was used providing 360-degree atraumatic circumferential retraction and allowing maximum exposure with a minimum incision size.

Before trocar introduction for the fiber-optic scope, the right lung was isolated from ventilation. A 5-mm trocar was then inserted in the 4th RICS, anterior to the midaxillary line, and the camera was positioned. In the 7th RICS in the AAL, a 7-mm trocar was introduced for insufflation of CO_2 and introduction of

Video clip is available online.

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FIGURE 1. Surgical markings. LAA, anterior axillary line; LAM, medium axillary line.

the left ventricle aspirator DLP (Medtronic, Minneapolis, MN USA). Through the 2nd RICS in the AAL, the Chitwood transthoracic clamp was introduced (Fehling Instruments, Karlstein, Germany). The right hemithorax was inspected for bleeding before resuming the procedure.

The surgical instruments used were specific for videothoracoscopy. Under optical vision, the pericardium was opened 2 cm anterior to the phrenic nerve, from the inferior to superior vena cava. The pericardium was retracted with two 2–0 polyester sutures exteriorized through the chest wall using a hook.

After systemic heparinization, peripheral cannulation of the right femoral vein and artery was performed under TEE guidance. The skin was incised in the right inguinal groove, and the femoral vessels were cannulated using Seldinger technique under direct vision. For arterial cannulation, Bio-Medicus cannulas 17F to 21F (Medtronic, Minneapolis, MN USA) were used, and for venous line, femoral cannulas Eopa DLP 21F to 23F were chosen (Medtronic, Minneapolis, MN USA). In the case of opening the right atrium, bicaval venous cannulation was performed with femoral and internal jugular vein cannulation. Seldinger technique was used to place a Bio-Medicus arterial cannula (Medtronic, Minneapolis, MN USA) No. 17F or 19F in the superior vena cava.

Cardiopulmonary bypass was established, and the patient was cooled to 32°C. With the aid of videothoracoscopy, the ascending aorta was clamped and punctured with a 30-cm metal needle (Glister Medizintechnik, Tüttlingen, Germany) for the administration of antegrade cold crystalloid cardioplegic solution Custodiol HTK (Köhler Chemie GmbH, Bensheim, Germany) (Fig. 2; see also Video, Supplemental Digital Content, http://links.lww.com/INNOV/A161). In the puncture site, a pledgeted 2–0 polyester purse-string suture and a tourniquet were placed for subsequent removal of air from the ascending aorta. With the aim of reducing the effects of air embolism, CO_2 was insufflated at a flow rate of 3 liters per minute. The venous drainage was vacuum assisted.

Depending on the type of surgery, the procedure was performed as follows:

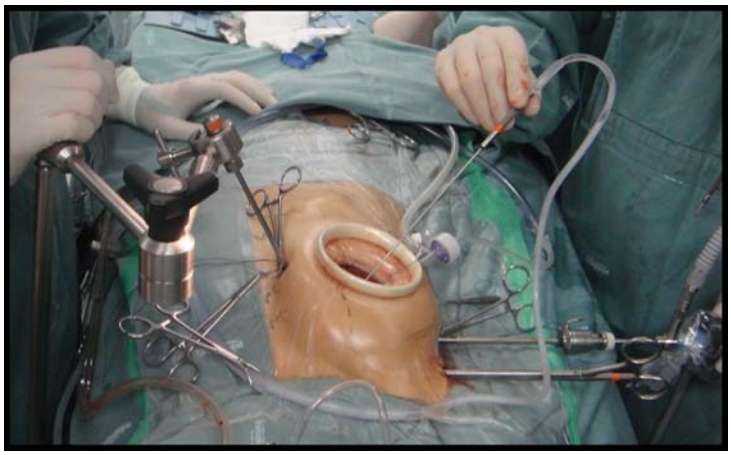

FIGURE 2. External aspect of operative field during antegrade cardioplegia administration.

- Mitral valve surgery: the left atrium was opened anteriorly to the right pulmonary veins and retracted using a transthoracic retractor (Estech, San Ramón, CA USA) positioned through the 4th RICS, lateral to the right internal thoracic artery. With the introduction of optics in the left atrium, the mitral valve was inspected and then repaired or replaced. In mitral valve repair, many techniques were used: annuloplasty, leaflet resection, leaflet augmentation, chordal transposition, and implantation of politetrafluorethylene neochords. The valve competency was tested with saline solution. In cases of mitral replacement, mechanical or tissue valves were used. In case of associated tricuspid insufficiency, repair was performed with ring annuloplasty. Patients with concomitant atrial fibrillation were submitted to pulmonary vein isolation using radiofrequency surgical ablation pen Cardioblator (Medtronic, Minneapolis, MN USA), and as routine, the left atrial appendix was closed. After the procedures, left and right atria were closed with 3–0 polypropylene running sutures and a ventricle aspirator was positioned through the mitral valve for deairing maneuvers.
- Atrial septoplasty: before right atrium opening, both venae cavae were dissected and a tourniquet was passed around. The right atrium was opened from the right atrial appendage toward the inferior vena cava. To reach a good exposure, a transthoracic retractor was used (Estech, San Ramón, CA USA). With the introduction of optics, the atrial septal defect (ASD) was visualized and remnants membranes resected. Using previous three-dimensional echocardiographic measurements, a compatible pericardial patch was made to fit the hole and implanted with 4–0 polypropylene running sutures. Desiring maneuvers of left chambers were performed before completing suturing the pericardial patch with lung inflation. The right atrium was also closed using continuous suture in two layers of 4–0 polypropylene. Then, both venae cavae were untied, and the purse-string suture in the ascending aorta was left open for desiring maneuvers.
- Pacemaker leads extraction: all the surgeries were performed on-pump with beating heart. After isolating the superior and inferior venae cavae, the right atrium was opened and retracted. The infected leads were explanted by pulling the system or, if needed, through scissors dissection.

During the intraoperative period, all patients underwent TEE guidance for peripheral cannulation and for deairing of the heart, and postoperative imaging showing successful valvuloplasty with absent or trivial mitral regurgitation, prostheses well positioned and functioning normally, and absence of residual shunt after ASD closure.

After disconnection of cardiopulmonary bypass, the femoral and jugular cannulas were removed, and heparin was reverted using protamine at a 1:1 ratio. Hemostasis review was carefully performed, and the pericardium was closed by interrupted sutures of 2–0 polyester. A chest drain Blake size 24 (Ethicon, St. Louis, MO USA) was exteriorized through optical trocar hole and placed into the pericardial sac. Such device was kept in negative aspiration of 20 cm H_2O or in a J-Vac vacuum drain (Ethicon, St. Louis, MO USA).

Before closing the chest, ropivacaine 0.75% was used for nerve block. The intercostal space was approximated with a figure of eight of two polypropylene Prolene (Ethicon, St. Louis, MO USA) suture transfixing the inferior rib and going around the superior rib, to avoid nerve compression. Periareolar access was then closed in layers. Initially, the muscle and preaponeurotic mammary tissue were sutured with 3–0 polyglecaprone 25 Caprofyl (Ethicon, St. Louis, MO USA). The edges of the surgical incision were held using Allis forceps for surgical correction of the layers and the mammary tissue approximation was performed in two or three layers using the same suture.

The center of the nipple cut was used as an initial reference, and from this, the subdermal plane was closed with 4–0 polyglycolic acid Monocryl (Ethicon, St. Louis, MO USA) interrupted sutures distributed equidistantly. When a good coaptation of the wound edges was achieved, the skin was closed with nylon 5–0 vertical-U interrupted sutures, reaching only the subdermal plane of the skin, and with the knots positioned inside the areola. The trocar orifices were closed using interrupted nylon 5–0 sutures.

Sutures were alternately removed 7 and 14 days after the surgery (Fig. 3A).

During the early postoperative period (30-day period), a surgical bra was recommended for support and light compression of the breasts. Patients were advised not to fully abduct the right arm for the same period and to avoid broad and forceful

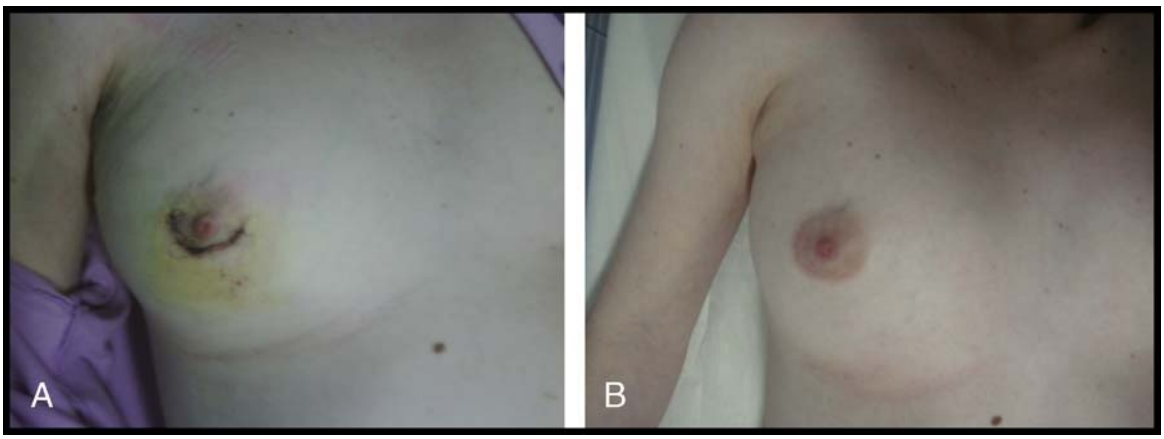

FIGURE 3. A, Wound aspect in the 7th postoperative day. B, Final aspect of the periareolar access.

movements of the arm or sun exposure for 3 months, to ensure a good aesthetic final result (Fig. 3B).

DISCUSSION

Since we pioneered the periareolar access in 2006 and published it in 2009,[3,4] we have operated 214 patients. Retrospective data were collected regarding types of procedures, conversion rates, morbidity, and mortality during long-term follow-up. All cardiac pathologies that could be corrected through a right minithoracotomy were considered suitable for the periareolar technique. Patients chose the approach and gave informed consent to participate in the study.

Most of patients were female (68.2%) and age ranged from 18 to 72 years. Mitral valve disease was found in 61.7% (n = 132), with associated tricuspid insufficiency in 24 cases and atrial fibrillation in 35 cases. Atrial septal defect was found and corrected in 34.5% (n = 74) and pacemaker leads endocarditis in 3.7% of patients (n = 8), requiring leads extraction.

Regarding patients with mitral valve disease, mitral valve repair was performed in 72% of cases (n = 95) and mitral valve replacement in 28%% (n = 37). In 18.2% of patients in this group, concomitant tricuspid valve repair was necessary. Atrial fibrillation surgical therapy was also performed in 26.5% of them. Special considerations have been made when there was massive annular calcification, because the size of the skin incision might limit the ability to decalcify the annulus. The periareolar technique has been used also for complex repair cases even in mitral valve endocarditis.

All surgeries were performed as planned, and there were no conversions to full sternotomy. No complications related to the periareolar access or peripheral cannulation were found, and morbidity was 0.7%, mainly arrhythmias (acute atrial fibrillation) and pleural effusion. There were no cases of reoperation for bleeding control, renal failure, neurological or cognitive changes, or surgical site infection. In this series, no early or late deaths were reported. At a follow-up of 8 years with sequential transthoracic echocardiography and mammography, there were no complications or reoperations.

The aim of MICS is to reduce surgical trauma as well as cardiac manipulation and accelerate patient recovery through the use of smaller and less invasive incisions when compared with conventional procedures.[1–4] The initial experience with MICS in the early 1990s was soon followed by the incorporation of video assistance, what greatly improved the results of the minimally invasive approach.[1,2] Over the years, with the development of new technologies and techniques, including methods of cardiac protection, incision points, and perfusion, the patient's experience has become more positive.[1–5]

The minithoracotomy performed for video-assisted cardiac surgery is typically an anterolateral incision at the 4th RICS in men or inframammary in women. However, especially in women with large breasts, it may be challenging to reach the intercostal space with a small incision and the visualization of the heart may be jeopardized. For that reason, we have developed the nipple cut.[4] This access allows easier manipulation of the cardiac structures, because the nipple-areolar complex is usually located at the 4th intercostal space, which is ideal for straight access of the heart.[4] The periareolar access is largely used in mammaplasty with low complication rates.[6–8]

In this procedure, the use of the videoscope is crucial, which is needed in most parts of the procedure, especially when the nipple is anteriorly placed and the mitral valve cannot be seen through the minithoracotomy. The video assistance plays a fundamental role in this approach enabling smaller skin incisions and reducing trauma to the periareolar complex and to the mammary gland.

Furthermore, to avoid surgical site complications, it is important to perform a careful preoperative evaluation of the breasts.[6–8] Young women with incomplete mammogenesis, women in the lactating period, and patients with diagnosed breast nodules are not suitable for the periareolar approach. It may be reasonable to perform preoperative screening with ultrasound or mammography in patients older than 40 years, in search of undiagnosed pathologies.[4]

Another very important issue in patient selection is the size of the areola. An areola diameter inferior than 2.5 cm is associated with limited exposure of cardiac structures and requires additional effort to perform the surgery, commonly resulting in unwanted extensions overriding the areolar region and increasing the risk of numbness of the region.[6] Therefore, this approach is not recommended in small nipples.

In women, the size of the breast is not a contraindication. In large breasts, to avoid a tunneled working port, it is

FIGURE 4. Periareolar access in large breast. A, Wound aspect in the 7th postoperative day. B, Final aspect of the periareolar access.

fundamental to use a soft tissue retractor as it increases the size of the port access and flattens the breast, facilitating the manipulation of intrathoracic structures (Fig. 4).

In conclusion, the periareolar access was demonstrated to be safe and effective for the correction of several cardiac pathologies, such as mitral and tricuspid valve disease, ASD, atrial fibrillation, and pacemaker leads endocarditis. It has been associated with excellent aesthetic and functional results, with low morbimortality at long-term follow-up. Currently, it is our approach of choice in video-assisted procedures, especially in female patients.

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