Less-invasive heart surgery: the preservation of median approach

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Abstract

Objective: Cardiac surgery has been traditionally performed via a median sternotomy incision where a large exposure of the mediastinum assured most of the cardiac procedures. Recently, the concepts of less-invasive surgery, well affirmed in many surgical specialties, led cardiac surgeons to develop limited accesses in coronary, valves and congenital operations.

Methods: Between January and May 1997, 30 patients were operated on with a less-invasive approach. A short (6–9 cm) median incision followed by a subcomplete sternotomy permitted a limited opening of the chest without compromising the surgical exposure; a conventional central CPB was instituted and valve surgery and most of intracardiac procedures were performed without modification of the standard technique.

Results: No mortality was observed; morbidity was minimal. Cardiopulmonary bypass time and aortic cross-clamp time averaged 84–9 and 61–11 min, respectively. The majority of patients were extubated and discharged from the ICU early. Chest drainage lost on average 290–180 ml/m².

Conclusions: Despite our limited initial experience, this technique seems to provide several potential and practical advantages: there is less trauma and pain reported by patients; the small wound reduces the potential for wound infection and blood loss. Patients are extubated and discharged from the hospital earlier with lower overall costs. © 1998 Elsevier Science B.V. All rights reserved

Keywords: Less-invasive cardiac surgery

1. Introduction

The classical surgical approach of most cardiac operations has been, since the beginning of the cardiac surgery era, the longitudinal median sternotomy. A 20-cm median skin incision permitted wide exposure of the heart and the origin of the great vessels. According to the evidence that less-invasive procedures maintain the effectiveness of the operation, accelerate patient recovery, decrease hospital stay and total cost, many centers have been concerned with the ‘minimally-invasive philosophy’ [1–4] and different surgical approaches have been developed for coronary, valve and congenital operations [4–9]. Cosgrove from Cleveland popularized longitudinal parasternal thoracotomy either for aortic or mitral procedures [6,7], transversal sternotomy recently replaced the parasternal incision for the aortic operations. Konertz, from Berlin [8], proposed a superior partial sternotomy approach for aortic and mitral valves. The limited surgical approach without video-assistance, beginning with a short skin incision (<10 cm), is the main technical aspect of these techniques; nevertheless, peripheral cannulation for CPB, the opening of pleural spaces with or without costal resection, internal mammary vessel ligation and the complexity of the conversion to the standard sternotomy, sometimes decreases the minimally-invasive character of the operations. Since January 1997, we adopted a less invasive technique, preserving the median approach to the heart, for the valves and other cardiac operations. This technique consists in a limited median approach to the heart through a subcomplete median sternotomy and a minimal opening over the mediastinum; a conventional central CPB is instituted without any modification of the surgical techniques. Many self-made instruments have been necessary to perform these operations safely. Our preliminary results confirm that this choice simplifies the technique for the surgeon and provides beneficial results to patients.

2. Materials and methods

Since January to May 1997, our less-invasive cardiac operations were performed in 30 patients; the average age was 65.3 (12 patients were older than 70 years). Type of surgery and concomitant procedures are listed in Table 1. Informed consent was obtained from all patients.

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2.1. Anesthetic and surgical technique

Induction and maintenance of anesthesia was accomplished using weight-related dosage of sufentanyl, midazolam and pancuronium. Patients are ventilated with a mixture of oxygen and air (fractionated inspired oxygen (FIO2) = 50%). External defibrillator pads are placed in the patient’s chest and the surgical field is prepared and draped as for a classical sternotomy. A midline skin incision (6–9 cm long) is performed from the first to the third interspace for the aortic procedures and from the third to the fifth interspace for the mitral and tricuspid operations (Fig. 1A,B). The variables directly affecting the incision length are: body mass, sternal bone length and the depth of the thorax. Having mobilized the soft tissues over the sternum, a complete bone median sternotomy (manubrium and body) is carried out with a self-adapted sternal saw (Fig. 2A); the portion of the sternum under the skin flap of both cephalad and caudad skin is easily divided with the aid of a general lighted disposable retractor (USSC MINI HARVEST, Norwalk, CT, USA) (Fig. 2B). Once the modified Finochietto retractor has been inserted, the opening of the two sternal edges is limited to 6–7 cm; the pericardial incision (longitudinal) exposes, in the aortic procedures, the entire ascending aorta and the tip of the right atrial appendage and, in the atrioventricular valve operations, all the right atrium and the proximal ascending aorta. The pericardial edges are suspended from the chest wall in order to elevate the heart towards the surface for better exposure. Normothermic cardiopulmonary bypass is instituted under systemic heparinization (300 IU/kg) with a low prime unit (1450 ml). The other components of the CPB system are: a membrane oxygenator, an arterial filter and a centrifugal pump. Myocardial protection is assured by a cold crystalloid cardioplegia with different delivery routes; the primary volume depends on the patient body mass and successive doses are injected according to the myocardial temperature (monitoring probe). A blood ultrafiltration (volume = volume of cardioplegia administered) is used during extra-corporeal circulation.

Fig. 1. Placement of the skin incision for the aortic (A) and mitral (B) procedures.

Fig. 2. Self-adapted instruments for the mini-invasive approach: the sternal saw (A) and the disposable lighted retractor (B).

Table 1

<table>
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<tr>
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<tr>
<td>Bentall operation</td>
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<tr>
<td>Endocarditis on pacemaker leads</td>
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<tr>
<td>Right atrial tumor</td>
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<tr>
<td>Left atrial tumor</td>
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<tr>
<td>Atrial septal defect</td>
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Concomitant procedure

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<tr>
<td>Carotid surgery</td>
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<td>Asc. aortic surgery</td>
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*Ascending aortic surgery included one endarterectomy and one end-to-end anastomosis.

2.2. Aortic surgery

Cannulation of the heart is performed as usual between right atrial appendage using a dual drainage venous cannula (Research Medical, TF 3646-0 or TF 2937-0) and ascending aorta (Jostra AD 18 or AD 21). After the pump is ‘on’, the aorta is encircled with an umbilical tape and clamped with a right-angled clamp and myocardial protection is performed by perfusion of the cardioplegia directly in the coronary ostia. A right-angled vent (13 French) is placed in the left
ventricle through the aortotomy or through the left atrial roof. The aortotomy edges are suspended from the drapes under tension to improve exposure. Surgery of the valve, left ventricular outflow or ascending aorta can now be performed without modification of the usual technique. All the procedures of valve replacement are performed using a suspended continuous technique with 2/0 polypropylene suture (Fig. 3).

2.3. Mitral and tricuspid surgery

Standard bicaval (right-angle tip cannula, Jostra AD 30-36) and ascending aorta (Jostra AD 18-21) cannulation is performed. In this approach, the vision of the ascending aorta is limited by the superior edge of the incision and then the proximal aorta is mobilized and lowered to prevent dangerous accidents during cannulation. The superior and inferior venae cava are snared after the beginning of CPB, the aorta is cross-clamped and anterograde cardioplegia is perfused in the ascending aorta. A left ventricular vent is placed through the right superior pulmonary vein. The left atrium is then opened with an incision just behind to the interatrial groove. When the exposition is not so easy, an alternative approach to the mitral valve is the oblique trans-atrial incision. The surgery of both atrioventricular valves is performed with the usual techniques.

When the surgery is completed, the air is removed from the heart with the assistance of the transesophageal echocardiography probe. The de-airing technique is the same as the standard approach, but a gentle suction on the ascending aorta through a 14-gauge needle is maintained for a longer time. After the insertion of pacing wires, the cross-clamp is removed and, when necessary, the heart is defibrillated by the external patches. After the return to normal cardiac function, the cannulae are removed and the chest is closed in layers, leaving one drain in the pericardium and one in the retrosternal space. As for the opening, the closure of the portion of sternum under the skin flaps is facilitated by the light-assisted retractor and the wire stitches are placed as single stitches, or figure-of-8 stitches according to what the surgeon considers appropriate. A redon catheter is positioned, anterior to the sternum, in the superficial layers. A subcuticular absorbable suture (5/0 monofilament) is then employed for the skin layer.

3. Results

The time for median aortic cross-clamp was 61 ± 11 min while median total bypass time was 84 ± 9 min. The chest-drainage lost during the first 24 h averaged 290 ± 180 ml/m²; 21 patients (70%) had no blood transfusion at all. All patients were extubated early with an average of 11 ± 8 h. The post-operative course was in the majority of cases uneventful. We observed three post-pericardiotomy syndromes with a moderate pericardial effusion treated medically. During surgery a rapid conversion to the standard approach was necessary in one patient aged 88 years subsequent to a profuse hemorrhage after decannulation; the reason was related to a subannular cardiac rupture after extensive decalcification of the annulus. This complication was repaired under cardiopulmonary bypass and aortic

Fig. 3. Aortic valve replacement: the prosthesis is sutured with a suspended continuous technique using a 2/0 monofilament.

Fig. 4. Patient after having an aortic valve operation, on the fifth post-operative day.
cross-clamping. The post-operative period of this patient was longer, but uneventful. The aesthetic result has been the more spectacular aspect of this technique: no complication in the healing wound was observed and the scar was in all patients shorter than 9 cm (Figs. 4 and 5).

4. Discussion

The current increase in interest in 'minimally-invasive' techniques has been in part stimulated by recognition of their effectiveness in other surgical specialties [1]. As modern cardiac surgery lowered the prognosis of many types of operation, a less invasive approach and the aesthetic result became important issues. Coronary surgery was the first to be concerned with a minimally-invasive 'philosophy' but, at present, single-vessel coronary artery disease involving the left anterior descending artery (LAD) remains the primary indication for minimally-invasive coronary artery bypass [4]. More recently, a minimal approach to valve surgery has been developed and different techniques have been popularized. A 10-cm parasternal or transversal sternotomy approaches for the aortic operations and a 10-cm paramedian incision for the mitral procedures have been proposed by Cosgrove [6,7]. Technical aspects in these modified approaches, like the rib cartilage resection, the internal mammary vessel sacrifice, the opening of pleural spaces and the complexity of a conversion to standard sternotomy, are potentially able to affect postoperative morbidity [11–13]. Furthermore, femoral vein and artery cannulation were often required to perform the cardiopulmonary bypass. Konertz from Berlin [8] proposed an interesting approach to valve surgery; the superior partial paramedian sternotomy, which permits exposure of either the aortic or the mitral valve without procedure-related morbidity and mortality. Several other reports concerning video-assisted mitral procedures through minithoracotomy have been described [9,10], but the elective indication seems to be directed still to selected patients. As of today, a Med-line search using 'minimally invasive valve surgery' does not show any other technique of less-invasive operation for cardiac valve disease. However, the definition of what is 'minimally-invasive' remains clouded and often centers on the size and location of incisions. Each option should be considered a trade-off between the exposure provided, the ease and speed of the operation and post-operative patient discomfort. Our technique of less-invasive cardiac operations remains faithful to the principle of the median approach to the heart. A small incision (6–9 cm), associated with a subcomplete median sternotomy (manubrium and body), with a limited opening over the mediastinum, gives excellent exposure to the base of heart. Few self-made specific instruments facilitate the approach. Nevertheless, many aspects must be emphasized to perform the operation safely.

The incision must be centered to the part of heart in which the surgery take place.

The position of traction sutures is fundamental, to elevate the heart maximally towards the surface and give a normal physiological orientation to the aortic root and mitral annulus.

Aortic cannulation is easily performed after the ascending aorta has been mobilized and lowered to the open surgical field. In the aortic surgery during cross-clamping, venous drainage of the heart must be complete, the right atrial pressure maintained near 0 mmHg and pulmonary ventilation must to be stopped. Venting of left cavities is performed with a small catheter positioned in the left ventricle directly through the aortotomy or through the left atrial roof.

2/0 Polypropylene suture with a suspended continuous technique has been used for all valve replacements; this technique is used routinely since 1991 in our department, has many technical advantages: raising the annulus, it facilitates the suture, especially in the small aortic root, fewer knots are necessary and the execution is faster.

The temporary pacemaker wires are preferentially positioned before the release of the aortic clamp.
The de-airing techniques must be meticulous and echo-guided; the gentle aortic suction is continued up to the decannulation.

The respect of median approach shows, in our opinion, many potential and practical advantages: the small skin incision associated with a limited opening of the mediastinum reduces the pain from the traction on the ribs and thoracic ligaments; post-operative chest wall function and therefore total lung compliance are greatly preserved particularly in elderly patients [11,12]. In our experience of MICABG, rib-cartilage removal and minithoracotomy cause patients increased postoperative pain. In addition, the opening of the pleural space has also been found a source of postoperative pulmonary complications [11,12]. This bone-limited median sternotomy appears fast in healing, stable and less painful. There is also less potential for wound infection and blood loss. Patient recovery is accelerated allowing a short ICU stay and hospital discharge, with overall cost reduced. Reoperation should be less difficult. An important advantage of this technique, experienced in one case, is the easy and rapid conversion to the standard sternotomy when necessary. Last, but no less important is the aesthetic result. Many works have reported the potential for psychological disturbance, especially in female patients, when an unsightly scar is present in the middle of the thorax. Essentially this approach shows a better aesthetic result because of the limited extension of the scar. In conclusion, this minimal modification to the standard technique seems to provide beneficial results for the patients and in our institution it may become the routine approach for many cardiac operations.

5. Note added in proof

Experience to date, 140 patients have been operated using this technique with a 3% perioperative mortality.

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References