Right submammary minithoractomy for repair of congenital heart defects

A. Giamberti*, E. Mazzeri, L. Di Chiara, E. Ferretti, L. Pasquini, R.M. Di Donato

Dipartimento Medico-Chirurgico di Cardiologia Pediatrica, Ospedale Pediatrico Bambino Gesù, P.zza S. Onofrio, 400165 Rome, Italy

Received 21 January 2000; received in revised form 20 September 2000; accepted 28 September 2000

Abstract

Objective: The initial experience with the right submammary minithoracotomy incision for correction of intracardiac congenital defects is reported. Methods: Between March 1997 and March 1999, 100 children underwent repair of congenital heart disease through this approach. Their mean age and weight were 4.6 years and 20 kg, respectively. Diagnosis included: atrial septal defect (78), ventricular septal defect (7), tetralogy of Fallot (6), partial atrioventricular canal (5), double-chambered right ventricle (3) and single ventricle with dextrocardia (1). The standard technique entailed a 5 to 6 cm right submammary incision, entering the chest through the third or fourth intercostal space (depending on the body weight), direct aortic and bicaval cannulation and aortic cross-clamping with cardioplegic protection. Results: There were no hospital deaths. Postoperative morbidity included bleeding in two cases, recurrent atrial septal defect in one, spleen injury in one. The average hospital stay was 3.5 days. All patients are currently free of symptoms and medications. Conclusions: (1) This approach for repair of selected congenital cardiac malformations is technically feasible, safe and effective; (2) younger age is a facilitating factor; (3) hospital stays are effectively reduced.

Keywords: Congenital heart defects; Minimally invasive surgery; Thoracotomy

1. Introduction

The increasing interest in reducing surgical cosmetic damage, postoperative morbidity and hospital costs has lead to the widespread success of minimally invasive techniques for coronary-artery bypass grafting [1,2] and for aortic and mitral valve surgery [3,4].

Most recently several minimally invasive surgical approaches have been proposed for the paediatric population [5–10]. However, neither indications nor technical matters have been clearly defined as yet.

We report our experience in the surgical treatment of selected congenital heart defects through a right submammary minithoracotomy.

2. Material and methods

From March 1997 to March 1999, 100 children (in a total of 758 open heart surgery performed in the same time period) underwent surgical treatment of congenital heart defects with a minimally invasive approach in our Department.

The ages ranged from 17 months to 16 years (median 4.6 years) and the body weight from 9 to 65 kg (median 20 kg). There were 48 males and 52 females.

Diagnosis included: atrial septal defect in 78 cases (ten with partial anomalous pulmonary venous return), perimembranous ventricular septal defect in seven, tetralogy of Fallot in six (all with normal pulmonary valve annulus), partial atrioventricular canal in five, double-chambered right ventricle in three and univentricular heart with dextrocardia in one.

A right submammary minithoracotomy approach was used in all patients.

2.1. Surgical technique

The patient is placed with the right side elevated 30°. The right groin is always prepared and draped for potential femoral cannulation. The femoral artery was, in fact, cannulated in eight patients: in three patients at the beginning of our experience, in four patients weighing more than 55 kg and in the patient with univentricular heart.

A 5 cm anterolateral thoracotomy incision (6 cm for patients weighing more than 25 kg) is made at the level of the fifth intercostal space more than 4 cm below the nipple or along the inframammary groove in older female patients.

All patients receive a preoperative intercostal nerve block with ropivacaine hydrochloride just before incision in the operating room. With this technique we reduce the use of...
intraoperative analgesic drugs. A subpectoral dissection is carried out to avoid severing the serratus anterior and latissimus dorsi muscles. The chest is entered in the third intercostal space. The fourth intercostal space is used in patients bigger than 40 kg of body weight. The right internal mammary vessels are always respected.

Two crossing spreaders are placed: a larger one to part the ribs and a smaller one, more superficial, to retract the skin (Fig. 1).

The right lung is retracted posteriorly and the right lobe of the thymus gland is resected. The pericardium is opened at least 2 cm anteriorly and parallel to the phrenic nerve. A wide piece of pericardium is harvested for later use as a patch. Three pericardial stay sutures keep the right lung retracted. The ascending aorta and both caval veins are surrounded with tapes.

The ascending aorta is cannulated first, followed by cannulation of the inferior vena cava. The inferior, right-angle, caval cannula is externally placed through a 2 cm chest incision in the seventh intercostal space for a better surgical view (Fig. 1). This incision will later serve as the passage for the chest drain. A 28–32° oesophageal hypothermic cardiopulmonary bypass is instituted. The superior vena cava is, then, directly cannulated, also with a right-angle cannula. Finally, a steady Y-connection for both cardioplegia infusion and aortic venting line is inserted in the aortic root. A left venting line is inserted through the right upper pulmonary vein in all patients but the atrial septal defects.

At the desired level of general hypothermia, the ascending aorta is cross-clamped and crystalloid solution is infused. A right atriotomy or a right ventriculotomy is performed according to the procedure. In the cases of right ventriculotomy, a better exposure can be achieved by pulling the right ventricular infundibulum towards the right using the stay sutures long the sides of the ventricular incision (Fig. 2).

Surgical procedures included: atrial septal defect closure in 78 (autologous pericardial patch in 66 cases and direct closure in 12 cases); transatrial ventricular septal closure in

Fig. 1. Surgical view of the right atrium from the right submammary minithoracotomy. Two spreaders are placed, the aorta is directly cannulated. The inferior vena cava cannula is inserted through a 2 cm chest incision just below the posterior edge of the minithoracotomy. This incision will be used at the end of the procedure, to insert a chest drain.
seven (with pericardial patch); tetralogy of Fallot repair in six (all with pericardial infundibular patch); partial atrioventricular canal repair in five; relief of the right ventricular outflow tract obstruction with pericardial infundibular patch in three; total cavo-pulmonary connection (modified Fontan operation) with intra-atrial inferior vena cava-to-pulmonary artery tunnel in one.

Video-assisted endoscopic support is often, through not indispensably, used for intraventricular procedures. The endoscope is manoeuvred by an assistant for visualization of the most inaccessible endocavitary regions.

Before removing the aortic cross-clamp, exhaustive care is devoted to de-airing manoeuvres including: minimized blood suctioning in the left-sided chambers; infusion of saline solution in the left atrium; full lungs expansion prior to complete closure of the atrial septal defect; activation of aortic venting while massaging the left ventricle and rotating the operating table in all directions.

After full rewarming, the patient is weaned off from cardiopulmonary bypass.

In our series, the mean cardiopulmonary by-pass time was 64 min (range 38–130 min).

Hemostasis is meticulous. Due to a residual large pleuro-pericardial window, a single right pleural drain, inserted through the inferior caval cannula hole, is sufficient to drain any pericardial fluid collections.

The duration of the operation ranged from 2–4.5 h (mean 190 min). In the second part of our experience, operative times shortened considerably due to increase familiarity with the technique.

3. Results

There were no deaths. Postoperative complications included: bleeding requiring surgical revision in two patients with atrial septal defect; recurrent atrial septal defect in one patient who underwent successful reoperation one month later through a secondary right submammary minithoracotomy; spleen injury requiring laparotomy in the patient with univentricular heart during postoperative chest drain insertion.

The average hospital stay duration was 3.5 days. All patients are currently free of symptoms and medications.

4. Discussion

Paediatric open heart surgery has traditionally been performed via a median sternotomy.

With the aim of reducing surgical trauma, efforts have been made to develop different minimally invasive approaches.

Besides obvious cosmetic advantages, other factors make this limited surgical aggression potentially more attractive
than the classical median sternotomy: reduced risk for wound infection with smaller incision, less postoperative pain, faster functional recovery, shorter hospital stay and, consequently, lower costs [1–13].

Several techniques have been proposed. Chang and associates [6], in 1996, reported closure of atrial septal defects using video-assisted right antero-lateral minithoracotomy. The same group in 1998, showed that ventricular septal defects could be closed through a left anterior minithoracotomy [7]. A partial sternal split with limited skin incision [8] or a transxiphoid approach [9] were also described for closure of atrial septal defects.

Our approach provides an excellent exposure of the right atrium, both caval veins and the ascending aorta. It also provides an acceptable exposure of the right ventricular infundibulum and of the pulmonary valve, with the help of appropriate right ventricular stay sutures pulled towards the right.

Arterial cannulation can be accomplished through the ascending aorta in over 90% of cases, with a rare need for femoral cannulation.

We feel that, due to greater elasticity of the tissue (of the ribs in particular), this type of procedure is more easily accomplished in younger patients. However, the cosmetic advantages of a no-less-than 4–5 cm long incision relative to body size is lost when applied in children less than 8–9 kg.

Few technical suggestions may facilitate the aortic and bicaval cannulation: near-total thymectomy, wide opening of the pericardium, direct superior vena cava cannulation, transthoracic insertion of the inferior vena cava cannula.

It is worth emphasizing that the safety of this type of procedure is based on proper cannulation and de-airing procedures.

As our experience with right submammary minithoracotomy grew, we were able to reduce the operative times. Furthermore, we extended the indications from simple atrial septal defect closures to more complex transatrial repairs (e.g. ventricular septal defect closure) to right ventricular procedure (e.g. tetralogy of Fallot repair), and even to a modified Fontan operation which remains, to our knowledge, as yet unattempted by others.

Currently three options are available for atrial septal defect closure: interventional cardiac catheterization with special devices and surgical closure through either a minithoracotomy or a median sternotomy [10]. A centrally located ostium secundum atrial septal defect can be safely and effectively closed by device in the cardiac lab. Whereas, an eccentrically located and/or large atrial septal defect, as well as a sinus venosus atrial septal defect, can only be treated surgically. The retrospective data [10] of 30 patients with atrial septal defects treated through a right submammary thoracotomy (group I) and 30 similar patients who underwent device closure of atrial septal defect (group II) where compared and matched with a control group of patients operated on through a classical median sternotomy (group III). Mean hospital stay was 2.2 ± 0.5 days for group I, 2.7 ± 1.0 days for group II and 7.6 ± 3.6 days for group III (P < 0.01 for group I and II vs. III). No statistical differences regarding the complications were found between group I, II and III [10].

Our current preference is for right submammary minithoracotomy approach.

In a broader sense, minimally invasive philosophy should be applied at different steps of hospital treatment: short skin incision, limited use of drugs, bloodless prime, lessened postoperative pain, early postoperative extubation (possibly in operating room) and short hospital stay. The wide pleuro-pericardial window reduces the risk of cardiac tamponade in eventual post-operative pericardial effusion and allows the use of a single right pleural drain. The preoperative intercostal nerve block with ropivacaine hydrochloride, reduces postoperative pain and is followed by early extubation and fast functional recovery.

The short follow-up of our series cannot show the real impact of the right submammary minithoracotomy in terms of chest deformity and unilateral growth of thoracic cavity especially in infancy, breast development and/or breast sensory changes, but up until now our patients have experienced no problems in this regard. Similar observations were made by others [11–13]. A crucial point to avoid breast asymmetry and parenthesis is probably the use of a subpectorar approach, sparing the serratus anterior and latissimus dorsi muscles.

Based upon our experience, we believe that the use of the right submammary minithoracotomy for the repair of selected congenital cardiac malformations is technically feasible, safe and effective. This approach is suitable for most right-sided cardiac anomalies not involving the pulmonary arteries, as well as for left anomalies (in particular, for mitral valve problems). From a technical point of view, the procedure is less challenging in younger patients. However, the cosmetic benefit of a no-less-than 5 cm incision is lost in patients under 8–9 kg of body weight. Hospital stays and consequently costs are effectively reduced by minimally invasive cardiac surgery.

Acknowledgements

We thank Sally Banks, RSCN, RN for her revision of the English language.

References
