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A minimal transverse incision with low median sternotomy for pediatric congenital heart surgery

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Abstract

Objectives: Median sternotomy is the incision of choice for most cardiac surgical procedures, but the full-length vertical skin incision generally leaves an unsightly scar. In certain patients undergoing short, low-risk procedures, cosmetic considerations are of relatively greater importance. **Methods**: A minimal transverse curvilinear skin incision with low median sternotomy is described which gives adequate exposure for selected open-heart procedures. Since September 1997, this approach has been used in 22 pediatric patients undergoing open-heart surgery including five cases of Fallot's tetralogy. We also compared the operation time and result with other approaches. **Results**: Using this modified method, the exposure of the heart was good enough, and there were no difficulties in cannulating the ascending aorta for cardiopulmonary bypass. Although it took a longer time to close the wound, the operation time was similar to the standard approach. The small transverse wound was not visible under conventional clothes. **Conclusions**: A minimal transverse incision with low median sternotomy provides an alternative approach for small wound open-heart surgery in patients with a simple congenital cardiac defect. It is technically feasible and has a good cosmetic result.

Keywords: Minimal incision; Low median sternotomy; Transverse incision; Full sternotomy

1. Introduction

Cardiac operations are performed more frequently through smaller incisions than traditional full-length median sternotomy. We used a 'low median sternotomy' technique for children who have undergone low-risk cardiac surgeries in this institute since February 1996. However, there were sometimes problems with wound healing at the upper edge of the small vertical skin incision because of undue retraction applied for better exposure. The upper end of the vertical scar is also visible with some low-collar clothes. To eliminate the problem, an approach was designed with limited transverse skin incision and low median sternotomy for patients undergoing simple congenital cardiac defect repair.

2. Materials and methods

From September 1997 to April 1998, this modified approach (transverse lower median sternotomy, TL group) was used for 22 pediatric congenital heart patients. For comparison of results, data of another 40 similar patients of the same attending surgeon either using the standard vertical full sternotomy approach (VF group) before 1996 or using a vertical low median sternotomy approach (VL group) between 1996 and 1997 were reviewed. The diagnoses of these patients are listed in Table 1.

The data recorded are expressed as the mean ± standard deviation and range. The ANOVA test was used to compare the operation time, cardiopulmonary bypass time, intensive care unit (ICU) stay after the operation and hospital stay among the three groups of patients.

2.1. Technique

A small curvilinear transverse skin incision was made within the bikini line over the lower sternum, at the level between the middle and the lower third of the sternum around the fourth intercostal space (Fig. 1A). The skin flaps were separated along the sternum just over the fascia layer to the xiphoid process inferiorly and to the level between the upper and the middle third of the sternum superiorly (around the third intercostal space). A manuable plate retractor folded at both ends was applied to the upper skin flap to facilitate exposure before sternotomy (Fig. 1B), and was fixed to the cross bar of the head holder to retract

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Table 1
Diagnosis of the three groups of patients[a]

Number	VF	VL	TL
ASD	4	2	3
VSD	10	17	13
ECD	2	1	1
TF	2	2	5
Total	18	22	22

[a] ASD, atrial septal defect; ECD, endocardial cushion defect; TF, tetralogy of Fallot; TL, transverse incision with low median sternotomy; VF, vertical incision with full sternotomy; VL, vertical incision with low median sternotomy; VSD, ventricular septal defect.

the upper skin flap continuously during the operation. The lower sternum was divided vertically in the midline using a standard sternotomy saw, from the xiphoid process to the third intercostal space. The upper sternum remained intact. A standard sternal retractor was then applied to spread the lower sternal edges; the junction with the upper sternum merely cracked slightly without fracture in children. The upper skin flap retractor also served to elevate the intact upper sternum anteriorly and superiorly (Fig. 1B).

As the upper skin flap retractor elevated the intact upper sternum, the exposure of the upper mediastinal structures becomes much better. The large thymus was excised if present. The pericardial sac was opened in the midline and divided to the aortic reflection. The retraction stitches placed on the upper edge of the pericardium were attached to the upper skin flap and both edges of the saw-opened sternum. They not only served to elevate the heart anteriorly but also to pull the pericardial cradle downward for better exposure of the upper mediastinal structures. Routinely, the first purse-string stitch on the right atrial appendage after heparinization was placed through here. The second one was placed on the root of the ascending aorta for the insertion of a cardioplegic catheter. When both stitches were pulled downward, the ascending aorta came into view and was quite ready for aortic cannulation and for the application of an aortic cross-clamp.

All of the cardiopulmonary bypass cannulae can be introduced through the sternotomy wound. It is usually possible to insert the aortic cannula high enough with a modified technique. The site of cannulation is cauterized and the adventitia is opened tangentially to tailor a small flap. After placement of the usual purse-string stitch, the surgeon uses a forceps with the left hand to grasp the aortic adventitia flap tightly and make a stab wound at the aorta with a scalpel. The small flap is immediately pulled down to cover the stabbing wound to prevent bleeding. Elevating the adventitia flap temporarily, dilatation of this stab incision was made with a mosquito and then pulled down again quickly. Afterwards the surgeon uses another forceps with the right hand to hold the tip of the aortic perfusion cannula and to insert it into the aorta. This technique has provided a safe and secure introduction of the aortic cannula into the relatively high portion of the aorta beneath the intact upper sternum.

Two venous cannulations are set up next. A straight cannula is introduced through the right atrial appendage to the superior vena cava. With the help of a muscle retractor applied on the right lower margin of the wound and temporary relief of the upper skin flap retractor, a right-angled cannula can be introduced through the low right atrium and advanced into the inferior vena cava. Caval tourniquets are then employed.

Cardiopulmonary bypass is established. A cardioplegia perfusion catheter is inserted and the aortic cross-clamp can be applied without difficulty. As the right atrium and right ventricle are lying at the center of the sternotomy wound, open-heart procedures can proceed with good exposure through a right atriotomy, ventriculotomy, and/or a

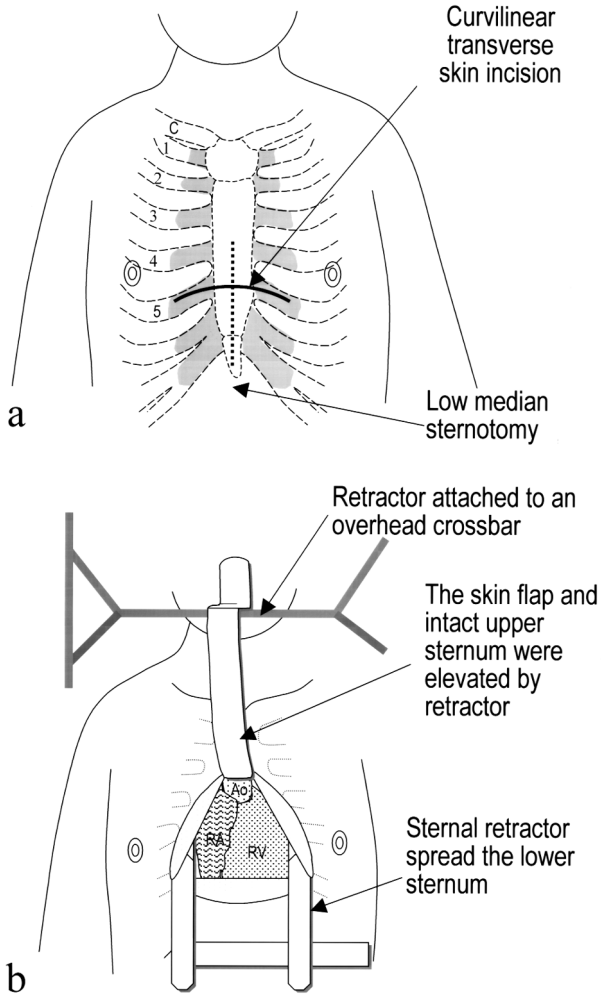

Fig. 1. Minimal transverse skin incision and low median sternotomy. (A) A curvilinear transverse skin incision is made within the bikini line over the lower sternum at the level of the fourth intercostal space. (B) The lower half of the sternum is divided vertically using a standard sternotomy saw and separated using a sternal retractor. A manuable retractor which is attached to the cross bar of the crossover head holder and applied to the upper skin flap elevates the intact upper sternum.

main pulmonary arteriotomy. Air is removed from the heart in the usual fashion after closure of cardiac incisions. Child-size internal defibrillating paddles can be applied easily if deemed necessary. Chest tube drains are brought out through stab incisions below the costal margin. Four 1-0 Ticron sutures placed across the divided sternum accomplish the sternal closure. Upon skin closure, it is usually not necessary to place a subcutaneous drain in a pediatric patient because the supra-fascia dissection is limited. Should the dissection area be large in an adult patient, two thin Hemo-Vac drains (Silicone Drain with Closed Wound Vacuum, Fortune Medical Instrument Corp., Taipei, Taiwan) are placed subcutaneously to prevent hematoma.

3. Results

There was no significant difference in age, gender, and diagnosis between the three groups. In the TL group, there were 22 patients in total: 12 boys and ten girls ranging in age from 3 months to 12 years (mean 3.6 ± 3.4 years). Lateral extension was not necessary to facilitate exposure in this series. A comparative VF group consisted of 18 patients: nine boys and nine girls ranging in age from 4 months to 13 years (mean 3.9 ± 3.7 years). Another similar VL group consisted of 22 patients: 11 boys and 11 girls ranging in age from 3 months to 9 years (mean 1.9 ± 2.1 years). The mean age of patients in the VL group is slightly younger ($P = 0.087$). No mortality was noted in any group.

The closure time, defined as the time from the end of cardiopulmonary bypass to the end of skin closure, was longer in the TL group (Fig. 2, $P < 0.01$). The cardiopulmonary bypass time, the approach time (from skin incision to the beginning of bypass), the ICU stay and the hospital stay were similar in all three groups of patients (Fig. 3).

One patient in each group had a wound problem. In the TL group, one 3-month-old girl had cyanotic discoloration of the lower skin flap of the wound after the operation in the early series. The wound healed later without further invasive procedure. A thicker flap including more subcutaneous tissue had abolished this problem in the later 20 cases. In the standard VF group, one 4-month-old child had a wound infection that debrided 1 week after the operation; therefore, he had a long hospital stay of 18 days. In the VL group, a 1-year-old girl had wound necrosis on the upper end. No seroma accumulated in the subcutaneous tissue in any group. There was no significant difference in wound complication among the three groups.

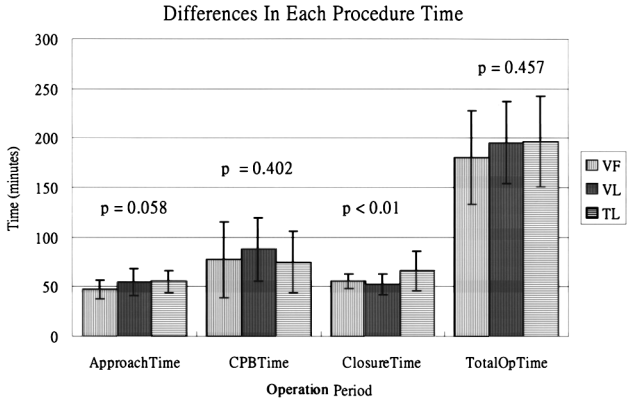

Fig. 2. Bar plots of approach time, cardiopulmonary bypass time, closure time, and total operation time of the three groups. The closure time of the TL group was significantly longer.

4. Discussion

Modern cardiac surgery has been based on cardiopulmonary bypass, myocardial protection and median sternotomy [1,2]. The median sternotomy incision provides simultaneous access to all cardiac valves and coronary arteries. However, the vertical skin incision for full sternotomy generally leaves an unsightly scar. In certain patients undergoing short, low-risk procedures, cosmetic considerations are of relatively greater importance. Alternative approaches include a range of parasternal (or peristernal) incisions, partial sternotomies, anterior small thoracotomies [3–5], or 'port-access' [6]. However, there are a few drawbacks. First, many of them require a femoral cannulation or a new instrument for the set-up of cardiopulmonary bypass, both unfamiliar to most surgeons. Second, a scar on the upper chest, even a small one, is visible with conventional clothes. Third, some approaches are limited to one simple valve operation or to a few accessible coronary arteries. Last, extension to standard full sternotomy might be difficult in some of the approaches, and thus troublesome if the exposure is not good enough.

The modified approach described has several advantages. Standard cannulation procedures were used. Exposure by splitting the lower two-thirds of the sternum is good enough for ascending aortic cannulation and bicaval venous cannulation, using all standard surgical equipment. It is especially easy in pediatric patients because their sternums are soft and easily spread with a standard sternal retractor. There is no need for a femoral wound or a stab wound on the chest for

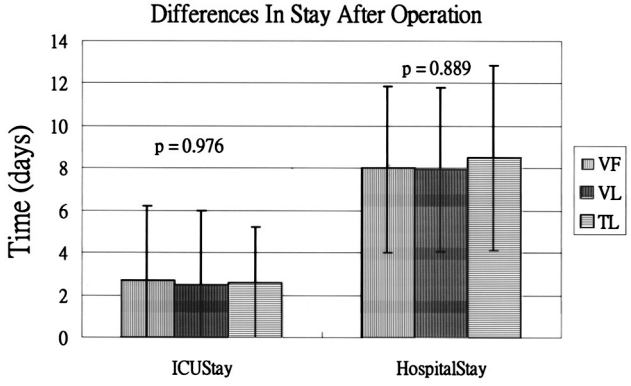

Fig. 3. Bar plots of ICU stay and hospital stay. There was no significant difference among the three groups.

the set-up of cardiopulmonary bypass. This is an important point because the standard procedure for cardiopulmonary bypass and myocardial protection is familiar. The whole body perfusion and myocardial protection would be as safe and secure as the standard sternotomy approach. It is not regarded as advisable to approach the heart from far away through a distant thoracotomy.

The small transverse skin incision described in this report is within the 'bikini' line. The scar would be invisible with most conventional clothing, bathing suits and swimsuits. This cosmetic advantage is superior to other peristernal 'small wound' incisions. Even a small scar on the upper chest is quite sensitive and causes discomfort if it is visible. The possible incision on a non-developed breast, as in small anterior lower thoracotomy, should be avoided. In addition, the transverse skin incision on the low chest is parallel to the lines of Langer and tends to heal with less tension than a vertical one [7,8].

There was no difficulty in an approach through right atriotomy or right ventriculotomy. Therefore, the closure of an atrial septal defect, a ventricular septal defect, an infundibulectomy, and/or other associated procedures could be performed smoothly. Our experience so far indicates that for these children undergoing short duration operative procedures there is little associated morbidity. Extensive experience with this incision for repair of tetralogy of Fallot and some cases of septal defects in adult patients had demonstrated good healing of the wounds and good correction of the defects. With the left heart vented and collapsed, the heart could be elevated and the left-inferior part of the heart could also be approached. Almost the whole heart is accessible through this low partial sternotomy. This approach makes sense because of the potential of adapting a small incision to the broad spectrum of cardiac operations [9]. The incision may be easily and rapidly extended to a conventional submammary incision and full sternotomy if the exposure is not adequate or the surgical strategy changes.

There are a few disadvantages to our modified small wound surgery. One of the principle drawbacks is the limited exposure. A few kinds of cardiac defects, especially with great arterial disease or a large heart, are difficult to approach through the small wound. It is recommended not to use the small wound in cases of great arterial disease or cardiomegaly. The second disadvantage of minimal transverse incision is that it might take a longer time for the approach, repair, and closure because of a relatively small operative field during the learning period. But the rhythm of the operation can be sped up once the team becomes familiar with this approach.

5. Conclusion

A minimal transverse incision with low median sternotomy provides an alternative small wound approach for open-heart surgery in patients with a simple septal defect and tetralogy of Fallot. It is technically feasible and has a good cosmetic result.

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