

Comparative study between inverted “L” mini-sternotomy and complete sternotomy for the surgical treatment of the atrial septal defect (ASD)

Estudo comparativo entre a miniesternotomia em “L” invertido e esternotomia longitudinal total na correção cirúrgica da comunicação interatrial

Luiz Cláudio Nery SAMPAIO, Jehorvan Lisboa CARVALHO, Carlos Alberto Paes ALVES, Marco Antonio Vieira GUEDES, Álvaro RABELO JR.

RBCCV 44205-728

Abstract

Objective: To compare the results obtained from two distinct surgical approaches in patients undergoing surgical correction of an atrial septal defect (ASD).

Method: The study series consisted of 20 patients, with a mean age of 24.1 ± 14.2 years, distributed in two groups. In group A, 10 patients (80% female, with a mean age of 20.9 ± 12.0 years) underwent surgical correction of ASD through a complete sternotomy. In group B, 10 patients (80% of females, with a mean age of 27.4 ± 16.1 years) were operated through an inverted ‘L’ ministernotomy. A p-value < 0.05 was considered statistically significant.

Results: There was no statistical significance for demographics variables, duration of surgery, cardiopulmonary bypass time, clamping time, amount of cardioplegia administered, thoracic drainage, ICU stay, duration of mechanical ventilatory support, amount of blood and its components transfused, arrhythmia or pacemaker usage. There was statistical significance ($p = 0.00001$) between incision size performed by complete sternotomy (group A) and inverted ‘L’ mini-sternotomy (group B), with mean incision sizes of 15.7 ± 0.8 and 6.8 ± 0.6 cm, respectively. There was a difference in the mean hospital stay between

the groups but without statistical significance (7.5 ± 1.6 days in group A and 6.4 ± 1.3 days in group B, with a p-value = 0.12). There was no mortality or complications reported in either surgical approach.

Conclusion: There was no difference in the operative and postoperative periods between the techniques that were performed except for the incision size, with a better cosmetic result seen with the inverted ‘L’ ministernotomy.

Descriptors: Heart septal defects, atrial, surgery. Surgical procedures, minimally invasive surgery.

Resumo

Objetivo: Comparar os resultados obtidos entre duas vias de acesso cirúrgico em pacientes submetidos à correção cirúrgica de comunicação interatrial (CIA).

Método: Foram distribuídos 20 pacientes, com média de idade de $24,1 \pm 14,2$ anos, em dois grupos. No grupo A, 10 pacientes (80% do sexo feminino, com média de idade de $20,9 \pm 12,0$ anos) foram submetidos à correção da CIA por meio de uma esternotomia longitudinal total. No grupo B, 10 pacientes (80% do sexo feminino, com média de idade de $27,4$

Work performed in the Cardiology and Cardiovascular Surgery Unit of the Hospital Universitário Professor Edgard Santos, Federal University of Bahia; Bahiana de Cardiologia Foundation

Correspondence address: Luiz Cláudio Nery Sampaio. Rua Altino Serbeto de Barros, n.173, Ed. Atlantis Multiempresarial, sala 408 – Itaigara, Salvador, Bahia CEP 41840-020. E-mail: cirurgiacardiovascular@uol.com.br

Article received in May, 2004
Article accepted in February, 2005

± 16,1 anos) foram submetidos à correção da CIA através de miniesternotomia em "L" invertido. Foi considerado significativo $p < 0,05$.

Resultados: Não houve diferença significativa entre as variáveis demográficas, tempo cirúrgico, circulação extracorpórea, pinçamento aórtico, quantidade de solução cardioplégica, drenagem torácica, tempo de permanência na UTI e ventilação mecânica, volume de sangue e plasma transfundidos, arritmia ou emprego de marcapasso. Houve diferença estatística ($p=0,00001$) entre o tamanho das incisões realizadas nos pacientes submetidos à esternotomia completa (grupo A) e a miniesternotomia (grupo B), sendo a média,

respectivamente, de $15,7 \pm 0,8$ e $6,8 \pm 0,6$ cm. O grupo A apresentou maior tempo de internação, porém sem diferença estatística ($7,5 \pm 16$ dias no grupo A e $6,4 \pm 1,3$ dias no grupo B, com $p=0,12$). Em ambos os grupos não houve mortalidade ou complicações relativas às vias de acesso cirúrgico.

Conclusão: Não houve diferença entre as técnicas empregadas no período intra e pós-operatório, excetuando-se o tamanho da incisão, o qual possibilitou melhor efeito estético com uso da miniesternotomia em "L" invertido.

Descritores: Defeitos do septo interatrial, cirurgia. Procedimentos cirúrgicos minimamente invasivos.

INTRODUCTION

The complete longitudinal sternotomy is the most commonly utilized incision for surgeons to access the heart and great vessels, because it allows ample approach to these structures. However, this approach presents disadvantages due to the aesthetic aspect, the possible occurrence of sternal instability in the postoperative period and the possibility of infection, mainly in old and diabetic patients. So, although recognizing the advantages of this form of access, surgeons have tried alternatives with small incisions to surgically treat some heart diseases, with the objective of decreasing surgical trauma [1].

Lateral thoracotomy [1] and parasternal mini-thoracotomy [2] represent alternative forms of access to the heart, which were developed with the aim of decreasing the trauma of the sternotomy. Subsequently, other variations have been suggested: from smaller incisions in the skin [3] with complete sternotomy, to video-assisted thoracic surgery [4].

The goal of this work is to compare the inverted 'L' mini-sternotomy to complete longitudinal sternotomy in the treatment of interatrial shunts.

METHOD

From August 1998 to September 2000, 20 patients were submitted to surgical correction of interatrial shunts by the same surgeon. Patients who presented with other associated valvar lesions were excluded with the exception of tricuspid regurgitation. These patients were divided in two groups of 10 patients (Groups A and B). In the patients of Group A, the approach was by complete longitudinal sternotomy and in Group B patients the form of access was the inverted 'L' mini-sternotomy. The research was approved by the ethics in research committee of the Federal University of Bahia.

The 20 patients had a mean age of 24.1 ± 14.2 years old and 80% were women. There were no statistical differences in respect to these parameters between the two groups.

Operative protocol

Complete sternotomy

In this type of access, an incision of the skin and the subcutaneous tissue was made, from the sternal manubrium and to 2 cm below the lower edge of the xiphoid appendix. After, the sternum was longitudinally split along its length. The sternum was opened and hemostasis was performed.

Inverted 'L' mini-sternotomy

For this approach, an incision of the skin and subcutaneous tissue of approximately 6 centimeters in length was made, beginning 3 cm under the sternal manubrium. After that, using two *Farabeuf*-type retractors, the skin was dislocated, above to expose the sternal manubrium and below to expose the sternum to 2 cm beyond the 4th intercostal space (Figure 1). Subsequently, the sternum was

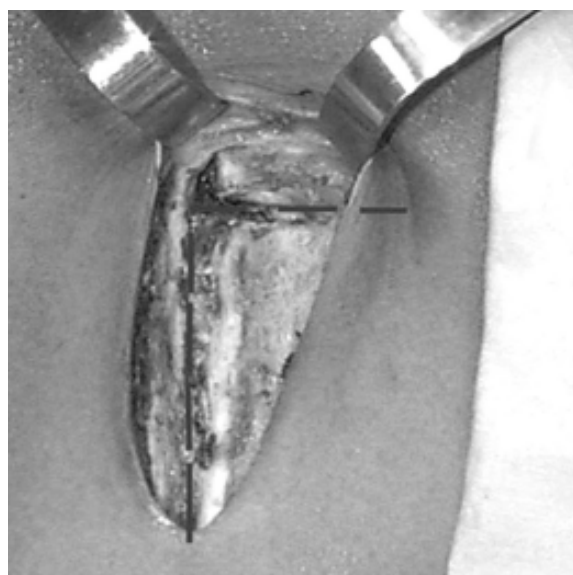


Fig. 1 - Traction of the skin by Farabeuf-type retractors to access the 4th intercostal space and delimitation of the inverted 'L' mini-sternotomy

longitudinally split to the 4th intercostal space. At this point transversal sectioning of the right half of the sternum was performed, thus creating the inverted 'L' incision.

After the sectioning of the sternum as mentioned, the edges of the manubrium and sternum were carefully separated, utilizing a retractor with low profile blades to avoid injuring the right internal thoracic artery.

Procedure after sternal opening

Cardiopulmonary bypass (CPB) was established using an infant or adult disposable membrane oxygenator according to the weight of the patient. Cooled St. Thomas crystalloid cardioplegic solution was utilized anterogradely, at a dose of from 1 to 3 mL/kg of body weight, to obtain cardiac arrest. This solution was again used at 15-minute intervals, at a dose of 1 mL/kg of body weight during aortic clamping.

Atrioseptoplasty was performed and when necessary a bovine pericardial patch was utilized fixed using continuous 5-0 polypropylene thread sutures. The patients were removed from CPB and after an infusion of protamine was administered. Closure was achieved by layers (Figure 2). Subsequently, the patient was sent to the intensive care unit.

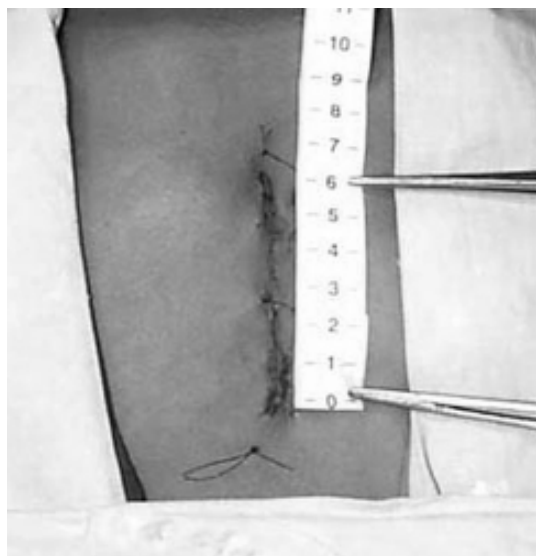


Fig. 2 – Final aspect of the mini-incision in the skin after synthesis by layer

Statistic analysis

The continuous variables were expressed as means \pm standard deviations and the categorical variables as

proportions. The chi-square or Fisher exact tests were used to confirm differences between proportions after verifying if these tests were suitable for the type of data. Continuous variables were compared using the Student t-test for independent samples or matched samples, when necessary. All calculations were performed using the SPSS-10.0 software. P-values of less than 5% ($p < 0.05$) were considered statically significant.

RESULTS

The results, comparing the complete longitudinal sternotomy and inverted 'L' mini-sternotomy access methods as described, are grouped in the intraoperative period (Table 1) and postoperative period (Table 2).

There were no statistically significant differences in the intraoperative data with exception of the size of the incision and the use of dopamine and sodium nitroprusside.

There was a statistically significant difference ($p = 0.00001$) between the size of the incisions performed in patients submitted to the complete sternotomy (Group A) compared to those who underwent mini-sternotomy (Group B). In Group A, a mean of 15.7 ± 0.8 cm was registered and in Group B the mean was 6.8 ± 0.6 cm. Even in the intraoperative period, a statistically significant difference in the use of dopamine and sodium nitroprusside was observed. Dopamine was infused in five (50%) patients of Group A and in none of the Group B patients, giving a statistical significance with a p -value = 0.03. Sodium nitroprusside was infused in six (60%) patients of Group A and in none of the Group B patients, also giving a statistically significant difference (p -value = 0.01).

The mean surgical time (181.0 ± 33.7 min in Group A and 182.0 ± 26.6 min in Group B) and cardiopulmonary bypass time (38.3 ± 23.0 min in Group A and 47.2 ± 13.6 min in Group B) did not present statistically significant differences. Also the aortic clamping time (19.5 ± 19.1 min in Group A and 18.8 ± 5.4 min in Group B) and the use of cardioplegic solution (260.0 ± 230.7 mL in Group A and 235.0 ± 97.3 mL in Group B) did not give statistically significant differences. Bovine pericardium patches were used to perform the correction of the interatrial shunt in 17 (85%) patients. In three of them (15%) patients, the correction was performed by direct raffia of the interatrial shunt. In Group A, bovine pericardium patches were employed in 90% of the cases (9 patients) and in Group B in 80% (eight patients), without demonstrating statistic differences between the groups.

In the postoperative period, as can be observed in Table 2, the mean values for both groups of complete thoracic drainage (406.5 ± 271.6 mL for group A and 485.5 ± 216.0 mL for group B), mechanical ventilatory support time (10.3 ± 3.5 hours for group A and 10.2 ± 3.3 hours for group B) and the

complete volume of transfused blood (325.0 ± 295.6 mL for group A and 433.0 ± 463.6 mL for group B) did not demonstrate statistically significant differences.

In respect to the use of vasoactive amines, there were no statistically significant differences between the groups. Dopamine was infused in two patients (20%) in Group A and in none of the patients in Group B (p -value = 0.47). Sodium nitroprusside was infused in four patients (40%) of Group A and in one patient (10%) of Group B (p -value =

0.30). In this period only one case (10%) of arrhythmia was evidenced in Group B and one patient (10%) in which a pacemaker was temporarily used in Group A. The mean ICU stay was 38.9 ± 13.2 hours for Group A and 43.9 ± 12.6 hours for Group B (p -value = 0.40). The mean in-hospital stay was 7.5 ± 1.6 days for Group A patients and 6.4 ± 1.4 days for Group B patients (p -value = 0.12).

There were no lesions of the right internal thoracic artery in either of the studied groups.

Table 1. Demographic and intra-operative data

Variables	Group A	Group B	<i>p</i> -value
Mean age	20.9 ± 12.1	27.4 ± 16.2	0.32
Women	8 (80%)	8 (80%)	1.0
Operative time	181.0 ± 33.7 min	182.0 ± 26.6 min	0.94
cardiopulmonary bypass time	38.3 ± 23.0 min	47.2 ± 13.6 min	0.31
Aortic clamping time	19.5 ± 19.1 min	18.8 ± 5.4 min	0.91
Cardioplegia solution	260.0 ± 230.7 ml	235.0 ± 97.3 ml	0.76
Bovine pericardium patch	9 (90%)	8 (80%)	0.5
Use of dopamine	5 (50%)	0 (0%)	0.03
Use of nitroprusside	6 (60%)	0 (0%)	0.01
Size of skin incision	15.7 ± 0.8 cm	6.8 ± 0.6 cm	0.00001

min: minutes; mL: milliliters; cm: centimeters

Table 2. Post-operative data

Variable	Group A	Group B	<i>p</i> -value
Thoracic drainage	406.5 ± 271.6 ml	485.5 ± 216.0 ml	0.48
Time of intubation	10.3 ± 3.5 h	10.2 ± 3.3 h	0.93
Volume of blood received	325.0 ± 295.6 ml	433.0 ± 463.6 ml	0.54
Volume of plasma received	0.0 ± 0.0 ml	160.0 ± 295.1 ml	0.12
Use of dopamine	2 (20%)	0 (0%)	0.47
Use of nitroprusside	4 (40%)	1 (10%)	0.30
Arrhythmia	0 (0%)	1 (10%)	1.00
Use of pacemaker	1 (10%)	0 (0%)	1.00
Time in Intensive care unit	38.9 ± 13.2 h	43.9 ± 12.6 h	0.40
Time of hospitalization	7.5 ± 1.6 days	6.4 ± 1.4 days	0.12

mL: milliliters; h: hours

COMMENTS

The mini-incisions have different forms of access to the anterior mediastinum aiming at minimizing the trauma. The majority of these techniques brings some disadvantages, when compared with the inverted 'L' mini-sternotomy: the

transaxiphoid access needs videothoracoscopy and utilizes the femoral artery for the arterial cannulation for CPB [5,6]; the mini-sternotomy of the inferior half of the sternum requires adaptation of one retractor and a second incision to introduce the clamp for aortic occlusion [7], the anterolateral and posterolateral thoractomies are possibly

responsible for bad-development of the pectoral tissue and of the breast in female patients [8], the right parasternal incision requires ligation of the right internal thoracic artery and removal of costal cartilages [2,9].

The inverted 'L' mini-sternotomy has several very interesting aspects: the aesthetic result, the maintenance of the abdominal muscle insertion points and of the diaphragm in the lower part of the thoracic cage, the possibility of conversion to complete sternotomy if there are operative complications [10] and the cannulation of the aorta under direct vision without the necessity of videothoracoscopy or to handle the femoral artery [11].

On comparing the inverted 'L' mini-sternotomy and complete longitudinal sternotomy, the intra- and post-operative variables need to be taken into consideration.

The literature shows that congenital defects of the interatrial septum are more frequent in girls with a ratio of 2:1 [12]. The predominance, in our series, of women, is similar to the literature, including publications from Brazil [11], and for this reason its indication is justified because of the aesthetic aspect.

The times of surgery, aortic clamping and CPB vary according to the complexity of the interatrial shunt, the necessity of other procedures associated to the correction of the CIA and of the necessity of using bovine pericardium patches or not. In 1999, DIAS et al. [10] verified the greatest times of surgery, CPB and ischemia are associated to the group of patients submitted to inverted 'L' mini-sternotomy, a conclusion that disagrees with our findings. This is, possibly, because in the series of these authors, the procedures were performed by more than one surgeon, as well as involving a learning curve. Our data are similar to other published results [13-15] which suggest that, with this form of access, the times of surgery, aortic clamping and CPB are similar with the times observed in complete sternotomy.

Injury of the right internal thoracic artery can occur in the inverted 'L' mini-sternotomy, both during sectioning and by stretching. These injuries, as they are a potential source of bleeding, must be investigated in the intraoperative period, with a careful review during the sectioning and suturing of the sternum. In patients submitted to the inverted 'L' mini-sternotomy, we did not observe any injuries to the right internal thoracic artery, a result also reported by Dias et al. [10]. The right internal thoracic artery is an important option as a source of grafts in coronary artery bypass grafting surgeries and so its preservation is essential.

A statistically significant difference was seen in respect to the use of vasoactive drugs in the intraoperative period by the mini-sternotomy group.

We believe this to be a type- β error due to the small number of cases. This fact was not reported in the literature

and we did not find any other explanation for its occurrence.

The size of incision was significantly shorter to the minimally invasive surgery group. The mean size of the mini-incision was similar to the size described by ROCHA & SILVA et al. [11].

In the Mini-sternotomy Group, the incision in the skin is performed 3 cm below the sternal manubrium, implicating a necessity of its detachment from the first section of the sternum. The fact that this detaching does not cause problems can be seen by the absence of ischemic skin injuries identified by necrotic areas.

It is important to call attention to the region of the purse-string sutures in the right atrium used for the cannulation of the inferior vena cava, as a potential source of bleeding in patients submitted to mini-sternotomy. This problem can be avoided, when finishing the surgery by maintaining the patient on partial CPB, first removing the cannula from the inferior vena cava and with the atrium partially empty, performing a hemostatic suture. We believe that this maneuver is essential to avoid problems of bleeding in the postoperative period.

There was no significant difference between the groups according to the volume of transfused blood, data similar to the findings of DIAS et al. [10]. However, other authors [16-18] have reported differences in the volume of blood derivatives transfused favoring the mini-incisions.

Moreover, there were no significant differences between the groups in respect to the necessity of mechanical ventilatory support, possibly because the minimally invasive surgery group was not submitted to any special protocol of early extubation. These data are in accord with the majority of published works [10,13,14,19], although data presented by SUN et al. [16] suggested a tendency for a reduced orotracheal intubation time in the group of patients submitted to mini-sternotomy.

A significant difference was also not confirmed in respect to the use of vasoactive drugs in the immediate postoperative period between the studied groups. It is important to stress that in studies comparing the mini-incisions with complete sternotomy for the correction of CIA there is no analysis of this variable.

Events of rhythmic disorders are observed in patients submitted to atrioseptoplasty [19]. Only one patient of Group B had arrhythmia and only one patient of Group A required the temporary use of a pacemaker. There was no significant difference between the studied groups but, a comparison of these variables in other series using mini-incisions and complete sternotomy procedures has not been reported.

In an attempt to avoid bias, the patients submitted to the minimally invasive surgery were not submitted to any special protocol of early release from hospital. It is possible that, considering the exposure, the observed tendency of a

shorter hospital stay would not be statistically significant. Our data are similar to other studies in which there were not distinctions in the protocol of hospital release between the two studied groups [10,14,20], although there are reports of shorter times in the ICU and in the hospital [17,18,20], all being results of specific protocols of early hospital release.

CONCLUSION

Finally, we must point out that an analysis of the variables related to surgical risk, studied in the intra- and post-operative periods, comparing the mini-sternotomy with the complete sternotomy, did not show any significant differences. These data demonstrated that the inverted 'L' mini-sternotomy is a safe procedure and has as a potential advantage of less surgical aggression and gives excellent aesthetic results.

BIBLIOGRAPHIC REFERENCES

1. Mitchell R, Angell W, Wuerflein R, Dor V. Simplified lateral chest incision for most thoracotomies other than sternotomy. *Ann Thorac Surg.* 1976;22(3):284-6.
2. Cosgrove III DM, Sabik JF. Minimally invasive approach for aortic valve operations. *Ann Thorac Surg.* 1996;62(2):596-7.
3. Laks H, Hammond GL. A cosmetically acceptable incision for the median sternotomy. *J Thorac Cardiovasc Surg.* 1980;79(1):146-9.
4. Landreneau RJ, Mack MJ, Hazelrigg SR, Dowling RD, Acuff TE, Magee MJ et al. Video-assisted thoracic surgery: basic technical concepts and intercostal approach strategies. *Ann Thorac Surg.* 1992;54(4):800-7.
5. Van de Wal HJ, Barbero-Marcial M, Hulin S, Lecompte Y. Cardiac surgery by transxiphoid approach without sternotomy. *Eur J Cardiothorac Surg.* 1998;13(5):551-4.
6. Barbero-Marcial M, Tanamati C, Jatene MB, Atik E, Jatene AD. Transxiphoid approach without median sternotomy for the repair of atrial septal defects. *Ann Thorac Surg.* 1998;65(3):771-4.
7. Grinda JM, Folliguet TA, Dervanian P, Mace L, Legault B, Neveux JY. Right anterolateral thoracotomy for repair of atrial septal defect. *Ann Thorac Surg.* 1996;62(1):175-8.
8. Cherup LL, Siewers RD, Futrell JW. Breast and pectoral muscle maldevelopment after anterolateral and posterolateral thoracotomies in children. *Ann Thorac Surg.* 1986;41(5):492-7.
9. Navia JL, Cosgrove III DM. Minimally invasive mitral valve operations. *Ann Thorac Surg.* 1996;6(5):1542-4.
10. Dias RR, Sobral MLP, Avelar Jr SF, Santos GG, Lima, MAVB, Haddad V et al. Cirurgia da valva aórtica: estudo prospectivo e randomizado da miniesternotomia versus cirurgia convencional. *Rev Bras Cir Cardiovasc.* 1999;14(2):98-104.
11. Rocha e Silva R, Canêo LF, Lourenço Filho DD, Franchi SM, Afiune CMC, Rodrigues Sobrinho CRM et al. Correção de comunicação interatrial com cirurgia minimamente invasiva em paciente pediátrico. *Rev Bras Cir Cardiovasc.* 1999;14(1):46-50.
12. Hurst JW. *The heart, arteries and veins.* 7th ed. New York:McGraw-Hill;1990.
13. Rosengart TK, Stark JF. Repair of atrial septal defect through a right thoracotomy. *Ann Thorac Surg.* 1993;55(5):1138-40.
14. Castilho F, Arnoni AS, Arnoni RT, Rivera JA, Almeida AFS, Abdulmassih Neto C et al. Miniesternotomia e mini-incisão: experiência inicial do Instituto Dante Pazzanese de Cardiologia. *Rev Bras Cir Cardiovasc* 2000;15(1):39-43.
15. Dietl CA, Torres AR, Favaloro RG. Right submammary thoracotomy in female patients with atrial septal defects and anomalous pulmonary venous connections: comparison between the transpectoral and subpectoral approaches. *J Thorac Cardiovasc Surg.* 1992;104(3):723-7.
16. Sun L, Zheng J, Chang Q, Tang Y, Freng J, Sun X et al. Aortic root replacement by ministernotomy: technique and potential benefit. *Ann Thorac Surg.* 2000;70(6):1958-61.
17. Svensson LG, D'Agostino RS. "J" incision minimal-access valve operations. *Ann Thorac Surg.* 1998;66(3):1110-2.
18. Bauer M, Alexi-Meskishvili V, Nakic Z, Redzepagic S, Bauer U, Weng Y et al. The correction of congenital heart defects with less invasive approaches. *J Thorac Cardiovasc Surg.* 2000;48(2):67-71.
19. Kirklin JW. *Cardiac surgery.* 2nd ed. New York:Churchill Livingstone;1993.
20. Marianeschi SM, Seddio F, McElhinney DB, Colagrande L, Abella RF, La Torre T et al. Fast-track congenital heart operations: a less invasive technique and early extubation. *Ann Thorac Surg.* 2000;69(3):872-6.