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Comparison of 3 Different Incisions Used for Atrial-Septal Defect Closure

Murat Basaran, MD, Ali Kocailik, MD, Cihan Ozbek, MD, Alper Ucak, MD, Eylul Kafali, MD, Melih Us

Goztepe Safak Hospital, Cardiovascular Surgery Clinic, Istanbul, Turkey

ABSTRACT

Background: Surgical closure of atrial-septal defects is now associated with low morbidity and mortality rates. We assessed surgical, cosmetic, and psychological results of 3 different surgical approaches to atrial-septal defect repair.

Methods: Study participants were 82 patients who underwent surgery for atrial-septal defect. Mean age was 21 ± 8 years, and the female:male ratio was 23:59. Patients were divided into 3 groups according to the incision used; group 1 (n = 26), partial lower sternotomy; group 2 (n = 34), right anterolateral thoracotomy via a submammary incision, and group 3 (n = 22), conventional median sternotomy.

Results: There was no operative or late mortality. No significant differences between groups were associated with the surgical technique used. Direct closure was the procedure of choice performed in 53 patients (64.6%). In the remaining patients the repair was performed with a pericardial patch (29 patients, 35.4%). One patient in group 1 required conversion to median sternotomy because transoesophageal echocardiography performed at the operating theater revealed a partial anomalous pulmonary venous connection of right pulmonary veins to the inferior vena cava. This patient was excluded from the study group. All patients were symptom free postoperatively, and control echocardiography revealed a trivial shunt in only 1 patient, with a Qp:Qs ratio of 1.3. Rhythm abnormalities, including atrioventricular block, atrial fibrillation, and flutter, were observed in 7 patients but were found to be unrelated to the surgical incision ($P = .3$). Cardiopulmonary bypass, cross-clamp, and operative times were longer with minimally invasive approaches; but these differences were not statistically significant. Intensive care unit and hospital stay periods were significantly shorter in groups 1 and 2. During the postoperative follow-up period, patients in groups 1 and 2 showed superior results in satisfaction with their cosmetic outcomes.

Conclusions: With the development of minimally invasive techniques that yield surgical results comparable to those of standard techniques, surgeons have changed their focus from survival to cosmetic and psychological outcomes, especially in the repair of simple cardiac defects. Operations performed via limited skin incisions are surgically safe and provide superior cosmetic and psychological results.

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Correspondence: Murat Basaran, Fahrettin Kerim Gokay Street, Goztepe Safak Hospital, Cardiovascular Surgery Clinic, Istanbul, Turkey; 00 90 216 565 44 44; fax: 00 90 216 566 16 16 (e-mail: dr_murat_basaran@yaboo.com).

INTRODUCTION

Surgical closure of atrial-septal defect (ASD) is associated with very low mortality rates, and since cardiac surgery began in the early 1950s, countless patients have benefited from this surgical procedure [Horvath 1992; Konstantinides 1995; Lange 2001; Doll 2003; Ryan 2003]. Conventional standard median sternotomy is the incision most commonly used by most surgeons, but this approach may be troublesome postoperatively because of the midline scar, especially for young patients. In addition to the achievement of a satisfactory surgical outcome, we believe that cosmetic aspects of surgery cannot be neglected in cardiac surgery. Currently, minimally invasive approaches have gained popularity in all areas of surgery, and various cardiac procedures can be performed safely through limited incisions [Barbero-Marcial 1998; Däbritz 1999; Houyel 1999; Bichell 2000; Abdel-Rahman 2001; Schreiber 2005; Ak 2007; Mishaly 2008]. New approaches may improve postoperative psychological status by increasing patient body-image satisfaction. Numerous reported studies [Abdel-Rahman 2001; Doll 2003; Schreiber 2005; Mishaly 2008] have focused on early morbidity and mortality rates of such techniques. In these studies, the investigators have tried to reveal the equivalency of these approaches to conventional approaches with regard to morbidity, mortality, and efficacy. A few authors, including Massetti and coworkers [Massetti 1996, 1999], evaluated the cosmetic and psychological implications of minimally invasive incisions; a major limitation of this study, however, was the absence of a control group. In this retrospective study, we assessed the early outcomes of 3 different approaches and also compared the cosmetic and psychological results obtained with each individual technique.

MATERIALS AND METHODS

From September 2000 to July 2005, 82 patients with a diagnosis of ASD were included into this retrospective study. Data were gathered by examining the surgical and medical records of patients. Mean age was 21 ± 8 years, and female:male ratio was 23:59. Preoperative diagnosis and type of ASD were determined by transthoracic echocardiography, and additional invasive diagnostic modalities were carried out in patients with appropriate indications. Older patients (>40 years) with known risk factors of coronary artery disease and peripheral arterial disease were routinely evaluated by coronary and peripheral arterial angiography, respectively. Defect closure was considered in symptomatic patients and in patients with a Qp:Qs ratio of 1.5 [Gatzoulis 1996]. To overcome any statistical bias, patients requiring additional procedures such as coronary artery bypass or valve repair/replacement were excluded from the study group. Patients were divided into 3 groups according to the incision used; group 1 (n = 26), partial lower sternotomy; group 2 (n = 34); right submammary incision, and group 3 (n = 22), conventional median sternotomy. Preoperative demographics of all patients are listed in Table 1.

Surgical Technique

Noninvasive monitoring by electrocardiogram, pulse oximetry, and measurements of inspiratory and expiratory gas concentrations were used as well as invasive monitoring of central venous and arterial pressures. The induction of anesthesia was achieved with intravenous fentanyl (3μg/kg), propofol (2 mg/kg), and vecuronium (0.1 mg/kg). Intermittent fentanyl and isoflurane were used for maintenance. Transesophageal endoscopic echocardiography was performed in patients to confirm the preoperative diagnosis.

In group 1, surgery was performed while the patient was in a supine position, and a longitudinal incision was made in the femoral region to prepare the femoral artery for later use. After a skin incision of 6-8 cm was made, the surgeon performed a J-shaped partial lower sternotomy extending from the xiphoid process to the right third intercostal space. After systemic heparinization (activated coagulation time >480 seconds), cardiopulmonary bypass was established through cannulations of the ascending aorta and both caval veins.

Table 1. Preoperative Demographics of All Patients*

	Group 1 (n = 26)	Group 2 (n = 34)	Group 3 (n = 22)	*P*
Age, y	19.1 ± 3.5	21.7 ± 4.1	18.6 ± 2.9	.14
Sex (F/M), n	7/19	14/20	2/20	
NYHA class	1.9 ± 0.3	2.1 ± 0.4	2.3 ± 0.4	.11
EF, %	64.5 ± 8.1	66.3 ± 7.9	63.2 ± 9.4	.09
Qp:Qs ratio	2.3 ± 0.2	2.1 ± 0.4	2.4 ± 0.3	.23
Mean PAP, mm Hg	28.9 ± 6.5	25.6 ± 3.7	23.2 ± 4.1	.19

*NYHA indicates New York Heart Association; EF, ejection fraction; PAP, pulmonary artery pressure.

Superior and inferior vena cavae were encircled with silicone rubber loops. In cases with difficult exposure of the ascending aorta because of significant cardiomegaly, the femoral route was used for inflow. After the application of a cross-clamp, a dose of 20 mL/kg of cold crystalloid cardioplegia was initially infused into the aortic root at a pressure of 30 mmHg to achieve cardiac arrest. Via a right atriotomy incision, the ASD was closed directly or with a pericardial patch, depending on the size of the defect. Before declamping, deairing was performed carefully by use of a standard method through the aortic root. Weaning from cardiopulmonary bypass was commenced when the patient's rectal temperature reached 37°C, and the chest and groin wounds were closed with subcuticular sutures to optimize the cosmetic results (Figure, A).

In group 2, surgery was performed while the patient was in a slightly oblique position at an angle of 45°. A 5-cm submammary incision was performed, and the cavity was entered via the right fourth intercostal space in female patients with developed breasts. In patients with undeveloped breasts, the position of the skin incision was slightly lower, at the level of the seventh intercostal space. The pericardium was opened anterior to the phrenic nerve, and retraction sutures were placed to improve surgical field exposure. The rest of the surgical procedure was carried out as in group 1 patients. The heart was arrested with antegrade cardioplegia, and the ASD was then closed either with previously harvested pericardium or directly. Weaning from cardiopulmonary bypass was commenced when the patient's rectal temperature reached 37°C, and the wounds were closed with subcuticular sutures to optimize the cosmetic results (Figure, B). In group 3, conventional median sternotomy with direct aortic and bicaval cannulations were performed. Cardioplegia was delivered antegradely and the ASD was closed through a right atriotomy incision.

The primary outcomes assessed were early postoperative parameters and pain scores. Prolonged mechanical ventilation time was defined as the requirement of mechanical ventilatory support for more than 24 hours. Other postoperative complications recorded were revision because of postoperative bleeding, superficial sternal infection, femoral wound infection, and pneumonia. Postoperative pain scores were quantified at 24, 48, and 96 hours by use of a visual analog rating scale ranging from 0 (no pain) to 10 (worst possible pain). The recorded need of pain medications was quantified with a numeric scale (analgesic scale) with 0 indicating no additional medication; 1, pain relieved with the use of diclofenac sodium intramuscularly; 2, use of meperidine intramuscularly; and 3, more than 2 doses of meperidine daily [Ogus 2007]. The secondary outcomes included cosmetic and psychological impacts of intervention. The patients were asked to complete a modification of a self-report questionnaire described by Massetti and coworkers [1996, 1999]. The answers were assessed to determine the impacts of their surgical scar on their routine daily life.

Data are expressed as mean ± SD. Statistical analysis was performed by one-way ANOVA test with the post-hoc Tukey for comparison of pre- and postoperative variables between groups. The comparison of 3 groups was performed with the

Photographs views of patients after partial lower sternotomy (A) and right anterolateral thoracotomy via submammary incision (B).

Kruskal-Wallis test, whereas differences between 2 groups were analyzed with the Bonferonni-adjusted Mann–Whitney U-test. Differences were considered statistically significant for a *P*-value of <.05.

RESULTS

There were no deaths or major complications during the early postoperative period. Skin incision lengths ranged from 5 to 8 cm in groups 1 and 2. Mean femoral incision length was 3.1 cm (range, 2 to 4 cm). One patient in group 1 required conversion to median sternotomy because transoesophageal echocardiography performed at the time of surgery revealed a partial anomalous pulmonary venous connection of the right pulmonary veins to the inferior vena cava. This patient was excluded from the study group. In 53 patients (64.6%) the septal defect was closed directly, whereas in the remaining 29 patients (35.4%) a pericardial patch was used to close the defect. There was no significant difference between groups in terms of surgical technique used (pericardial patch vs direct closure). The number of patients having direct closure in groups 1, 2, and 3, respectively, were 17 of 26 (65.4%), 22 of 34 (64.7%), and 14 of 22 (63.6%).

Intra- and postoperative patient data are presented in Table 2. Cardiopulmonary bypass, cross-clamp, and skin-to-skin operative times were longer with minimally invasive approaches, but this difference was not statistically significant. During the early postoperative period there were no significant differences in mechanical ventilation time or postoperative blood loss (Table 2). All patients were extubated within a few hours after surgical intervention. No patient required revision because of postoperative drainage. Intensive care unit and hospital stays were significantly shorter in groups 1 and 2 (Table 2). Rhythm abnormalities, including atrioventricular block, atrial fibrillation, and flutter, were noticed in 7 patients, but these findings were not related to the surgical incision ($P = .3$). One patient in each group experienced atrial fibrillation postoperatively, but all patients were converted to normal sinus rhythm with medical treatment. Two patients in group 1, 1 patient in group 2, and 1 patient in group 3 had transient right or left bundle-branch block that resolved spontaneously. There were no wound-healing problems at sternal and thoracic incision sites in any group. All patients who underwent the operation via femoral cannulation were free from complications except 2 patients who developed paresthesia at the inguinal region. Extreme care was undertaken to avoid the phrenic nerve during surgery, and there was no phrenic palsy in any patient. More patients in group 3 required analgesic medication postoperatively, and analgesic scores were lower in groups 1 and 2 (Table 3). During the early postoperative period, 1 patient in group 2 suffered from intercostal neuralgia, which was treated with medical therapy.

All patients were symptom free postoperatively and in New York Heart Association Class I. Postoperative

Table 2. Intra- and Postoperative Data of All Patients

	Group 1 (n = 26)	Group 2 (n = 34)	Group 3 (n = 22)	*P*
Operation time, min	149.4 ± 17.8	153.6 ± 16.5	145.8 ± 14.2	.1
Cross-clamp time, min	25.8 ± 4.9	24.9 ± 5.3	21.1 ± 3.2	.09
Cardiopulmonary bypass time, min	62.4 ± 13.6	60.4 ± 11.4	56.4 ± 14.7	.08
Direct closure/ patch, n	17/9	24/10	12/10	
Ventilation time, h	4.2 ± 1.2	3.9 ± 0.8	4.4 ± 1.6	.11
Blood loss, mL	325 ± 56.7	347 ± 63.5	363.8 ± 48.1	.1
Intensive care unit stay, h	14.5 ±3.2*	13.9 ± 4.1†	18.2 ± 5.6	.04
Hospital stay, d	5.1 ± 0.8*	5.4 ± 0.9†	7.2 ± 1.2	.03

*Group 1 vs 3, $P < .01$.

†Group 2 vs 3, $P < .01$.

Table 3. Visual Analog Pain Scale (VAS) and Analgesic Scale Scores

	Group 1 (n = 26)	Group 2 (n = 34)	Group 3 (n = 22)	*P*
VAS				
24th hour	1.3 ± 0.4*	1.1 ± 0.3†	5.2 ± 0.9	.03
48th hour	1.1 ± 0.2*	0.9 ± 0.1†	4.5 ± 0.7	.02
96th hour	1.0 ± 0.1*	0.9 ± 0.1†	4.3 ± 0.6	.02
Analgesic scores	0.3 ± 0.1*	0.45 ± 0.1†	2.7 ± 0.8	.03

*Group 1 vs 3, $P < .01$

†Group 2 vs 3, $P < .01$

echocardiographic evaluation revealed a trivial shunt in only 1 patient, with a Qp:Qs ratio of 1.3. Among the patients examined postoperatively, no changes in breast volume and symmetry were observed. The results obtained from the self-report questionnaires and the comparisons of the 3 groups are presented in Table 4.

DISCUSSION

Previous investigations have revealed excellent outcomes obtained with minimally invasive cardiac surgery performed via approaches other than median sternotomy [Barbero-Marcial 1998; Däbritz 1999; Houyel 1999; Bichell 2000]. An important limitation of such studies, however, is the underevaluation of psychological aspects of surgical intervention. In our study, we aimed to assess the early outcomes of 3 different approaches and also to compare the cosmetic and psychological results obtained with 3 different techniques. Our experience suggests that ASD closure can be performed as safely with minimally invasive surgical procedures as with the standard median sternotomy incision. Furthermore, minimally invasive surgery avoids the midline scar and positively affects the psychological status of the patient.

Surgeons are currently using a variety of incisions to obtain adequate exposure, and the decision of approach usually depends on personal preference. Some conflicting results have been reported in the medical literature. Some studies have suggested that none of these approaches have specific superiority over each other [Bichell 2000; Ryan 2003]. In contrast, other studies have demonstrated the advantage of minimally invasive surgery, especially in regard to intensive care unit and hospital stays [Abdel-Rahman 2001; Mishaly 2008]. Indeed, our patients who underwent surgery with minimal incisions had shorter intensive care unit and hospital stay periods. Short incisions undoubtedly reduce surgical trauma, which in turn leads to better postoperative recovery; but these approaches are not free of complications. The major drawbacks for the use of these approaches include the potential for complications such as increased operative time and risk of injury to cardiac structures, especially during the surgeon's learning-curve period, and difficulty in the achievement of adequate exposure and deairing.

The midline skin incision may leave an unsightly scar, which leads to psychological displeasure that modifies the patient's body image. At the beginning of minimally invasive surgery, the main goal was a nearly invisible, cosmetically acceptable scar along with successful ASD closure comparable to that obtained with a conventional approach. Most surgeons have thus tried to obtain acceptable results with surgery performed via short incisions leaving an invisible scar. But studies of these procedures have generally failed to investigate the psychological impacts of surgical scars. We totally agree with Massetti [1996, 1999], who suggested that the psychological sequelae of cardiac surgery have been generally underevaluated by surgeons who focus only on the achievement of satisfactory surgical outcome. In the current surgical era, however, one of the major aims should be the reduction of surgical impact caused by a midline scar.

The performance of the surgical procedure through a small incision requires established skill and experience. Limited exposure of the ventricles requires specific strategies regarding deairing, pacing-wire insertion, and defibrillation. Minimally invasive surgery can be accomplished in various ways. Encouraging results have been obtained with the use of percutaneous transcatheter closure of ASD [Liang 2006; Hongxin 2007], but the major limitation of such intervention is the need for special equipment. Furthermore, the use of percutaneous transcatheter closure is usually limited to cases with a maximum defect size of 34 mm and an accessible neck.

Table 4. Answers to Self-Report Questionnaire

	Group 1 (n = 26)	Group 2 (n = 34)	Group 3 (n = 22)
Perception of the scar			
Invisible	80.7% (21/26)	85.3% (29/34)	22.7% (5/22)
Slightly visible	15.4% (4/26)	11.8% (4/34)	27.3% (6/22)
Visible	3.9% (1/26)	2.9% (1/34)	50% (11/22)
Evaluation of the cosmetic result			
Good	88.5% (23/26)	91.2% (31/34)	31.8% (7/22)
Mediocre	11.5% (3/26)	8.8% (3/34)	68.2% (15/22)
Absence of psychological problems when:			
Dressings are removed	80.7% (21/26)	85.3% (29/34)	31.8% (7/22)
Wearing a bathing suit	84.6% (22/26)	88.2% (30/34)	36.4% (8/22)
Participating in sports	92.3% (24/26)	85.3% (29/34)	40.9% (9/22)

In addition, data are not yet available regarding the long-term results of percutaneous transcatheter closure, so the risks of endocarditis and thrombus formation are not clear.

In our series, both femoral and aortic cannulations were used for arterial inflow. The introduction of all cannulas through the chest incision may obscure the surgical field; we thus did not hesitate to use a groin incision during the operation. As mentioned by Schreiber and colleagues [2005], a minimum weight requirement of approximately 10-15 kg is required for the use of femoral-artery cannulation. Because our patients were generally older than those of Schreiber et al, we used the femoral artery more liberally and observed no major postoperative complications related to the femoral incision. Methods for myocardial protection are the subject of considerable debate. Although fibrillatory arrest can be considered as an alternative adjunct, in our cohort every effort was made to administer cardioplegia through a needle introduced into the aortic root.

Another controversial issue addressed in the literature is the optimal approach for young female patients. Some surgeons recommend the use of a small thoracotomy incision in young patients [Giamberti 2000]. Others question the use of this type of incision in this patient group because asymmetric development of the right breast has occurred in female patients who underwent surgery through a right anterolateral thoracotomy during the prepubescent period. Because our patient group was older, with developed breast tissue, we generally used a bikini-line incision, which can be easily hidden by the patient. In 4 patients younger than 12 years, however, we chose a lower partial sternotomy approach to avoid any future problem with breast development.

In conclusion, with the development of minimally invasive techniques that yield comparable surgical results, surgeons have changed their focus from survival to cosmetic and psychological outcomes, particularly when repairing simple cardiac defects. Minimally invasive approaches reduce surgical trauma and postoperative pain and allow faster postoperative recovery. Operations performed via limited skin incisions are surgically safe and provide superior cosmetic and psychological results.

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