The Heart Surgery Forum #2008-1011
11 (5), 2008 [Epub October 2008]
doi: 10.1532/HSF95.20081011 Online address: http://cardenjennings.metapress.com

Totally Endoscopic Atrial-Septal Defect Repair through 3 Ports

Yunge Cheng, MD, Yuejun Wang, MD, Weijun Wang, MD, Jianmin Gu, MD, Da Ni, MD

Department of Cardiovascular Surgery, No. 3 People's Hospital, School of Medicine, Shanghai JiaoTong University, Shanghai, China

ABSTRACT

Background: The standard techniques of laparoscopic surgery were first used in the late 1980s, and this method rapidly developed into a safe and effective procedure that became the standard of care. Cardiac surgery has been the last surgical specialty to completely embrace endoscopic techniques. Our working hypothesis was that atrial-septal defect (ASD) repairs can be performed by using a totally 2-dimensional endoscope view through 3 ports with results that are similar to those obtained with traditional surgical techniques.

Methods: From May 2000 to May 2006, we performed totally endoscopic ASD repairs through 3 ports in 238 patients. Femorofemoral cardiopulmonary bypass and transthoracic clamp techniques were used.

Results: The operation was performed successfully in 234 patients (98%). In 4 patients the port was enlarged to a 5-cm incision. Neither conversion to median sternotomy incision nor reoperation was necessary in any patients. Mean operation time was 2.2 ± 0.8 hours; mean cardiopulmonary bypass and aortic cross-clamp times were 66 ± 19 minutes and 25 ± 8 minutes, respectively. No in-hospital deaths occurred. Major postoperative complications occurred in 13 patients (5%). Echocardiographic examinations performed at the time of discharge revealed no residue leaks. Mild mitral valve regurgitation was observed in 2 patients and mild tricuspid valve regurgitation in 4 patients. Patients reported satisfaction with cosmetic results and levels of postoperative discomfort.

Conclusions: Totally endoscopic ASD repair through 3 ports is technically feasible and safe.

INTRODUCTION

The standard techniques of laparoscopic surgery were introduced in the late 1980s. This method has rapidly developed into a safe and effective procedure and has become the standard of care. Cardiac surgery is the last surgical specialty to embrace totally endoscopic techniques [Mack 2006]. From May 2000 to May 2006, we have performed totally endoscopic atrial-septal defect (ASD) repairs in 238 patients. Our working hypothesis has been that surgical ASD repairs can be performed by using a under 2-dimensional endoscopic view through 3 ports, with conventional instrumentation and with results that are similar to those obtained with traditional surgical techniques.

Received January 24, 2008; received in revised form July 28, 2008; accepted August 4, 2008.

Correspondence: Yunge Cheng, Division of Cardiac Surgery, NO. 3 People's Hospital, School of Medicine, Shanghai JiaoTong University, 280 Mohe Road Shanghai 201900, China; +86-021-56691101-6125; fax: +86-021-56691662 (e-mail: chengyunge@126.com).

PATIENTS AND METHODS

Study participants were patients who underwent totally endoscopic ASD repairs through 3 ports at our institution during the period from May 2000 to May 2006. The study received institutional ethics committee approval, and every patient or patient parent or guardian gave written informed consent. The study included 238 patients (91 men, 147 women; mean age 26.5 ± 8.6 years, range 3-56 years; mean body weight 48.2 ± 11.6 kg, range 15-66 kg). Among the study patients were 89 children (age 3-12 years, body weight 15-35 kg) and 149 adults (age 13-56 years, body weight 36-66 kg). The type of ASD was ostium secundum in 126 patients, foramen primium in 19 patients, mixed type in 74 patients, and sinus venosus in 19 patients. In some cases ASD was associated with other comorbidities, including anomalous drainage of right pulmonary veins into the right atrium in 12 patients, mitral valve regurgitation in 11 patients, and tricuspid valve regurgitation in 43 patients. The mean preoperative New York Heart Association functional class was 1.9 ± 0.1 (range 1-3). The left ventricular ejection fraction was within the normal range in all patients, and mean pulmonary artery pressure was 35 ± 7 (range 30–86) mmHg. Mean shunt volume was 39% ± 8% (range 21% to 68%). In the beginning of the study period, from May 2000 to May 2001, only patients with ostium-secundum–type ASD were selected for totally endoscopic techniques. As our experience increased, we also performed totally endoscopic surgery on patients with other types ASD and with other comorbidities, as described above (Table 1). Preoperative Doppler ultrasound of the abdominal aortic, iliac, and femoral arteries was used routinely. Evidence of a major peripheral vascular disease served as a contraindication for totally endoscopic techniques using retrograde arterial perfusion.

Table 1. Preoperative Patient Characteristics*

No. of patients	
Total	238
Male	91
Female	147
Age, y	26.5 ± 8.6 (3-56)
No. of children (age 3-12 y)	89
No. of adults (age 13-56 y)	149
Body weight, kg	48.2 ± 11.6 (15-66)
No. of children (weight 15-35 kg)	89
No. of children (weight 36-66 kg)	149
New York Heart Association functional class	1.9 ± 0.1 (1-3)
Pulmonary artery pressure, mm Hg	35 ± 7 (30-86)
Shunt volume, %	39 ± 8 (21-68)
Pathology	
Ostium secundum	126
Foramen primium	19
Mixed type	74
Sinus venosus	19
Atrial-septal defect size, cm	3.4 ± 1.1 (1.2-5.2)
Associated comorbidities	
Mitral valve regurgitation	11
Anomalous drainage of pulmonary veins	12
Tricuspid valve regurgitation	43

*Results are expressed as n or mean ± SD (range).

Patients were positioned supine with a slight elevation of the right hemithorax. Three small ports were necessary for the procedure (Figure 1). First, a 15-mm incision was made along the seventh intercostal space (ICS) at the preaxillary line; second, a 15-mm incision was made along the third ICS at the right parasternal region; and third, a 15-mm incision was made along the third ICS at the midaxillary line.

After the patient received general heparinization, arterial cannulation (12-21 Fr; DLP, Grand Rapids, MI, USA) was done through the right femoral artery. In the 89 patients who were children, 1 venous cannula (17-21 Fr; DLP) was inserted into the right femoral vein and the other (19-21 Fr; DLP) was inserted into the superior vena cava (SVC) through the third port and right atrium (Figure 2). In the 149 adult patients we used a 2-stage design venous cannula, the 24/29-30/33 Fr DLP Carpentier™ cannula, which has a unique 2-stage design that drains the heart more efficiently by meeting the 3:1 interior vena cava (IVC)/SVC drainage requirements. Superior flow rates are obtained by simultaneous drainage of the IVC and SVC. The Carpentier cannula was inserted into the right femoral vein and forwarded into the right atrium and the SVC. Cardiopulmonary bypass was established between the femoral artery and femoral veins and/or the SVC; the SVC and IVC were snared by use of crossing lines. Venous drainage was passive and depended totally on gravity. We performed aortic cross-clamping by using a long transthoracic clamp inserted through the third port and administered intermittent antegrade cardioplegia directly into the aortic root by using a needle-vent catheter (Figure 3).

A 10-mm 30° endoscope camera was inserted into the thoracic cavity through the first port, the right-hand instrument through the second port, and the left-hand instrument and the aortic cross-clamp through the third port. Surgical tasks in the thoracic cavity were performed completely with 2-dimensional video and without direct vision, by use of conventional instruments (Figure 3). Incisions in the pericardiun and the right atrium were performed as in conventional ASD repair. The ASD was exposed and identified through the right-atrium incision (Figure 5). The mean ASD size was 3.4 ± 1.1 cm (range 1.2-5.2 cm). The ASD was closed with a 2-layer primary suture technique in 129 patients and with a 4-0 Prolene running suture (Figure 6) in 119 patients. Tricuspid valve annuloplasty was performed in

Figure 1. Three ports on the right chest.

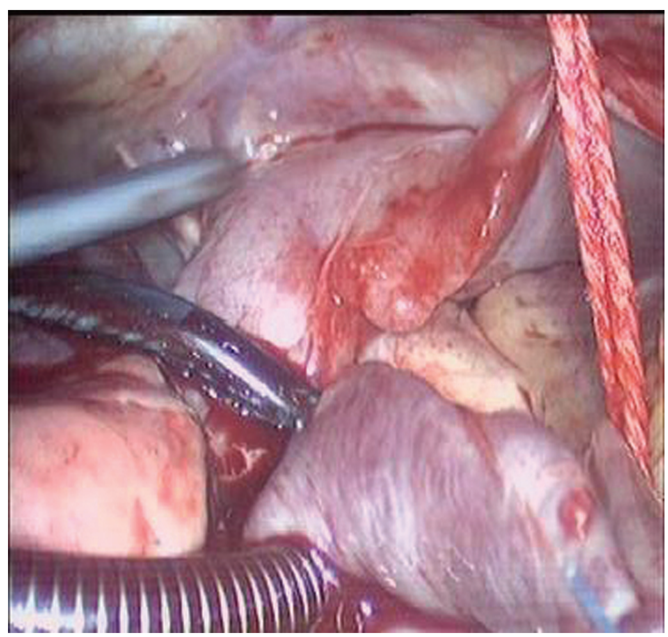

Figure 2. One venous cannula inserted into the superior vena cava through the third port and right atrium

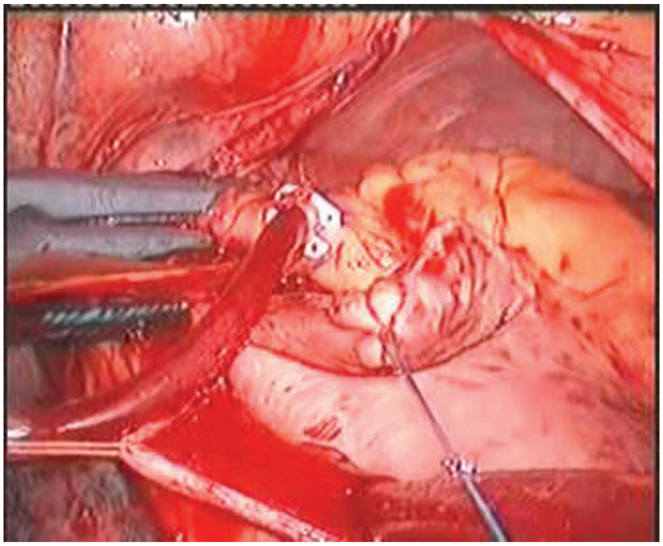

Figure 3. Aortic cross-clamping with a long transthoracic clamp and intermittent antegrade cardioplegia through the aortic-root catheter

Figure 4. The screen display of the camera was placed at the upper left of the operating table.

33 patients and mitral valve annuloplasty in 9 patients (Table 2). Before the suture of the atrial septum was tied, we perfused blood in the left atrium to perform retrograde deairing of the left atrium. Antegrade deairing was done from the ascending aorta through the needle vent. Air was removed by lung inflation with simultaneous reduction of venous drainage performed with the patient in the Trendelenburg position. The right atrium was closed using a 4-0 Prolene running suture. After reperfusion, patients were weaned from cardiopulmonary bypass, and a tub for postoperative drainage was inserted into the right thorax through the first incision.

RESULTS

Totally endoscopic ASD repairs were completed successfully in 234 patients (98%). In 4 patients we enlarged the second port to a 5-cm incision (because of bleeding of the aortic root in 3 patients and mitral valve regurgitation in 1 patient). For these procedures a retractor was used and surgical tasks were performed under direct vision. Neither conversion to a median sternotomy incision nor reoperation was necessary in any patients. No patient deaths occurred during hospitalization. Mean total surgical time was 2.2 ± 0.8 hours (range 1.8-5.6 hours). Mean cardiopulmonary bypass and aortic cross-clamp times were 66 ± 19 minutes (range 38-96 minutes) and 25 ± 8 minutes (range 8-46 minutes), respectively. Mean postoperative ventilation time was 4.3 ± 1.6 hours (range 2-9 hours). Mean intensive care unit time was 8.3 ± 2.8 hours (range 6-13 hours). Mean postoperative hospital stay time was 6.6 ± 1.8 days (range 4-11 days). Mean postoperative drainage volume was 160 ± 21 mL (range 20-1000 mL) (Table 3). Major postoperative complications occurred in 13 patients (5%) (Table 4). Reexploration for bleeding was required in 3 patients, impaired wound healing occurred in 4 patients, and hemopneumothorax occurred in 6 patients. No major complications occurred; in particular, no cerebrovascular accidents or aortic dissections occurred. Echocardiographic examinations at the time of discharge revealed no residual leaks. Mild mitral valve regurgitation was detected in 2 patients and mild tricuspid valve regurgitation in 4 patients (Table 4). Patients

Table 2. Surgical Procedures*

No. of patients	238
Incisions	
Three ports	234
Incision enlargement	4
Conversion to median sternotomy	0
Cannulation for cardiopulmonary bypass	
Femoral artery	238
Femoral vein plus right atrium/superior vena cava	89
Two-stage femoral veins	149
Cardioplegia antegrade	238
Closure technique	
Direct closure	129
Path closed	119
Tricuspid valve annuloplasty	33
Mitral valve annuloplasty	9

*Results are expressed as n.

Table 3. Surgical Outcomes*

Hospital deaths	0
Total operation time, h	2.2 ± 0.8 (1.8-5.6)
Cardiopulmonary bypass time, min	66 ± 19 (38-96)
Aortic occlusion time, min	25 ± 8 (8-46)
Postoperative ventilation time, h	4.3 ± 1.6 (2-9)
Intensive care unit time, h	8.3 ± 2.8 (6-13)
Postoperative hospital stay time, d	6.6 ± 1.8 (4-11)
Drainage, mL	160 ± 21 (20-1000)

*Results are expressed as n or mean ± SD (range).

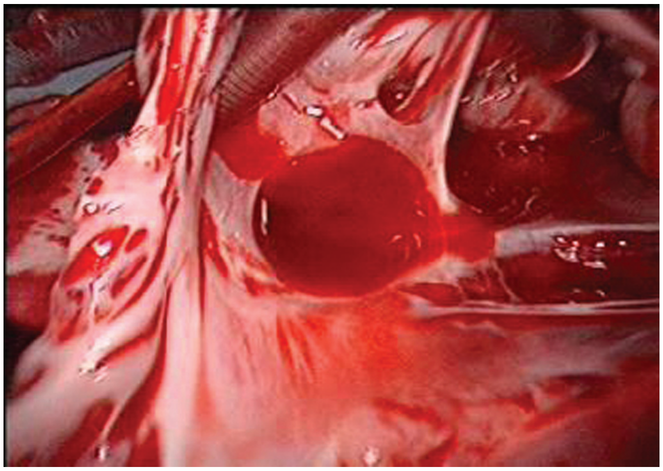

Figure 5. The atrial-septal defect was exposed through the right-atrium incision.

expressed a high degree of satisfaction with cosmetic results and with the amount of postoperative discomfort.

DISCUSSION

Standard surgical ASD closure via sternotomy is a safe and effective procedure with low morbidity and mortality. To minimize surgical trauma and scars, however, various types of minimal access surgical ASD closure have recently been proposed. Although transcatheter closure of the defect is the least invasive procedure, this technique is not practiced at all centers, and many patients do not meet the selection criteria. Recurrence and occluder dislodgment have also been reported; therefore, traditional surgical methods certainly still have a place in ASD closure [Casselman 2005]. Recently, computerized robotic enhancement has emerged as a potential facilitator of endoscopic cardiac surgery, including coronary artery bypass grafting and mitral valve repair. An important development in endoscopic cardiac surgery was the da Vinci telemanipulator, the only surgical telemanipulator that is currently being used in endoscopic cardiac surgery. The majority of cardiac surgeons, however, still perform less invasive procedures such as coronary bypass, valve repair, and ASD closure without the use of a robotic telemanipulator. Robotic-based endoscopic cardiac surgery is time-consuming and costly, 2 obvious problems that have deterred many cardiac surgeons from adopting these techniques [Vassiliades 2006].

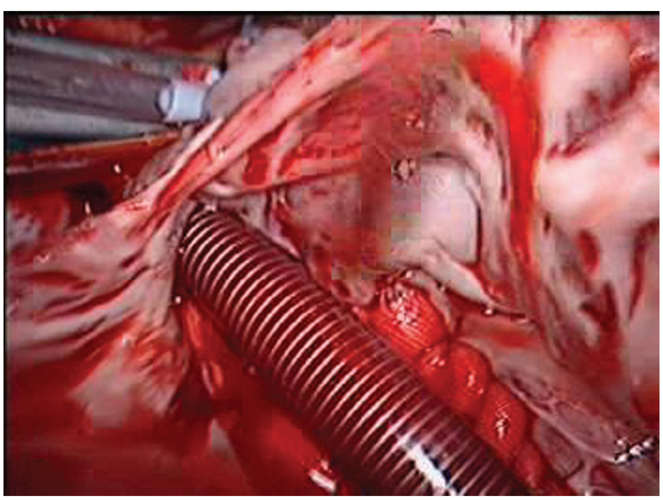

Figure 6. The path closing the atrial-septal defect was performed by using a 4-0 Prolene running suture.

Table 4. Surgical Complications*

Postoperative complications	13 (5%)
Reexploration for bleeding	3
Hemopneumothorax	7
Wound complications	3
Cerebrovascular accident	0
Ascending aortic dissection or disruption	0
Vascular complications	0
New atrial fibrillation	2
Residual leak	0
Reoperations	0
Mild mitral valve regurgitation	2
Mild tricuspid valve regurgitation	4

*Results are expressed as n or n(%).

The standard techniques for laparoscopic cholecystectomy were first used in the late 1980s, and laparoscopic surgery rapidly developed into a safe and effective procedure that has become the standard of care. Advantages of laparoscopic surgery include tiny incisions and marked reduction in postoperative pain, both of which have led to patient satisfaction. Our results demonstrate that ASD repairs can be performed totally with 2-dimensional endoscopic imaging through 3 ports, with conventional instrumentation and with results similar to those obtained with traditional surgical methods. Surgeon training and experience are among the most important variables for successful performance of totally endoscopic surgery. We have found that performing surgery on animals is an effective method for training surgeons. From October 1998 to October 1999, we performed totally endoscopic cardiac surgery through 3 ports on 100 animals, a training time of more than 400 hours. We believe that it is necessary for surgeons to gain experience in visualizing the surgical field and performing surgical tasks with the 2-dimensional vision provided by the endoscope, skills necessary for successful totally endoscopic cardiac surgery through 3 ports in human patients.

The success rate of totally endoscopic ASD repairs in our series was 98%. In 4 patients we enlarged the second port to an incision because of bleeding of the aortic root. Suturing of the aortic root under totally endoscopic conditions is a challenging procedure, particularly for surgeons without prior experience in this technique. Neither conversion to a median sternotomy incision nor reoperation was necessary in any of our patients. The times of surgery, cardiopulmonary bypass, and aortic cross-clamp were acceptable, although some were longer than required for traditional techniques, particularly early in the study. There were no hospital deaths, and echocardiography at the time of discharge revealed no residue leaks. Postoperative complications occurred in 13 patients (5%). There were no major complications; in particular, no cerebrovascular accidents or aortic dissections occurred. The surgical outcomes were excellent and were similar to those of traditional operations. Patients reported high satisfaction with cosmetic results and the amount of postoperative discomfort.

In conclusion, this report documents the feasibility and safety of totally endoscopic ASD repair through 3 ports.

REFERENCES

Casselman FP, Dom H, De Bruyne B, et al. 2005. Thoracoscopic ASD closure is a reliable supplement for percutaneous treatment. Heart 91:791-3.

Mack MJ. 2006. Minimally invasive cardiac surgery. Surg Endosc 20:s488-92.

Vassiliades TA Jr. 2006. Robotics in cardiac surgery. Int J Med Robotics Comput Assist Surg 2:4-6.