CLOSURE OF ATRIAL SEPTAL DEFECTS WITHOUT CARDIOPULMONARY BYPASS: THE SANDWICH OPERATION

Wiwat Warinsirikul, MD
Surapot Sangchote, MD
Pirapat Mokarapong, MD
Sant Chaiyodsilp, MD
Supreecha Tanamai, MD

Background: Cardiopulmonary bypass has adverse effects on patient physiology. A prospective randomized trial was undertaken to evaluate closure of atrial septal defects with or without cardiopulmonary bypass.

Methods: Between August 1997 and March 2000, 150 patients with ostium secundum atrial septal defects were enrolled. Patients were randomized for repair without cardiopulmonary bypass (ie, the sandwich operation; $n = 74$) as a study group or with cardiopulmonary bypass ($n = 76$) as a control group. In the sandwich group the sandwich patch was passed into the right atrium and placed at the defect during transesophageal echocardiography. The patch was secured with external transfixing sutures and endoscopic staples. Clinical outcomes were compared. Outcome variables included perioperative morbidity, mortality, length of stay in the intensive care unit, hospital length of stay from operation to discharge, residual shunt, reoperation, hematologic profile, transfusion requirement, and hospital fee. The follow-up duration ranged from 1 to 29 months (mean, 8.7 ± 7.5 months).

Results: There was no operative mortality. The success rate of the sandwich operation was 68 (92%) of 74 patients. Patients in the sandwich group had shorter operative times and lengths of stay in the intensive care unit, fewer requirements of transfusion, and lower hospital fees. The differences in postoperative drainage, arrhythmias, and hematologic profiles could be due to chance. Two patients in the sandwich group required reoperation for residual shunt. The risk factor for residual shunt was earlier date of repair. Mitral and tricuspid valve function was not adversely affected by the operation.

Conclusions: Closure of atrial septal defects without cardiopulmonary bypass can be done effectively. Adverse effects of cardiopulmonary bypass can be avoided, as shown by improvements of postoperative parameters with the sandwich operation. (*J Thorac Cardiovasc Surg* 2001;121:1122-9)

A number of undesirable side effects occur to a greater or lesser degree with cardiopulmonary bypass (CPB). These include blood coagulation abnormalities and changes in red blood cell and plasma proteins produced by their passage through the extracorporeal system. Gaseous and particulate emboli and various vasoactive and otherwise biologically active substances were produced by contact of blood with foreign surfaces.¹ Therefore, pulmonary, myocardial, and neurologic dys-

function occurs.²⁻⁴ A number of ingenious closed methods for repair of atrial septal defects (ASDs) were proposed and studied.⁵ The aim of this study was to evaluate closure of ASDs with or without CPB.

Patients and methods

Between August 1997 and March 2000, 150 patients with ostium secundum ASD diagnosed by means of transthoracic echocardiography were enrolled. There were 39 male and 111 female patients, with an age range from 3 to 65 years (mean, 25.0 ± 15.2 years). Body weight ranged from 12 to 72 kg (mean, 39.9 ± 15.0 kg). The patients were randomized for repair without CPB (ie, the sandwich operation) as a study group ($n = 74$) or with conventional CPB as a control group ($n = 76$) according to the last digit (even vs odd number) of the medical record number of the patient. Informed consent was obtained from all patients before participation in the study, which was approved by the ethical committee of the

From the Institute of Cardiovascular Diseases, Rajavithi Hospital, Bangkok, Thailand.

Read at the Twenty-sixth Annual Meeting of The Western Thoracic Surgical Association, The Big Island, Hawaii, June 21-24, 2000.

Copyright © 2001 by The American Association for Thoracic Surgery

0022-5223/2001 \$35.00 + 0 12/6/113324

doi:10.1067/mtc.2001.113324

Fig 1. The sandwich patch. **A**, Left-side view; **B**, lateral view; **C**, right-side view.

Institute of Cardiovascular Diseases, Rajavithi Hospital, on August 1, 1997.

Operative techniques. General anesthesia was achieved. Transesophageal echocardiography was performed throughout the operation in the sandwich group. The median sternotomy was performed, heparin (3 mg/kg) was infused, and the pericardium was opened.

In the sandwich group 2 purse-string sutures, 1 above the other, were made at the right atrial appendage. Digital examination of intracardiac anatomy was performed by the surgeon placing his or her left index finger through the superior purse-string suture. The anteroposterior and superoinferior diameters of the defect were estimated, and the complete or incomplete rims of the defect were noted. The defect size or area was calculated with the following formula:

$$\text{Area of an ellipse} = \text{Diameter 1} \times \text{Diameter 2} \times 0.7854$$

The locations of the pulmonary veins, coronary sinus, venae cavae, and mitral and tricuspid valves were examined. The anterior rim of the defect had to be more than 5 mm from the mitral valve to avoid interference with valve function. The sandwich patch was then constructed, as shown in Fig 1. Two patches of Teflon material were tailored in different sizes, a small and a large patch. The small patch was about 1 cm larger than the defect in both anteroposterior and superoinferior diameters. The larger patch was 1.5 cm larger than the defect. The patches were put together with the small patch on top of the larger one. The patches were sutured in the middle, together with interrupted 4-0 polypropylene sutures. One stay suture was sewn at the superior edge of the larger patch. The anterior and posterior edges of the larger patch were bent together and grasped with an O'Shaughnessy clamp covered with a rubber tube (Fig 2).

The surgeon's right index finger passed into the right atrium through the inferior purse-string suture. The patch was passed into the right atrium through the superior purse-string suture and guided by the right index finger, which was already in the right atrium (Fig 3). Synchronized movement of the surgeon and assistant was important to minimize blood loss during insertion of the patch. The smaller patch was

Fig 2. The larger patch was grasped with an O'Shaughnessy clamp covered with a rubber tube.

Fig 3. The patch was passed into the right atrium through the superior purse-string suture and guided by the right index finger. *AV node*, Atrioventricular node; *CS*, coronary sinus; *IVC*, inferior vena cava; *PV*, pulmonary vein; *RV*, right ventricle; *SVC*, superior vena cava; *TV*, tricuspid valve.

pushed with the right index finger to the left atrial side of the defect. The clamp holding the larger patch was then removed, and the left index finger was passed into the right atrium through the superior purse-string suture. Maneuvers with both fingers were used until the patch was placed in proper position; that is, the smaller patch was on the left atrial side of the defect, and the larger patch was on the right atrial side of the defect. The axis of the patch was in the same direction as that of the defect, and the edges of the patch adhered firmly to the rims of the defect. The right index finger was withdrawn. The left index finger pressed the patch against the interatrial septum. External transfixing sutures were placed through the patch at 3 points of the interatrial groove between the ascending aorta and superior vena cava, superior vena

Fig 4. Three external transfixing sutures were placed.

Fig 5. Stapling was carried out along the edge of the patch guided by the left index finger.

cava and right upper pulmonary vein, and inferior vena cava and right lower pulmonary vein, as guided by the left index finger (Fig 4). The surgeon now could feel friction as the needle passed through the patch. An endoscopic stapler (Endopath EMS; Ethicon Endo-surgery, Inc, Cincinnati, Ohio) was passed into the right atrium through the inferior purse-string suture. Stapling was extended along the edge of the patch, which was guided by the left index finger (Fig 5). Care was taken not to injure the atrioventricular node by not placing staples on the anteroinferior part of the patch. The transesophageal echocardiography confirmed that the patch

Fig 6. Schematic drawing of intraoperative transesophageal echocardiography demonstrated closure of ASD with the sandwich patch. LA, Left atrium; LV, left ventricle; RA, right atrium; RV, right ventricle.

was secured in place (Fig 6), and the left index finger and stapler were withdrawn. The stay suture was removed.

In the CPB group arterial cannulation was performed on the ascending aorta just below the innominate artery. Bicaval cannulation was performed through the right atrium. The CPB circuit was primed with balanced salt solution. Packed red cells were added if the patient's weight was less than 20 kg or the hemoglobin level was less than 5 g/dL during CPB. Under CPB, the patient was cooled to 30°C, and the aorta was crossclamped. Cold crystalloid cardioplegic solution was then infused through the aortic root. Topical cooling was performed with ice sludge. A right atriotomy was made. The size of the defect was estimated and closed either directly or with a Teflon patch by using 4-0 polypropylene sutures. The patient was rewarmed during repair of the defect and closure of the right atriotomy. A deairing procedure was performed, the aortic clamp was released, and CPB was discontinued. No blood conservation methods, such as hemofiltration or a cell salvage system, were used.

In both groups protamine sulfate was infused, and the wound was closed as usual. Patients were transferred to the intensive care unit. Extubation was done as early as possible, usually within 6 hours after operation. Criteria for transferring the patient to the general ward were that he or she had to be conscious, in hemodynamically stable condition, and have no respiratory distress or active drainage. During the postoperative period, the sum of the mediastinal and pericardial drainage was calculated. Packed red cells were given if the patient's hemoglobin level was less than 7 g/dL. Transfusion of fresh frozen plasma or platelet concentrate depended on the attending surgeon's judgment to correct coagulation abnormalities according to the amount of the drainage, activated clotting time, and platelet count. A blood sample was

Table I. Patient demographics

Variable	Sandwich group (n = 74)	CPB group (n = 76)	P value
Age (y)	25.8 ± 14.6	24.3 ± 15.8	.544
Body weight (kg)	39.4 ± 15.0	40.4 ± 15.1	.683
Male sex	19 (26%)	20 (26%)	.929
Echocardiography			
Mitral regurgitation			
Mild	14 (19%)	13 (17%)	.773
Tricuspid regurgitation			
Mild	47 (65%)	36 (47%)	.133
Moderate	4 (6%)	7 (9%)	
Ejection fraction (%)	66 ± 14	67 ± 16	.792
Estimated PAP (mm Hg)	44 ± 14	45 ± 14	.825

PAP, Pulmonary artery pressure.

Table II. Intraoperative and postoperative characteristics

Variable	Sandwich group (n = 72)	CPB group (n = 76)	P value
Defect size (cm ²)	4.3 ± 2.0	4.0 ± 2.5	.299
Operative time (min)	112 ± 21	123 ± 23	.005
Intraoperative blood loss (mL)	285 ± 191	NA	NA
Postoperative drainage (mL)	277 ± 192	302 ± 250	.500
Length of stay in ICU (h)	18.4 ± 12.9	24.4 ± 11.4	.003
Hospital length of stay (d)	4.9 ± 2.2	5.3 ± 1.9	.241
24-h ambulatory electrocardiography			
Premature atrial contraction	45 (63%)	36 (48%)	.065
Premature ventricular contraction	41 (56%)	32 (42%)	.071
Aberrant conduction	9 (13%)	3 (4%)	.057
Atrial fibrillation	4 (6%)	3 (4%)	.714
Atrioventricular dissociation	0 (0%)	3 (4%)	.245
Ventricular tachycardia	0 (0%)	2 (3%)	.497
Intraventricular conduction delay	0 (0%)	2 (3%)	.497
Sinus rhythm	18 (25%)	16 (21%)	.568

NA, Not applicable; ICU, intensive care unit.

sent for hematologic study before and 1 day after the operation. Twenty-four-hour ambulatory electrocardiography was performed 1 week after the operation. Hospital length of stay from operation to discharge and fee were calculated on the discharge day.

Follow-up. Patients were followed up in the hospital and outpatient clinic. Follow-up was complete in all patients from 1 to 29 months (mean, 8.7 ± 7.5 months). Transthoracic echocardiography was performed 1 week and 1 year after the operation in the sandwich group. All patients in the sandwich group received warfarin for 6 weeks postoperatively.

Statistical analysis. Data were presented as means ± SD or percentage. Comparisons between groups were calculated by using the χ^2 , Fisher exact, or 2-sided Student *t* tests, and comparisons between preoperative and postoperative variables were calculated by using the McNemar χ^2 or paired Student *t* tests when appropriate. Risk factors for early residual shunt were analyzed by logistic regression analysis. Regression coefficients were presented with or without SEs. Odds ratios were estimated and accompanied by 95% confidence limits.

Results

Patient demographics. A total of 150 patients were enrolled and randomized into the study; 74 were randomized to the sandwich group, and 76 were assigned to the CPB group. As summarized in Table I, the 2 groups were equivalent with respect to a variety of preoperative factors.

Clinical outcome measures. There was no operative mortality. Two patients in the sandwich group crossed over to CPB because of unsuitable anatomy (common atrium in one and partial anomalous pulmonary venous return in the other). They were excluded from further statistical analysis.

Intraoperative and postoperative characteristics were shown in Table II. Only operative time and length of stay in the intensive care unit were shorter in the sandwich group than in the CPB group (*P* = .005 and *P* = .003, respectively); otherwise, the differences in the

Table III. Hematologic profile

Variable	Sandwich group (n = 72)	CPB group (n = 76)	P value
Preoperative			
Hemoglobin (g/dL)	13.2 ± 1.6	12.9 ± 1.5	.220
WBC ($\times 10^3$ cell/mm ³)	8.5 ± 2.5	8.6 ± 2.6	.831
PMN ($\times 10^3$ cell/mm ³)	5.0 ± 2.0	5.2 ± 2.0	.613
Platelets ($\times 10^3$ cell/mm ³)	292 ± 73	282 ± 80	.574
Postoperative			
Hemoglobin (g/dL)	10.9 ± 2.0	10.4 ± 1.6	.095
WBC ($\times 10^3$ cell/mm ³)	18.5 ± 6.0	18.6 ± 5.4	.905
PMN ($\times 10^3$ cell/mm ³)	15.5 ± 5.8	15.7 ± 5.0	.847
Platelets ($\times 10^3$ cell/mm ³)	189 ± 39	207 ± 44	.114
Transfusion			
None	67 (93%)	39 (51%)	<.001
PRC (unit/patient)	0.1 ± 0.3	0.6 ± 0.9	<.001
FFP (unit/patient)	0.0 ± 0.0	0.2 ± 0.7	.047
Platelets (unit/patient)	0.0 ± 0.0	0.1 ± 0.5	.321

WBC, White blood cell; PMN, polymorphonuclear cell; PRC, packed red blood cell; FFP, fresh frozen plasma.

Table IV. Risk factors for early residual shunt (n = 72)

Risk factor	Coefficient ± SE	Odds ratio	95% CL		P value
			Lower	Upper	
Younger age	-0.011 ± 0.036	0.989	0.921	1.062	.761
Larger defect	0.282 ± 0.228	1.326	0.849	2.072	.215
Incomplete rims	1.275 ± 1.180	3.580	0.354	36.163	.280
Earlier date of repair	-0.012 ± 0.006	0.988	0.975	1.000	.049

CL, Confidence limits.

intraoperative and postoperative characteristics could have been due to chance. Two patients in each group had pneumonia. In the CPB group 1 patient had left hemiparesis and 1 required reoperation on the same day to stop bleeding. Most patients in both groups had premature atrial contractions, ventricular contractions, or both.

The differences of the hematologic profile, except transfusion, between both groups could have been due to chance (Table III). The percentage of patients who did not require transfusion was higher in the sandwich group ($P < .001$). Patients in the sandwich group required fewer transfusions of packed red blood cells and fresh frozen plasma per patient than did those in the CPB group ($P < .001$ and $P = .047$, respectively).

Echocardiography 1 week after the operation showed residual shunt in 4 (6.0%) patients of the sandwich group. Therefore, the technique was unsuccessful in 6 (8%) of the 74 patients. Two (3.0%) of them had significant residual shunt and underwent successful reoperation with the same techniques within 2 weeks after the first operation. During reoperation, malposition of

the patch was found because a transfixing suture did not catch the patch. The other 2 patients who had a residual defect of less than 5 mm were followed up and had no residual shunt at the 1-year follow-up echocardiogram. Only earlier date of repair was a risk factor for early residual shunt ($P = .049$), as shown in Table IV. All patients who had a residual shunt were in the first 10 patients. There were no residual shunts in subsequent patients. The mitral and tricuspid valve function was shown in Table V. Tricuspid regurgitation decreased after operation ($P = .017$). Average estimated pulmonary arterial pressure decreased from 44 ± 14 to 31 ± 9 mm Hg after the operation ($P < .001$). Differences between the preoperative and postoperative ejection fractions could be due to chance ($66\% \pm 14\%$ vs $70\% \pm 11\%$, $P = .189$). Average hospital fees in the sandwich and CPB groups were 876 ± 273 and 1473 ± 181 US dollars, respectively, including hospital fees for reoperation ($P < .001$). During follow-up, potential complications, such as malposition of the patch, embolization, endocarditis, or increasing atrioventricular valve regurgitation were not found.

Table V. Valve function (*n* = 72)

Valve regurgitation	Preoperative			P value
	No	Mild	Moderate	
Postoperative				
Mitral				
No	51 (71%)	8 (11%)	0 (0%)	1.000
Mild	7 (10%)	6 (8%)	0 (0%)	
Tricuspid				
No	16 (22%)	15 (21%)	2 (3%)	.017
Mild	5 (7%)	32 (44%)	0 (0%)	
Moderate	0 (0%)	0 (0%)	2 (3%)	

Discussion

Because adverse effects of CPB are widely recognized, a number of ingenious closed methods for repair of ASD were proposed and studied experimentally in the past, and now percutaneous transcatheter techniques are the most widely investigated. However, only small defects with complete rims can be closed with percutaneous techniques. The overall success rate is from 80% to 90%, with complete closure of defects in 50% to 90% of patients. Complications include 5% to 15% malposition, cardiac perforation, embolization, and atrioventricular valve regurgitation.⁶⁻⁹ Apart from that, the devices are very expensive. In this study the results of closure of ASDs without CPB are encouraging.

Our patients were older and larger than most patients undergoing ASD repair in developed countries because most patients were poor and lived in rural areas. They usually seek medical attention later in their lives.

Our results confirm that the sandwich operation is simple and safe. We believe that almost all simple ostium secundum ASDs can be repaired with this technique. Intracardiac anatomy can be assessed intraoperatively. If unfavorable anatomy is found or the attempt fails, the operation can be crossed over to CPB immediately. Intraoperative transesophageal echocardiography provides a real-time view of the procedure in addition to the sensation of the surgeon's fingers. The left-sided patch is made smaller than the right one to avoid interference with mitral valve function and pulmonary venous drainage. Security of the patch depends on 4 factors: the matched size and shape between the sandwich patch and the defect; the proper position of the patch; external transfixing sutures; and staplers.

Avoidance of CPB gives advantages of this operation over the conventional bypass techniques. Operative time and length of stay in the intensive care unit in patients of the sandwich group were shorter than those found in patients of the CPB group. However, these differences

may not be clinically important. Blood components were better preserved, and patients required fewer transfusions. Patients in the CPB group required more transfusion of blood components than those in the sandwich group because of 3 factors: (1) the hemodilution and coagulation abnormalities caused by CPB; (2) requirement of blood priming of the CPB circuit in children; and (3) absence of blood conservation methods, such as hemofiltration or cell salvage, in the CPB group. The hematologic profile on the first postoperative day was not different between the 2 groups because hematologic abnormalities of the patients in the CPB group were corrected with transfusion of blood components.

The risk factor for early residual shunt was the earlier date of repair. We had less experience at the beginning of the study. The minimal residual shunt early after operation can be followed expectantly because it will close spontaneously, as demonstrated by means of echocardiography in this study. The significant residual shunt may be repaired with the same surgical technique if it is suitable. Mitral and tricuspid valve function was not adversely affected by the operation. Tricuspid regurgitation and pulmonary arterial pressure decreases after the operation were caused by abolishment of left-to-right shunt. Hospital fees for both groups were quite low because our hospital is governmental, and therefore the rate of charge was very low, many medical supplies were reused, and there was no physician or nurse fee. Hospital fees for the sandwich operation were also much lower than those of CPB techniques because the expense related to CPB was avoided.

The sandwich operation is more difficult in the patient with a large defect with incomplete rims because of difficulties in stabilizing the patch and in small children because the right atrium may not accommodate the fingers and instruments. However, with increasing experience, these limitations can be overcome. The operation cannot be done in patients who

have associated lesions that require repair with CPB, such as partial anomalous pulmonary venous drainage, pulmonary valve stenosis, or significant mitral regurgitation. We do not perform 24-hour ambulatory electrocardiography preoperatively. Therefore, postoperative arrhythmias may be difficult to interpret.

In summary, this study shows the early results of closure of ASDs with or without CPB. The sandwich operation is simple, safe, reproducible, and cost-effective. The adverse effect of CPB can be avoided. We propose that this operation is an alternative technique of closure of ASDs. Longer term follow-up is required to confirm the results of this report.

We thank biostatistician Dusit Sujirarat (Department of Epidemiology, Faculty of Public Health, Mahidol University) for statistical analysis. We also thank our cardiologists, Drs Wilai Puawilai, Sirichai Tanasarnsombat, Saowaluk Prompongsa, Tanarat Choon-ngam, Donpichit Laorakpongse, Poonchai Jitanantwittaya, Sutham Sutherapatranont, Kitiporn Angkasuwapala, Tawatchai Girawittaya, Thanarat Layangool, Chaisit Sangtawesin, and Vachara Jamjureeruk, for echocardiography and 24-hour ambulatory electrocardiography. We thank Prapawan Prapaitrakul, RN, for her idea of using the O'Shaugnessy clamp and rubber tube; Yuppayong Teepraasarn, RN, for assistance with intraoperative transesophageal echocardiography; Suchart Narabua for illustrations; and Dr Pantpis Sakornpant, consultant cardiac surgeon, for his tremendous help and in-depth critique of this study.

Received for publication July 5, 2000; revisions requested Oct 11, 2000; revisions received Oct 23, 2000; accepted for Nov 30, publication 2000.

Address for reprints: Wiwat Warinsirikul, MD, Institute of Cardiovascular Diseases, Rajavithi Hospital, 2 Rajavithi Rd, Bangkok 10400, Thailand (E-mail: wwarin@hotmail.com).

REFERENCES

1. Kirklin JK, Kirklin JW. Cardiopulmonary bypass for cardiac surgery. In: Sabiston DCJ, Spencer FC, editors. *Surgery of the chest*. 5th ed. Philadelphia: WB Saunders; 1990. p. 1107-25.
2. Chai PJ, Williamson JA, Lodge AJ, Daggett CW, Scarborough JE, Meliones JN, et al. Effects of ischemia on pulmonary dysfunction after cardiopulmonary bypass. *Ann Thorac Surg* 1999;67:731-5.
3. Wan S, Izzat MB, Lee TW, Wan IY, Tang NL, Yim AP. Avoiding cardiopulmonary bypass in multivessel CABG reduces cytokine response and myocardial injury. *Ann Thorac Surg* 1999;68:52-7.
4. Zeithofer J, Asenbaum S, Spiss C, Wimmer A, Mayr N, Wolner E, et al. Central nervous system function after cardiopulmonary bypass. *Eur Heart J* 1993;14:885-90.
5. Kirklin JW, Barratt-Boyes BG. Atrial septal defect and partial anomalous pulmonary venous connection. In: Kirklin JW, Barratt-Boyes BG, editors. *Cardiac surgery*. 2nd ed. New York: Churchill Livingstone; 1993. p. 609-44.
6. Rao PS, Sideris EB, Hausdorf G, Rey C, Lloyd TR, Beelman RH, et al. International experience with secundum atrial septal defect occlusion by buttoned device. *Am Heart J* 1994;128:1022-35.
7. Worms AM, Rey C, Bourlon F, Losay J, Marcon F, Godart F. French experience in the closure of atrial septal defects of the ostium secundum type with the Sideris button occluder. *Arch Mal Coeur Vaiss* 1996;89:509-15.
8. Rosenfeld HM, van der Velde ME, Sanders SP, Colan SD, Parness IA, Lock JE, et al. Echocardiographic predictors of candidacy for successful transcatheter atrial septal defect closure. *Cathet Cardiovasc Diagn* 1995;34:29-34.
9. Berger F, Vogel M, Alexi-Meskishvili V, Lange PE. Comparison of results and complications of surgical and Amplatzer device closure of atrial septal defects. *J Thorac Cardiovasc Surg* 1999;118:674-80.

Discussion

Dr. Michael Teodori (*Phoenix, Ariz*). I commend the authors for a very interesting and well-done study. Of all open cardiac procedures, ASD repair is the simplest and safest procedure that we do, and yet ASD repair still requires use of CPB and opening of the heart, leading to its attendant complications. Those complications occur very rarely, but they still occur. The authors' technique describes a novel use of the patch and endoscopic stapler and, to my mind, a blinded examination of the atrium. It is important that they randomized their patients. Their results appear valid. They achieved ASD closure without complication after a short learning curve in virtually all their patients. My questions are just for clarification.

With the use of echocardiography, did you exclude any patients at all from your sandwich technique?

Dr Warinsirikul. Yes. Patients with sinus venosus defects or primum ASDs or patients with associated cardiac anomalies, such as pulmonary stenosis or severe mitral regurgitation, were excluded from the study.

Dr Teodori. Air entry into the left side of the heart often occurs during an ASD closure. Did you have any evidence of air entry into the left side of the heart, either obtained by means of your transesophageal echocardiography or by means of right-side heart dysfunction occurring after the operation?

Dr Warinsirikul. Yes. We measured central venous pressure continuously. The pressure inside the heart is above the atmosphere, and therefore I believe that there will be no air getting into the heart. Also, by means of transesophageal echocardiography, we have seen no air bubbles inside. I think the important thing during the steps of this operation is the bleeding because the synchronized movement between surgeon and assistant is important to minimize bleeding.

Dr Teodori. Was it difficult to learn the blind suture technique? I can imagine having my finger inside the heart trying to hold the patch, trying to feel the needle, and thinking that I would most likely be stitching my finger on occasion.

Dr Warinsirikul. I admit that it is somewhat difficult in the beginning, but after I learned this technique, I taught my colleague. He did it the first time without difficulties.

Dr Teodori. Last, is there a size limitation? Can you do this on a 10-kg patient?

Dr Warinsirikul. The smallest patient was a 3-year-old patient who weighed 12 kg. I think that if the patient is over 10 kg, we can do it.

Dr Teodori. I think this is an interesting procedure. Using a golf analogy, when I first saw it, I wondered whether it was not turning a 1-foot putt into a 6-foot putt, considering how simple an ASD closure is. However, I think, in fact, that this is more a tap-in than even the 1-foot putt may be.

Dr William Brenner (*Hackensack, NJ*). Considering the high incidence of human immunodeficiency virus (HIV) in Thailand, would this be considered a very risky procedure for the surgeon? Second, the *New York Times* recently reported, as a “breakthrough,” a group in Siberia doing hypothermic bathtub protection and then inflow occlusion. When I got to Los Angeles, John Winkley, who started the cardiac surgery program at Kaiser before the heart-lung machine was available in the 1950s, repaired 50 consecutive ASDs using inflow occlusion, with no deaths and no recurrences.

Dr Warinsirikul. There are 2 things about HIV. I think the percentage of patients who have both cardiac disease HIV-positive serum is lower than that of the normal population. Second, when we do the operation, we are very careful. An accident in the operation usually occurs when we move our hand without being careful, but we do this operation slowly. After 74 cases, I have never hurt my finger.

Dr Denton Cooley (*Houston, Tex*). This very interesting presentation recalls for me the years before CPB. As a guest surgeon at the University of Tokyo 40 years ago, I was involved in a surgical field day with Professors Nakayama and Kimoto. In a 1-hour period, Nakayama performed 2 esophagectomies for cancer under the same operating light. I then repaired an abdominal aneurysm with a bilateral femoral graft in 1 hour. In another 1-hour session, Professor Kimoto closed ASDs in 2 patients. In both cases he used only cerebral cooling and temporary caval inflow occlusion. I suggest that one could accomplish the same result by repairing the defect under direct vision by using moderate induced hypothermia with cerebral cooling. The Sondergaard technique of blind circumclusion on the beating heart was usually successful. In my opinion the sandwich technique may be a retrograde step.

Dr. Vaughn A. Starnes (*Los Angeles, Calif*). I have 1 question for you. You are obviously applying free staples within the right side of the heart. Do you have any evidence or lack of evidence that these staples actually ended up where they were intended, or did any of them get loose and migrate to the pulmonary circulation? In other words, did you have a chest x-ray film that showed staples outside in the lungs?

Dr Warinsirikul. Actually, there were 1 or 2 such incidents (ie, a titanium clip in the periphery of the lung), but I think a titanium clip of 3 mm would be of no harm to the patient.

Targeted

The Journal of Thoracic and Cardiovascular Surgery gives you two tables of contents.

The condensed table of contents tells you at a glance what topics and authors are presented each month. The expanded table of contents gives you a brief abstract of each article. You select only those articles of most interest to you for further reading.