Modified Single-Patch Compared With Two-Patch Repair of Complete Atrioventricular Septal Defect

Shinya Ugaki, MD, PhD, Nee S. Khoo, MBChB, David B. Ross, MD, Ivan M. Rebeyka, MD, and Ian Adatia, MBChB

Division of Pediatric Cardiac Surgery, Cardiology and Critical Care, Stollery Children's Hospital, Mazankowski Alberta Heart Institute, University of Alberta, Edmonton, Alberta, Canada

Background. We compared the outcomes of modified single-patch and two-patch surgical repair of complete atrioventricular septal defect (CAVSD) on left ventricular outflow tract (LVOT) diameter and on left atrioventricular valve (LAVV) coaptation.

Methods. We reviewed retrospectively postoperative 2-dimensional echocardiograms of all CAVSD patients who underwent modified single-patch or two-patch repair between 2005 and 2011. We measured the leaflet coaptation length of the LAVV in the apical four-chamber view. The LVOT was measured in the long axis view.

Results. Fifty-one patients underwent CAVSD repair at a median age of 4 months (range, 1 to 9 months) (single-patch, n = 29; two-patch, n = 22). The images from 46 echocardiograms were adequate for analysis. Modified single-patch repair required significantly shorter bypass time (102.0 ± 33.6 vs 152.9 ± 39.5 minutes, $p < 0.001$) and ischemic time (69.0 ± 21.7 vs 106.9 ± 29.7 minutes, $p < 0.001$) than did two-patch repair. The indexed coaptation length of the septal and lateral leaflets was not different between single-patch and two-patch (3.1 ± 2.3 vs 4.1 ± 3.1 mm/m^2, $p = 0.25$; 2.3 ± 2.3 vs 3.3 ± 3.0 mm/m^2, $p = 0.21$). Indexed LVOT diameter was not different in the two groups (26.1 ± 5.2 vs 28.5 ± 7.1 mm/m^2, $p = 0.22$). There was no hospital or late death during the median follow-up time of 35 months (range, 1 to 69 months). Five patients underwent reoperation after single-patch repair (3 with residual ventricular septal defect [VSD] and LAVV regurgitation, 1 with residual VSD, 1 with pacemaker implantation). After the two-patch repair, 1 patient required reoperation for a residual VSD and right atrioventricular valve regurgitation ($p = 0.22$).

Conclusions. The modified single-patch repair was performed with significantly shorter bypass time and myocardial ischemic time. The postoperative LVOT diameter and LAVV leaflet coaptation length were not significantly different between techniques.

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Since the first successful repair of complete atrioventricular septal defect (CAVSD) by Lillehei and coworkers [1], the outcomes of surgical procedures for CAVSD have improved steadily, owing to more precise and accurate preoperative diagnosis and surgical technique together with a better understanding of the morphology and pathophysiology, including the management of postoperative pulmonary hypertensive episodes [2, 3]. In addition, the management strategy has changed from a two-staged approach to primary correction in early infancy [3–8]. Several techniques have been developed to repair CAVSD. Maloney and colleagues [4] reported the single-patch technique with a single autologous pericardial patch in 1962. Then, Trusler and colleagues [5] introduced the two-patch technique in 1976, using a prosthetic patch to close the ventricular septal defect (VSD). These techniques have played an important role in achieving the current excellent surgical outcomes of CAVSD repair [6–8]. Wilcox and colleagues [9] in 1997, and then Nicholson and colleagues [10] in 1999 and Nunn in 2007 [11] suggested another procedure without using a patch to close the VSD. This innovative procedure, called the simplified or modified single-patch technique, has become increasingly popular because the method to close the VSD is simpler, with the advantages of shorter cardiopulmonary bypass and myocardial ischemic times [12–14]. However, major concerns with this technique are that it may result in left atrioventricular valve (LAVV) regurgitation, left ventricular outflow tract (LVOT) obstruction, or both, especially if there is a large ventricular scoop or outlet extension of the VSD. In this case, direct VSD closure may cause distortion and malcoaptation of bridging leaflets and obstruction of the already narrow LVOT [7–9, 15, 16].

Recent advances in echocardiography and understanding of the mechanisms of atrioventricular valve regurgitation have made it possible to evaluate valve function, before and after intervention, both more accurately and quantitatively. The effects of the modified single-patch repair and other definitive techniques on the LVOT and LAVV have not been documented well in patients with CAVSD. Therefore, we sought to assess quantitatively the functional morphology of the LAVV

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Address correspondence to Dr Adatia, Room 4C1.19, 8440-112 St, Edmonton, Alberta, Canada, T6G 2B7; e-mail: iadatia@ualberta.ca.

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and LVOT and to evaluate the surgical outcomes after modified single-patch and two-patch repair in patients with CAVSD.

Material and Methods

Patients

We reviewed retrospectively all available clinical data in patients with CAVSD who underwent definitive repair at our institution since the initiation of our database in May 2005 until July 2011. The University of Alberta Institutional Review Board approved the study, and the need for parental consent was waived. We excluded patients with an unbalanced atrioventricular septal defect who were in our opinion unsuitable for biventricular repair; also excluded were those with tetralogy of Fallot or double-outlet right ventricle.

Echocardiographic Examination

A full two-dimensional, pulsed and continuous-wave Doppler and color Doppler echocardiographic assessment was conducted routinely within 1 month before total correction and 6 weeks afterward. The apical four chamber view was used to evaluate the LAVV, right atrioventricular valve (RAVV), VSD, size and LV parameters. The preoperative VSD size was measured from the crest of the ventricular septum to the common atrioventricular valve at end-diastole. Left ventricular end-diastolic area (LVEDA) and end-systolic area (LVESA) were measured by tracing the area of LV at end-diastole and end-systole, respectively. Left ventricular fractional area change (LVFAC) was calculated by use of the following equation:

$$\text{LVFAC}(\%) = \text{LVEDA} - \text{LVESA}/\text{LVEDA} \times 100$$

The LAVV end-diastolic and midsystolic annular diameter was the distance between the insertion of the left septal leaflets and the left lateral leaflets at end-diastole and midsystole, respectively. The LAVV annular fractional change was calculated by use of the following equation:

LAVV annular fractional change (%) = the annular diameter at end-diastole – the annular diameter at midsystole/the annular diameter at end-diastole × 100

The left-sided septal and lateral leaflet lengths (Ld) were measured from the LAVV annulus to the tip of each leaflet during the diastole. The length of uncoapted segments of each leaflet (Lc) was the distance from the annulus to the coaptation point at midsystole. Therefore, the indexed coaptation length for each leaflet was calculated by use of the following equation:

$$\text{Indexed coaptation length} = \text{Ld} - \text{Lc}/\text{body surface area}$$

The LAVV tenting height was the distance between the left-sided septal and lateral annuli to the coaptation point of the leaflets at midsystole. The LAVV tenting area was calculated by multiplying the LAVV annular diameter at midsystole by 0.5 times the tenting height. Both the tenting height and the area were indexed by body surface area. The vena contracta width was measured at the narrowest region of the regurgitant flow just distal to the area of flow convergence at midsystole and was indexed to body surface area. The degree of LAVV and RAVV regurgitation was graded on the ratio of the color Doppler jet to the area of the atrium. Regurgitation was ranked as none (0), trivial (1), mild (2), moderate (3), and severe (4). The LVOT diameter was measured from the long axis view at midsystole and indexed to body surface area [17, 18]. We reviewed all echocardiograms 6 weeks after the first repair of the AVSD, irrespective of the need for reoperation.

Surgical Procedures

In 2001, modified single-patch repair was introduced at our institution. One surgeon performed only the modified single-patch technique, and the other surgeon performed only the two-patch repair regardless of the size of VSD during the study period. All children underwent cardiopulmonary bypass with use of bicaval cannulation under moderate hypothermia. A left ventricular vent was inserted through the right superior pulmonary vein. The heart was arrested with cold blood cardioplegia. A standard right atriotomy was madem and the edges were retracted on stay sutures for exposure. The common atrioventricular valve was floated with saline to mark sites for the reapproximation of the superior and inferior bridging leaflets. The zone of apposition (LAVV cleft) was completely closed in patients with an adequate left lateral leaflet or partially closed in patients without a sufficient left lateral leaflet.

For the modified single-patch technique, the zone of apposition (LAVV cleft) was closed with a series of interrupted Prolene sutures. Then, a series of horizontal mattress pledgeted Prolene sutures was passed through the right side of the ventricular septal crest and through the base of the LAVV before being passed through a trimmed bovine pericardium. The sutures were then tied to close the ventricular component, with the LAVV sandwiched between the bovine patch and the crest of the ventricular septum. The bovine pericardial patch was secured to the rim of the ostium primum defect with continuous Prolene suture, leaving the coronary sinus draining normally to the right atrium.

The two-patch repair was performed with use of a Dacron VSD patch, which was placed on the right ventricular aspect of the septum, insinuating it between the chordate in a running horizontal mattress fashion buttressed with a strip of autologous pericardium. The suture was then brought out through the hinge point of both the superior and the inferior bridging leaflets. The autologous glutaraldehyde-treated pericardial patch was sutured to the superior portion of the VSD patch, sandwiching the bridging leaflet tissue between the two patches with running horizontal mattress sutures. Then, the zone of apposition (LAVV cleft) was approximated with interrupted Prolene sutures before the atrial septal defect was closed.

Data Analysis

Categoric variables are described as frequencies and percentages. Continuous variables are described as mean

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