Modified Single Patch: Are We Still Worried About Subaortic Stenosis?

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Background. **When the modified single-patch technique for atrioventricular septal defect (AVSD) repair was introduced by Dr Benson Wilcox, there was concern that these patients might be at risk for late subaortic stenosis and left ventricular outflow tract obstruction (LVOTO). This review evaluated our modified single-patch population for LVOTO in the postoperative period.**

Methods. **Between January 2000 and 2013, 77 infants underwent AVSD repair with a modified single-patch technique. Median age was 4.2 months, and median weight was 5 kg. Eight patients had a prior repair of coarctation of the aorta via left thoracotomy in the newborn period.**

Results. **The median hospital stay was 10 days. No patient required a pacemaker. The mean and median follow-up times were 4.6 and 3.7 years, respectively. Only 2 patients (2.5%) required reoperation for LVOTO; both had prior repair of coarctation of the aorta (2 of 8 vs 0 of 69, $p = 0.01$). A discrete fibrous subaortic membrane developed in the first patient that required resection at 3 and 7 years after repair. The other patient had LVOTO from accessory chordae of the left atrioventricular valve and required mitral valve replacement 5 months after repair. One early death occurred at 4 months postoperatively due to liver failure related to hyperalimentation.**

Conclusions. **At intermediate term follow-up, LVOTO does not appear to be a significant postoperative issue after modified single-patch repair of AVSD. Coarctation of the aorta was the most significant predictor of late LVOTO after repair of AVSD with the modified single-patch technique.**

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The modified single-patch technique for repair of complete atrioventricular septal defect (AVSD) was independently proposed by Wilcox and colleagues [1] and Nicholson and colleagues [2]. The change in strategy from the classic 2-patch technique was to perform direct closure of the ventricular element, eliminating the patch used for closure of the ventricular component [3]. When Wilcox presented his concept at The Society of Thoracic Surgeons meeting in 1997, the second question during the discussion was, "Did you see any subsequent increased flow velocity in the left ventricular outflow tract indicative of obstruction?" [4]. The answer was: "we find no evidence of that [LVOTO] whatsoever. I think it has less to do with the particular repair that is used than with the basic anatomy. "

When the Nicholson et al [2] paper was presented at the American Association for Thoracic Surgery meeting in 1999, Dr John Brown noted, "it would seem that this [repair] would increase the likelihood of LVOTO obstruction . . ." [5]. However, there were no reoperations for left ventricular outflow tract obstruction (LVOTO) in the series by Nicholson and colleagues [2].

The potential for LVOTO using the modified single-patch technique continues to be raised by surgeons using the "classic" single and 2-patch techniques and by some cardiac morphologists [6, 7]. Proponents of the 2-patch technique contend that the patch placed to close the ventricular component of the AVSD helps to contribute to the width of the left ventricular outflow tract. They contend that pulling the valve leaflets down to the septum using the modified single-patch technique will encroach upon the left ventricular outflow tract and narrow it. Another issue raised relates to the known fact that LVOTO is more common in partial than complete AVSD [8]. The concern is that using the modified single-patch technique essentially converts a patient with a complete AVSD to a partial AVSD [9]. This could potentially increase the risk of developing LVOTO.

We previously published our results comparing the modified single-patch technique with the 2-patch technique [3]. At that time we reported 26 patients undergoing the modified single-patch technique. No patient in that small group required reoperation for LVOTO at short-term follow-up. We have now tripled the size of that initial series and have follow-up of more than 10 years. Our hypothesis was that the modified

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(simplified) single-patch technique would not be associated with an increased risk of LVOTO (subaortic stenosis).

Material and Methods

The Ann & Robert H. Lurie Children's Hospital of Chicago Institutional Review Board approved this study on June 12, 2012, as a retrospective record analysis and waived the need for patient consent. The congenital cardiac surgery database was analyzed, and all patients undergoing repair of complete AVSD between 2000 and 2013 were included. We excluded AVSD with tetralogy of Fallot, AVSD with double-outlet right ventricle, and unbalanced AVSD. We analyzed the serial postoperative echocardiograms of each patient to assess the degree of LVOTO. Statistical analysis was performed using the Fisher exact test.

Seventy-seven patients underwent repair of complete AVSD using a modified single-patch technique at our institution from 2000 to 2013. We previously reported our specific surgical technique [3]. During that period, we transitioned from the 2-patch technique, as shown in Figure 1. Eight patients (10%) had undergone a previous operation for coarctation (CoAo) repair in the newborn period. All CoAo repairs were done via left thoracotomy using resection with extended end-to-end anastomosis.

Results

The median age at operation was 4.2 months (mean, 4.8 ± 2.4 months) and the median weight was 5 kg. In this series, 57 patients (74%) had trisomy 21. No patient had a procedure for LVOTO as part of the primary procedure. Rastelli classification was: A in 39, B in 3, C in 16, and unknown in 2. The VSD size was assessed by measuring the distance from the crest of the VSD to the common AV valve in diastole. We considered more than 12 mm to be an indication for a 2-patch repair. Only two patients since 2006 have had a 2-patch repair, both because of a very large ventricular component of 12 and 16 mm.

Mean cross-clamp time for the AVSD repair was 103 ± 23 minutes. Mean cardiopulmonary bypass time was 135 ± 33 minutes. Median length of stay was 10 days. No child required a pacemaker in the postoperative period. One early death occurred 4 months postoperatively as a result of liver failure in a child awaiting a liver transplant. Liver failure was secondary to long-term preoperative and postrepair hyperalimentation.

At a mean follow-up of 4.2 years, 58 patients with at least 1 year of echocardiographic follow-up had no evidence of LVOTO by serial echocardiography (Fig 2). LVOTO developed in 4 patients, 3 of whom had prior CoAo repair: 3 of 8 (38%) vs 1 of 69 (1%; $p = 0.007$ by Fisher exact test; Fig 3). Only 2 patients required reoperation for LVOTO, both had prior CoAo repair: 2 of 8 (25%) vs 0 of 69 ($p = 0.01$ by Fisher exact test).

The patient who died of liver failure 4 months postoperatively had mild LVOTO, which was unchanged on serial echocardiograms up until the time of death while awaiting liver transplant. A patient who underwent repair in 2001 had stable mild LVOTO for 11 years, with no change in gradient. That patient had repair of CoAo as an infant.

A patient who underwent AVSD repair in 2003 at age 4 months had prior repair of CoAo as a newborn. This child started with mild LVOTO that progressed to moderate to severe obstruction at 3 years of age. At that time, reoperation was performed, and a discrete subaortic membrane was resected. The postoperative LVOTO was initially mild but during the next 5 years progressed to become severe again. A second reoperation was performed, and a recurrence of the fibrous subaortic membrane was resected. The child now has mild LVOTO, which has been stable.

The final patient with LVOTO underwent CoAo repair at age 1 week and AVSD repair at age 3 months. After this repair, there was moderate LVOTO from substantial crowding of the LVOTO by accessory chords from the left atrioventricular valve. This progressed over a short period of time, and at 4 months postoperatively, the child underwent attempted resection of chordae but required

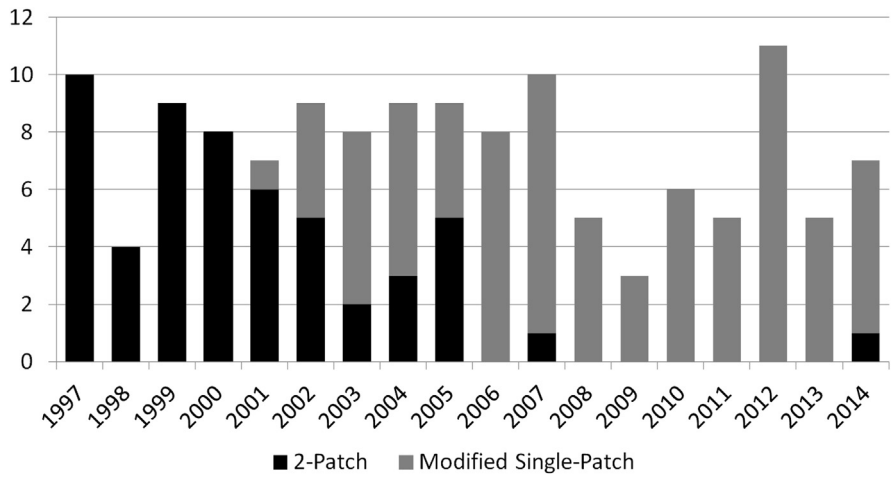

Fig 1. Graph shows the evolution of the 2-patch technique (black bars) to the modified single-patch technique (gray bars) at Ann & Robert H. Lurie Children's Hospital of Chicago during a 13-year period (1997 to 2014). The 2-patch technique has been used in only 2 patients in the past 9 years.