Midterm results of mitral valve repair with artificial chordae in children

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Objective: We have used artificial chordal replacement with expanded polytetrafluoroethylene sutures for mitral valve repair in children and reported favorable early clinical results. In this article we evaluate the midterm results of mitral valve repair with expanded polytetrafluoroethylene sutures in 39 children.

Methods: From April 1995 through September 2003, mitral valve repair with chordal replacement using expanded polytetrafluoroethylene sutures was performed in 39 patients. In all patients the preoperative grade of mitral regurgitation was moderate or more because of prolapse of the anterior mitral leaflet. The mean age and body weight at the time of the operation were 4.7 ± 5.3 years (range, 1 month to 17.8 years) and 14.4 ± 12.2 kg (range, 3.9-54.4 kg), respectively. The number of expanded polytetrafluoroethylene sutures ranged from 1 to 3 (mean, 1.4). The mean follow-up period and body weight at the latest follow-up were 5.0 ± 2.3 years (range, 1.1-8.5 years) and 25.7 ± 16.4 kg (range, 6.9-73 kg), respectively.

Results: There were no operative or late deaths. Only one patient required mitral valve replacement, which occurred 17 days after repair. Two patients underwent redo mitral valve repair 2 and 5 years after initial repair, respectively. The actuarial freedom from reoperation at 5 and 8 years was 94.8% and 89.5%, respectively. At the latest follow-up, trivial or less mitral regurgitation was observed in 33 (84.6%) patients.

Conclusions: Mitral valve repair with expanded polytetrafluoroethylene sutures in children demonstrated favorable midterm outcome. The procedure is safe and effective, with potential for patients' growth.

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For mitral valve (MV) reconstruction, various techniques have been used to avoid prosthetic valve replacement, especially in children. Recently, MV plasty in children has gained popularity, and its operative results are satisfactory.[1-3] However, mitral regurgitation (MR) caused by anterior leaflet prolapse is sometimes more difficult to repair with a simple method, such as triangular resection, chordal shortening, or chordal transfer.[4,5]

Chordal replacement with expanded polytetrafluoroethylene (ePTFE) sutures was introduced as an alternate technique for MV repair, and favorable early outcomes have been reported, including our previous study.[1,6] Recently, this procedure has become an essential component in the armamentarium for MV plasty in children. However, the long-term durability and biologic adaptation of ePTFE sutures after patient growth has been a great concern. Therefore, in this study we evaluated the midterm effectiveness of chordal replacement with ePTFE sutures for MV repair in 39 children operated on during the past 8 years.

Patients and Methods

Patients

From April 1995 through December 2003, we performed MV repair with chordal replacement using ePTFE in 39 children. The patient group consisted of 9 male and 30 female subjects with a mean age of 4.7 ± 5.3 years (range, 1 month to 17.8 years) and body weight at the time of the operation of 14.4 ± 12.2 kg (range, 3.9-54.4 kg). A total of 11 (28.2%) of 39 patients underwent MV repair before 1 year of age. The grade of MR at the operation was moderate in 34 (89%) patients and severe in 5 (13%) patients. All patients had anterior mitral leaflet prolapse (39/39 [100%]) that was caused by chordal elongation in 20 (51%) patients, torn chordae in 14 (36%) patients, and absent chordae in 5 (13%) patients. Associated cardiac anomalies were present in 23 (59%) patients, as shown in Table 1. Nine patients had a history of previous cardiac operations, including MV plasty in 3 patients, closure of ventricular septal defect in 2 patients, closure of atrial septal defect in 1 patient, bidirectional Glenn procedure in 1 patient, ligation of patent ductus arteriosus in 1 patient, and central shunt in 1 patient. Informed consent was obtained from patients before surgical intervention, and this study was approved by our institutional review board.

TABLE 1. Associated cardiac anomalies

	N	(%)
No cardiac anomalies	16	41
Ventricular septal defect	9	23
Atrial septal defect	4	10
Bland-White-Garland syndrome	2	5
Left coronary artery obstruction	2	5
Pulmonary atresia/intact ventricular septum	1	3
Complete form of atrioventricular septal defect	1	3
Tricuspid atresia	1	3
Double-chambered right ventricle	1	3
Patent ductus arteriosus	1	3
Double aortic arch	1	3

Indications for MV Repair

The indication for surgical intervention was based on the experience of our institution. Medical therapy, including angiotensin-converting enzyme inhibitors and diuretics, were initiated by referring pediatric cardiologists. Before surgical consultation, most of the patients experienced severe MR. Moderate or severe MR, despite optimal medical treatment, with an episode of congestive heart failure and significant morphologic changes of the anterior leaflet prolapse is our indication for surgical intervention. Pulmonary hypertension (mean pulmonary artery pressure > 20 mm Hg by means of a Swan-Ganz catheter) was observed in 25 (64%) patients. Preoperative ventilator support was necessary in 6 (15%) patients.

Surgical Procedures

Our original procedure was described previously, as shown in Figure 1.[1] In brief, during cardiopulmonary bypass the MV was approached through a left atriotomy (34 patients) or atrial septostomy (5 patients). We placed double-armed mattress sutures of 4-0, 5-0, or 6-0 ePTFE reinforced with felt pledgets between the papillary muscle and free margin of the anterior leaflet. The length of the ePTFE sutures was adjusted with the adjacent normal anterior leaflet or facing posterior leaflet. When the prolapsed portion was wide, another ePTFE suture was placed in the same fashion. The number of ePTFE sutures ranged from 1 to 3 (mean, 1.4; 1 suture in 25 [64%] patients, 2 sutures in 12 [31%] patients, and 3 sutures in 2 [5%] patients). In addition, Kay-Reed annuloplasty was performed in all patients to correct annular dilatation. In 18 patients concomitant repair of a congenital cardiac anomaly was performed. After completion of MV repair to examine the competency of the MV, the left ventricle was filled with fluid injected across the MV into the left ventricle. Valvular function and anatomy were further assessed with transesophageal or epicardial echocardiography while the patient was weaned from cardiopulmonary bypass. All patients received warfarin anticoagulation for 3 months postoperatively.

Follow-up

Follow-up was completed in all patients, with a mean period of 5.0 ± 2.3 years (range, 1.1-8.5 years). The mean body weight at the latest evaluation was 25.7 ± 16.4 kg (range, 6.9-73.0 kg). During the follow-up period, all patients were evaluated annually by transthoracic echocardiography at our hospital. If multiple echocardiographic measurements were obtained, the latest one was taken into the analysis. The normal size of the mitral annular diameter and the left ventricular diastolic dimension were calculated from body surface area, according to the method of Kirklin and Barratt-Boyes.[7]

Functional Assessment of the MV

To assess the adaptability of ePTFE sutures in accordance to the patients' growth, we measured (1) the distance between the plane of the mitral annulus and the top of the papillary muscle (AP distance) and (2) the diameter of the mitral annulus (MV diameter) at the end-systolic phase, as shown in Figure 2. The AP distance reflected the depth of the mitral coaptation zone and the length of the artificial chordae. The ratio of MV diameter to AP distance was calculated and was compared with that of 50 control children with normal hearts (age, 4.2 ± 3.1 years [range, 2 months to 10.8 years]; body weight, 15.7 ± 10.1 kg [range, 1.9-44.3 kg]).