Efficacy of Artificial Chordal Reconstruction for Idiopathic Severe Mitral Regurgitation Due To Chordal Rupture in Infancy

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Early surgical intervention is required for sudden onset, severe mitral regurgitation (MR) due to chordal rupture in infants with normal development younger than 1 year. The condition has been recognized as idiopathic. However, the surgical options in children are limited because of their size and somatic growth. We sought to examine the efficacy of mitral valve plasty by artificial chordal reconstruction for these infants in mid-to-long term. From August 2005 through June 2012, 8 consecutive patients aged 1-7 months underwent mitral valve plasty by chordal reconstruction using expanded polytetrafluoroethylene sutures for MR, owing to leaflet prolapse. The geometric parameters of the diameter of the mitral annulus (D1), the long axis of the left ventricular (LV) chamber (D2), and the length of the papillary muscle including the reconstructed chordae (D3) were measured, as well as MR grade (0–4) and LV end-diastolic dimension, at each time point. The parameters were compared with those in the control group that included Kawasaki disease patients without cardiac lesions and healthy children ($n = 51$). Mean follow-up period was 5.8 (2.8-9.6) years. Freedom from reoperation was 100%. MR grades were 3.9 ± 0.4 preoperatively, 2.4 ± 0.9 at discharge, and 1.4 ± 0.6 at the latest. Postoperative MR was improved within 1 year in 5 of 6 patients who had grade 2 or higher regurgitation. LV end-diastolic dimensions were 109% (% of normal), 113%, and 107% at discharge, 3, and 5 years, respectively. Geometric configuration indicated by the D1/D2 ratio did not significantly change with time. The length of the papillary muscle including reconstructed chordae (D3) strongly correlated with body surface area ($r^2 = 0.65$), which seemed to be equivalent to that in the control group. In conclusion, postoperative mitral valve function and geometry was preserved. This procedure with a low morbidity should be an option for pediatric patients with acute severe MR.

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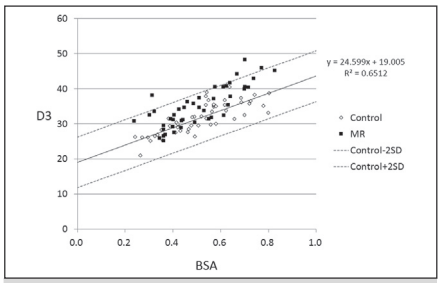

Correlation between the length of papillary muscle including reconstructed chordae and BSA

Central Message

We examined the efficacy of artificial chordal reconstruction for idiopathic mitral regurgitation (MR) in 8 infants. Mean follow-up period was 5.8 years. Freedom from reoperation was 100%. The length of papillary muscle including reconstructed chordae significantly correlated with BSA. This procedure is applicable for MR in infancy.

Perspective Statement

Artificial chordal reconstruction with a low morbidity should be an option for pediatric patients with acute severe MR.

See Editorial Commentary pages 326–327.

INTRODUCTION

"Idiopathic," sudden onset, severe mitral regurgitation (MR) due to chordal rupture has been recognized among normally developed infants younger than 1 year. The etiology remains unknown. It is relatively rare but is of concern because it is largely fatal and often requires early surgical intervention.[1]

Mitral valve plasty (MVP) for MR in children is thought to be more ideal compared with valve replacement, and some studies showed that the surgical outcome of conservative mitral repair in the pediatric group is acceptable.

There are unsolved issues such as the uncertain prognosis of various operative procedures for MVP and whether these procedures are appropriate for congenital MR associated with other cardiac lesions. Since we started MVP using artificial chordae, as described previously,[2] we have questioned

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whether this technique is a reliable surgical option for infants experiencing somatic growth. We therefore examined the mid-to-long-term surgical outcome of MVP using artificial chordae for idiopathic MR in infancy.

PATIENTS AND METHODS

From August 2005 through June 2012, 8 consecutive infants underwent MVP by chordal reconstruction using expanded polytetrafluoroethylene (ePTFE) suture for MR owing to anterior or posterior leaflet prolapse. Kay-Reed annuloplasty was concomitantly performed to correct annular dilatation in all patients. The age at the time of the operation ranged from 1-7 months (mean = 5.0 ± 2.0 months). The body weight ranged from 4.1-9.1 kg (mean 6.9 ± 1.5). MR was significant (more than moderate) in all patients, with annular dilation owing to anterior or posterior leaflet prolapse. Patients with associated cardiac anomalies such as atrioventricular septal defect and anomalous left coronary artery from pulmonary artery were excluded.

The geometric parameters of diameter of mitral annulus (D1), long axis of left ventricular (LV) chamber (D2), and the length of the papillary muscle including reconstructed chordae (D3) were measured, at each time point. The parameters were compared with those in the control group that included 46 (90%) Kawasaki disease patients who have no cardiac sequelae such as coronary lesion or any other cardiac lesion and healthy children (n = 51, body surface area [BSA] ranged from 0.24-0.81 m^2).

The grade of MR was assessed by transthoracic echocardiography and was based on the length of regurgitant jet relative to left atrial cavity (none or trivial = 0, mild = 1, mild-moderate = 2, moderate = 3, and severe = 4). Parameters of LV function such as LV end-diastolic dimension, mitral annulus diameter, and mitral valve flow velocity were also examined. These data were collected preoperatively, postoperatively at discharge, and at later time points, mostly in the outpatient clinic in our hospital.

OPERATIVE TECHNIQUE

Median sternotomy was made, and cardiopulmonary bypass was established with the ascending aorta and bicaval cannulation with moderate hypothermia. Myocardial protection was provided through intermittent administration of blood-based St. Thomas' Hospital cardioplegic solution. The approach to the mitral valve was either through the left atrium on the right side or atrial septum depending on the size of the left atrium and associated procedures. The entire mitral valve apparatus was carefully inspected and the prolapsed lesion was observed. Cold cardioplegic solution was routinely injected into the LV cavity to test for valve competence and to assess leaflet motion and coaptation. Prolapse of the anterior or posterior leaflet was found in all patients. The main cause of prolapse was torn chordae in 7 patients and absence of chordae in 1 patient.

Next, we placed 4-0 or 5-0 ePTFE sutures reinforced with felt pledgets. This unique technique of MV repair was described by Matsumoto et al.[2]

First, a double-armed mattress ePTFE suture was passed through the free edge of the prolapsed leaflet from the ventricular side to the atrial side. After each end of the suture was passed through the papillary muscle corresponding to the prolapsed area, the suture was passed through a pledget. Then, this suture was pulled upward until the leaflet was drawn to the papillary muscle. Second, the knot was then tied a little longer than at the level of the opposing normal leaflet for adjusting appropriate length. The new chordae was then pulled back until the pledget came up against the muscle.

When the prolapsed area was too wide for support by a single suture, another suture was anchored, either from the same papillary muscle or from the other side in the same fashion. In all the cases, either bilateral or unilateral Kay-Reed annuloplasty was performed concomitantly according to the dilatation of the mitral annulus, so that the diameter of the annulus was reduced to 90%-100% of the normal size, according to the publication by Rowlatt and colleagues.

FOLLOW-UP

All patients had postoperative transthoracic echocardiography before discharge. Clinical examination and serial echocardiography were done at 3 months, 6 months, and annually, while the patients were followed-up carefully by pediatricians at the outpatient clinic in our hospital. The follow-up period ranged from 2.8-9.6 years (mean ± standard deviation [SD]; 5.8 ± 2.3 years). Body weight ranged from 4.1-9.1 kg (6.9 ± 1.5 kg).

STATISTICAL METHODS

Computerized statistical analysis was performed using IBM SPSS statistics software version 22 (IBM Japan, Tokyo, Japan). The values of this study are reported as mean ± SD. Student t-test and Mann-Whitney test were used to compare continuous variables. Significance was set at $P < 0.05$.