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Effect of left atrial plication for the giant left atrium on left ventricular function.

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Abstract

Left atrial plication (LAP) following Kawazoe's method was performed on eight patients with mitral valve stenosis associated with a giant left atrium. To investigate the effect of LAP particularly on left ventricular function, the preoperative and postoperative left ventricular function in these patients were compared. The data were also compared to that of the non-left atrial plication (non-LAP) group with left atrial dimension of 60 mm or over. In the LAP group, there were significant differences between preoperative and postoperative data in the following parameters; New York Heart Association (NYHA) class, cardiothoracic ratio, mean pulmonary arterial pressure (PAP), left ventricular end-diastolic pressure (LVEDP), left atrial dimension, stroke volume index, ejection fraction and cardiac index. On the contrary, in the non-LAP group, there were significant differences between preoperative and post-operative data in the following two factors; NYHA class and PAP. The size of the left atrium in the non-LAP group remained unchanged over the course of long-term follow-up. Despite severe clinical symptoms and severely reduced cardiac function of the patients in the LAP group, cardiac function in all patients improved satisfactorily. This suggests that left atrial plication has a considerably beneficial effect on left ventricular function, and therefore, may be recommended for patients with a giant left atrium.

KEYWORDS: giant left atrium, left atrial plication, left ventricular function

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Effect of Left Atrial Plication for the Giant Left Atrium on Left Ventricular Function

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Left atrial plication (LAP) following Kawazoe's method was performed on eight patients with mitral valve stenosis associated with a giant left atrium. To investigate the effect of LAP particularly on left ventricular function, the preoperative and postoperative left ventricular function in these patients were compared. The data were also compared to that of the non-left atrial plication (non-LAP) group with left atrial dimension of 60mm or over. In the LAP group, there were significant differences between preoperative and postoperative data in the following parameters; New York Heart Association (NYHA) class, cardiothoracic ratio, mean pulmonary arterial pressure (PAP), left ventricular end-diastolic pressure (LVEDP), left atrial dimension, stroke volume index, ejection fraction and cardiac index. On the contrary, in the non-LAP group, there were significant differences between preoperative and post-operative data in the following two factors; NYHA class and PAP. The size of the left atrium in the non-LAP group remained unchanged over the course of long-term follow-up. Despite severe clinical symptoms and severely reduced cardiac function of the patients in the LAP group, cardiac function in all patients improved satisfactorily. This suggests that left atrial plication has a considerably beneficial effect on left ventricular function, and therefore, may be recommended for patients with a giant left atrium.

Key words : **giant left atrium, left atrial plication, left ventricular function**

Mitral valve disease is occasionally complicated by the giant left atrium. Because few cases have been reported and a method to evaluate the effect of left atrial plication (LAP) has not been established, LAP has not been generally recognized as a routine therapy for the giant left atrium.

To evaluate the effect of LAP on left ventricular function, we focused the present study on the effect of LAP on left ventricular function, analysing changes in hemodynamics before and long after surgery.

Materials and Methods

In the present study, when the left atrial dimension is 60mm or over, we defined it as the giant left atrium. To investigate the effect of LAP on left ventricular function

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in patients with the giant left atrium, we studied eight patients (4 men, 4 women) with mitral valve stenosis (MS) who underwent LAP (the LAP group) in 1981-1986 and 12 patients (5 men, 7 women) who underwent mitral valve surgery without performing LAP at almost the same period (the non-LAP group).

In the LAP group, the relevant surgery was the repeat surgery for 4 of the 8 patients (50 %). Complication of tricuspid regurgitation (TR) was observed in 6 patients (75 %). In surgery, left atrial plication was combined with mitral valve replacement (MVR) and tricuspid annuloplasty (TAP) in 6 patients, and with MVR in 2 patients (Table 1). In the non-LAP group, the relevant operation was the second cardiac operation for 5 of the 12 patients (42 %). Five patients (42 %) suffered from TR. The types of surgeries were MVR on 7 patients, and MVR with TAP on 5 (Table 1).

Examinations in all patients via cardiac catheterization and ultrasonic cardiography (UCG) were conducted before and after surgery. Cardiac Catheterization was conducted an average of one month before and one month after surgery. UCG was done one week before and 5 years after surgery on the average. The study evaluated NYHA class, cardiothoracic ratio (CTR), time of extracorporeal circulation, blood pressure, heart rate, mean pulmonary arterial pressure (PAP), and left ventricular end-diastolic pressure (LVEDP). Determined from UCG data were left atrial dimension (LAD), left ventricular end-diastolic volume index (LVEDVI), left ventricular end-systolic volume index (LVESVI), stroke volume index (SVI), ejection fraction (EF), cardiac index (CI), and mean circumferential fiber shortening velocity (mVcf). Also evaluated were surgical methods, whether surgery was repeated or not, presence of complications, and results of follow-up.

Surgery was performed on all patients in whom a state of cardiac arrest was maintained via topical cooling and cold cardioplegia.

Analysis of data. The average value of ten cycles of echocardiographic recording was used. All results were expressed as the mean ± SD. A paired t test was used and differences were considered significant if $p < 0.05$.

Table 1 Clinical characteristics in both groups

	LAP[a] group ($n = 8$)	Non-LAP group ($n = 12$)
Age (mean; range)	50.5 (40–62)	47.8 (40–59)
Sex; Male / Female	4/4	5/7
Mitral valve lesion MS[b]	8	12
Complication TR[c]	6	5
Previous heart surgery	4	5
Operative methods		
MVR[d] + TAP[e]	6	5
MVR	2	7
Left atrial plication procedures		
Para-annular plication	8	—
Superior plication	8	—
Right side plication	7	—

a: Left atrial plication, *b*: Mitral stenosis, *c*: Tricuspid regurgitation, *d*: Mitral valve replacement, *e*: Tricuspid annuloplasty.

Results

LAP group. Patients age at time of surgery ranged from 40 to 62, with an average of 50.5 years. Time of extracorporeal circulation was 180 min on the average. Preoperative clinical states in 6 of the 8 patients was NYHA class IV and 2 were class III (mean: 3.8). Postoperatively, 4 were NYHA class II and 4 were class I (average: 1.5), showing an improvement in clinical state ($p < 0.05$).

Clinical and hemodynamic data are listed in Table 2. There were significant differences between the pre- and post-surgical status in the following parameters; CTR, PAP, LVEDP, LAD, SVI, EF and CI. There were no significant differences in blood pressure and heart rate before and after surgery.

Björk-Shiley prostheses (#27 used in 4 and # 29 in 4) were used for MVR, and tricuspid annuloplasty was performed by using DeVega's method to plicate the tricuspid annulus to a 2.5 finger breadth. Kawazoe's method (1) was followed for LAP: superior and para-annular plication were performed for all patients, and right-side plication was performed on 7. In addition, right atrial plication was performed on one patient. Postoperative follow-up period averaged 7.4 years.

Non-LAP group. The patient's ages at the time of surgery ranged from 40 to 59 (mean: 47.8). Mean extracorporeal circulation time was 180 min. Preoperative clinical status of the 12

Table 2 Clinical and hemodynamic findings in the two groups

	LAP[a] group		Non-LAP group	
	Preoperative	Postoperative	Preoperative	Postoperative
NYHA[b] class	3.8 ± 0.7	1.5 ± 0.4*	3.3 ± 0.8	1.3 ± 0.5*
Cardiothoracic ratio (%)	80 ± 7	69 ± 7*	72 ± 8	59 ± 9
ECC[c] time (minutes)	180 ± 45	—	108 ± 24	—
Blood pressure (mmHg)	132 ± 10	128 ± 11	126 ± 14	130 ± 10
Heart rate	58 ± 8	57 ± 9	51 ± 6	59 ± 7
PAP[d] (mmHg)	37.0 ± 15.4	24.6 ± 8.0*	35.3 ± 16.4	23.8 ± 8.0*
LVEDP[e] (mmHg)	9.0 ± 3.6	5.3 ± 2.8*	7.8 ± 2.3	8.0 ± 2.0
LAD[f] (mm)	68 ± 7	41 ± 9*	63 ± 5	59 ± 6
LVEDVI[g] (ml/m²)	104 ± 28	118 ± 26	101 ± 20	110 ± 17
LVESVI[h] (ml/m²)	56 ± 30	50 ± 19	50 ± 16	54 ± 14
SVI[i] (ml/m²)	48 ± 25	68 ± 20*	51 ± 13	56 ± 12
EF[j] (%)	46 ± 5	58 ± 7*	50 ± 8	51 ± 6
CI[k] (1/min/m²)	2.8 ± 1.2	3.9 ± 0.7*	2.6 ± 0.8	3.3 ± 0.6
mVcf[l] (circ/sec)	1.18 ± 0.20	1.26 ± 0.24	1.26 ± 0.34	1.30 ± 0.28

a: Left atrial plication, *b*: New York Heart Association, *c*: Extracorporeal circulation time, *d*: Mean pulmonary arterial pressure, *e*: Left ventricular end-diastolic pressure, *f*: Left atrial dimension, *g*: Left ventricular end-diastolic volume index, *h*: Left ventricular end-systolic volume index, *i*: Stroke volume index, *j*: Ejection fraction, *k*: Cardiac index, *l*: mean circumferential fiber shortening velocity. *: significantly different from corresponding values in preoperative group. $p < 0.05$

patients were evaluated as NYHA class IV in 4 cases, class III in 8 (mean: 3.3). Postoperative clinical status was evaluated as class II in 4 cases and class I in 8 (mean: 1.3), indicative of improvement.

Clinical and hemodynamic findings are listed in Table 2. There were significant differences only in PAP before and after surgery. There were no significant differences between blood pressure and heart rate before and after surgery.

In MVR, Björk-Shiley prostheses were used in all patients (#25 in 1, #27 in 10, and #29 in 1). Tricuspid annuloplasty was performed on 5 patients. Kay's method was used in 4 cases and DeVega's method in 1. Mean postoperative follow-up period was 7.0 years.

Discussion

The giant left atrium can be induced by enlargement of the left atrial wall resulting directly from rheumatic disease or secondary changes in hemodynamics. However, etiology of this condition is not completly understood. Since Owen *et al.* (2) reported mitral valve disease associated with the giant left atrium in 1901, several investigators have reported on the characteristic pathology of the giant left atrium. However, no definition has been established for the disease, and its pathophysiology and clinical significance remain unclear. In addition, there are no criteria for selecting left atrial plication for individual patients with the giant left atrium, and surgical indication continues to be controversial. In 1981, Kawazoe *et al.* (1) reported diagnostic crieria for the giant left atrium that were based not only on left atrial volume but the morphological features of the organs compressed by the enlarged left atrium. The giant left atrium has often been described in relation to the resulting compression on neighboring organs, especially on the respiratory organs, such as the lungs and bronchi (3–5). Nevertheless, the giant left atrium may also affect the pumping function, which may lead to impairment of cardiac function. Reports were lacking that described the effect of the left atrial plication on cardiac function. In this setting, we studied the effect of left atrial plication on cardiac function over the course of long-term follow-up.

Patients with mitral valve disease associated with giant left atrium are often in a clinical state of cardiac cachexia before surgery and frequently develop low cardiac output syndrome (LOS) subsequently, which often becomes fatal. Plaschkes (6) believes that the cause of the aforementioned is severe myocardial impairment. However, Fujita (7) has indicated that there is a relationship between abnormal motion of the posterobasal wall of the left ventricle resulting from compression caused by the giant left atrium, and a postoperative decline in cardiac function. He also reported that left atrial plication reduced the frequency of LOS. UCG detected abnormal position and motion of the posterobasal wall of the left ventricle, strongly supporting the idea that the giant left atrium affects left ventricular function (8). However, Some investigators (9,10) believe that a greatly enlarged left atrium may act to reduce the left ventricular preload and propose that left atrial plication should be elected very cautiously or else it may have an adverse effect.

In our study, preoperatively the LAP group consisted of patients in severe clinical states with large cardiothoracic ratios (mean: 80 %) and with substantially lower cardiac indexes than the non-LAP group. Nevertheless, many indexes for cardiac function in the LAP group were greatly improved in the course of postoperative long-term follow-up. In contrast, no significant changes were observed in the non-LAP group after surgery.

As patients in the LAP group suffered not only from a giant left atrium but from repeat surgery for valve diseases as well, and 75 % of them underwent tricuspid annuloplasty, we should consider the effect of the giant left atrium on the right side of the heart as well. In other words, patients with a giant left atrium may frequently suffer from bilateral heart failure not only due to atrial enlargement but also to advanced valve disease. The evidence indicates that patients with the giant left atrium are in serious conditions. Therefore, surgery should be considered cautiously for mitral valve disease associated with a giant left atrium, despite the fact that left atrial plication improves cardiac function.

We followed Kawazoe's method when performing para-annular plication on patients. UCG confirmed that abnormal motion of the posterobasal wall of the left ventricle was corrected. This suggests that improvement in the mode of left ventricular contraction, which can be brought about with left atrial plication, is needed to improve cardiac function.

On the average, extracorporeal circulation time in the LAP group was 72 min. The length of time in surgery was also significantly longer than in the non-LAP group. These factors do not appear to have a great effect on prognosis because the myocardial protection technique has been improved enough to preserve cardiac function. It should be noted that the ameliorating effect of left atrial plication on left ventricular function was marked in late prognoses. Significant reductions of CTR and the size of the left atrium following left atrial plication increased both the stroke volume and the ejection fraction. Size of the left atrium was reduced by 60 % postoperatively in the LAP group, and by 94 % in the non-LAP group and remained unchanged over the course of long-term follow-up.

Despite severe clinical symptoms and severely reduced cardiac function of the patients in the LAP group, cardiac function in all patients improved satisfactorily. This suggests that left atrial plication has a considerably beneficial effect on left ventricular function, and is an appropriate procedure for patients with a giant left atrium.

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