Effects of Operation on Left Atrial Size and the Occurrence of Atrial Fibrillation in Patients with Hypertrophic Subaortic Stenosis

DONALD C. WATSON, M.D., WALTER L. HENRY, M.D., STEPHEN E. EPSTEIN, M.D., AND ANDREW G. MORROW, M.D.

SUMMARY The relation between left atrial size and atrial fibrillation was examined in 37 patients who had left ventriculotomy and myectomy at the National Heart and Lung Institute. Atrial fibrillation was present in 11 of 27 (41%) patients with an echocardiographically measured left atrial dimension greater than 45 mm. No patient with a left atrial dimension less than 45 mm had atrial fibrillation pre or postoperatively. Eleven of 13 patients less than 40 years of age with an abnormal preoperative left atrial dimension had a 10% or greater reduction in left atrial dimension postoperatively. A group of 21 patients 40 years of age or older had an abnormal left atrial dimension preoperatively, and no significant change postoperatively. These results indicate that left ventriculotomy and myectomy can produce a significant decrease in left atrial size in younger patients with idiopathic hypertrophic subaortic stenosis. It is hoped that the decrease in atrial size may reduce the risk of atrial fibrillation in these patients.

In asymmetric septal hypertrophy (ASH), one of the predominant causes of hemodynamic compromise is a decrease in left ventricular compliance that results from severe left ventricular hypertrophy. As a consequence of the decreased compliance, left ventricular filling pressure increases and left atrial hypertrophy and dilatation may ensue. Atrial fibrillation, when it appears, also adds to the hemodynamic burden of these patients and is often associated with marked clinical deterioration.

In one study, atrial fibrillation, with rare exception, occurred in patients with a dilated left atrium. The present study was undertaken to determine whether there is a similar relation between left atrial size and atrial fibrillation in patients with obstructive ASH (idiopathic hypertrophic subaortic stenosis, IHSS) who have had left ventricular outflow obstruction relieved by myotomy and myectomy. The results of this study are relevant to the controversy concerning the efficacy of operation in this condition. The reduction in left ventricular outflow gradient that occurs following myotomy and myectomy is thought to reflect a favorable hemodynamic change responsible for the symptomatic improvement experienced by most patients. However, other investigators have suggested that abolition of the gradient may be due to the damage that has been inflicted upon the left
ventricle as a result of operation.\textsuperscript{3, 4} In this view, the diminution or abolition of the gradient reflects reduced left ventricular contractile force and increased failure. Examinations of the size of the left atrium before and after operation might help resolve this controversy. If left atrial size diminished after operation, it would be reasonable to assume that operation did improve left ventricular function.

Methods

The patients in this study were drawn from an initial cohort of 64 adults undergoing left ventriculotomy and myectomy\textsuperscript{7} for IHSS from January 1972 (when clinical echocardiographic studies were begun in this institution) to December 1975. Each patient's medical record was reviewed for age at the time of operation, history of preoperative arrhythmias, pre and postoperative hemodynamic variables, and the occurrence of postoperative arrhythmias. In 37 patients, complete historical, electrocardiographic, and hemodynamic data were available. These 37 patients comprise the study group; 21 (57\%) were men and 16 (43\%) women; the mean age was 44 years (range 21 to 67 yrs). Postoperative evaluation was performed three months to 31/2 years after operation (mean 11 months). In all 37 patients the left ventricular outflow pressure gradient decreased after operation. Of the 27 patients who were excluded from this study, 16 were excluded because they did not have adequate pre or postoperative echocardiograms, nine lacked postoperative hemodynamic data, and two died following operation.

Atrial flutter or fibrillation was considered to have been present preoperatively if the patient had a documented occurrence of this rhythm, regardless of its duration. Atrial flutter or fibrillation was considered to be present postoperatively if the patient had at least one episode of either rhythm documented postoperatively, from 30 days after operation until the time of most recent follow-up.

Echocardiograms were obtained using an Ekoline 20A ultrasound unit, Honeywell 1850 Line Scan recorder, Hewlett-Packard X-Y display, and a custom-built video amplifier. Recordings were made with the patient in the left decubitus position and in a resting state. Left atrial dimension was obtained by angling the ultrasound beam medially and cephalad from the mitral valve tip until the aortic root signals were visualized. Minor transducer angulations were made until the left atrial signals were seen. Signal intensity was reduced to clarify the left atrial wall and lung interface. Left atrial dimension in millimeters was measured in early diastole from the damped record.\textsuperscript{6} In all instances the left atrial dimension utilized for analysis was the maximum one observed during the cardiac cycle. A left atrial dimension greater than 38 mm was considered abnormal. Data were analyzed statistically using the Fisher's exact test and median test for significance.

Results

Left Atrial Dimension Pre and Postoperatively

The mean left atrial dimension for all 37 patients was 45 mm preoperatively, and it decreased to 43 mm postoperatively ($P < 0.03$). To determine the influence of age on this change, patients were divided into those less than 40 years of age at the time of operation and those 40 years or older. No significant difference in mean left atrial dimension was evident preoperatively between the two groups (45 mm vs 46 mm). However, a significant difference was found postoperatively (40 mm vs 45 mm, $P < 0.01$).

Of the 16 patients younger than 40 years of age, mean left atrial dimension averaged 45 mm preoperatively and 40 mm postoperatively ($P < 0.001$, fig. 1). When only those younger patients whose left atria were dilated preoperatively were considered, 11 of 13 (85\%) had a ten percent or greater reduction in left atrial dimension, and in none did the left atrium increase in size after operation (fig. 2). Moreover, of seven patients with a preoperative left atrial dimension greater than 45 mm, five (71\%) had a postoperative left atrial dimension that was less than 45 mm (fig. 2).

In 21 patients 40 years of age or older, mean left atrial dimension was 46 mm preoperatively and 45 mm postoperatively (NS, fig. 3). When those older patients with an abnormally large preoperative left atrial dimension were considered, only 3 of 19 (16\%) had a ten percent or greater decrease, and two (11\%) had a ten percent or greater increase in left atrial size (fig. 4). The remaining sixteen patients had a less than ten percent change in left atrial dimension postoperatively.

Regardless of age, there was a greater likelihood that patients with a preoperative left atrial dimension of 50 mm or greater would reduce their left atrial dimension postoperatively by ten percent or more, when compared to patients with a smaller preoperative dimension ($P < 0.02$). However, of the seven patients with a preoperative left atrial dimension of 50 mm or greater, only one had a postoperative left atrial dimension less than 45 mm.

The percentage of patients with abnormal preoperative
left atrial dimension who reduced their dimension by greater than ten percent was significantly larger for patients younger than 40 years of age when compared to patients 40 years of age or older ($P < 0.001$). This resulted in the younger group having a higher prevalence of patients with a postoperative left atrium 40 mm or less than did the older group ($P < 0.01$).

Left atrial (or pulmonary artery wedge pressure) and left ventricular end-diastolic pressure were decreased in most patients after operation. No significant correlation existed between pre or postoperative left atrial size or change in left atrial size and pre or postoperative left atrial pressure (or pulmonary artery wedge pressure), left ventricular end-diastolic pressure, or left ventricular outflow tract gradient.

**Atrial Fibrillation Pre and Postoperatively**

In the entire group 17 patients had preoperative left atrial dimensions of 45 mm or greater. Of these, 8 (47%) had a preoperative history of atrial flutter or fibrillation. None of the 15 patients with an abnormal preoperative left atrial dimension (>38 mm), but less than 45 mm, developed this arrhythmia preoperatively ($P < 0.001$). A subgroup of ten patients 40 years of age or older with a preoperative left atrial dimension of 45 mm or greater had a higher occurrence (60%) of preoperative atrial fibrillation ($P < 0.001$) when compared to all other patients. However, this occurrence rate was not significantly different from that of the younger group with a preoperative left atrial dimension of 45 mm or greater (29%).

Three of ten patients with a postoperative left atrial dimension of 45 mm or greater had postoperative atrial fibrillation during an average follow-up period of nine months. None of the 22 patients with preoperative left atrial dimension greater than 38 mm and a left atrial dimension less than 45 mm postoperatively had this arrhythmia.
LA SIZE AND AF IN IHSS

Watson, Henry, Epstein, Morrow

(P < 0.03). Three of the five patients with preoperative but without postoperative atrial fibrillation decreased their left atrial dimension by greater than ten percent of preoperative dimension. No significant correlation existed between pre or postoperative left atrial or pulmonary artery wedge pressure, left ventricular end-diastolic pressure, or left ventricular outflow tract gradients, or change in any of these hemodynamic variables.

Discussion

This investigation supports previous suggestions that atrial fibrillation in patients with IHSS is related to both left atrial dilatation and age. The major etiologic factor appears to be left atrial size, with the patient's age being relatively less important. This study extends previous observations by demonstrating that left atrial dimension and the occurrence of atrial fibrillation also correlate well in the postoperative IHSS patient.

Another observation of considerable clinical significance is that relief of left ventricular outflow obstruction after myotomy and myectomy results in a significant decrease in left atrial dimension in patients younger than 40 years of age. Of 13 patients in this group who had a dilated atrium preoperatively, 11 (85%) had a ten percent or greater reduction in left atrial dimension postoperatively. Furthermore, five of seven younger patients with a left atrial dimension 45 mm or greater preoperatively had a dimension less than 45 mm postoperatively. Since atrial fibrillation in the entire patient population studied was not seen in patients with a left atrial dimension less than 45 mm, it is possible that operative relief of left ventricular outflow obstruction reduced the risk of atrial fibrillation in these five patients, at least temporarily.

The effects of operation on reducing left atrial size appear to be limited largely to patients who are less than 40 years of age at the time of operation. Of 19 patients operated upon at 40 years of age or older, and who had a dilated atrium preoperatively, only 16% experienced a 10% or greater decrease in left atrial dimension. This compares with 85% of patients who were less than 40 years of age at operation. There were no differences in the hemodynamic effects of operation in the two groups of patients. Hence, the differences in the results between the younger and older patients with IHSS suggest that duration of exposure to the hemodynamic burden may be an important factor in determining whether reduction in left atrial size accompanies hemodynamic improvement after operation. Alternatively, it is possible that intrinsic changes in left atrial structure occurring as a result of age may influence the potential for reversibility.

Other investigators have been of the opinion that operation has no useful role in the management of patients with IHSS because they believe symptoms can be attributed mainly to the cardiomyopathic component of the disease. They have suggested that any reduction in left ventricular outflow obstruction produced by operation is the result of further compromise of left ventricular function, as has been noted to occur in some patients during the natural progression of the disease. If this hypothesis were correct, left atrial size would not be expected to diminish following operation. The fact that left atrial size decreased in many patients following left ventriculotomy and myectomy suggests that operation does in fact improve left ventricular function.

In conclusion, patients with IHSS are at risk of atrial fibrillation, particularly as left atrial dimension exceeds 45 mm. The occurrence of atrial fibrillation in all the present patients was related to pre and postoperative left atrial dimension. Operation leads to a significant reduction in left atrial dimension, especially in patients less than 40 years of age. This change is associated in some patients with abolition of atrial fibrillation. These observations suggest that left ventriculotomy and myectomy may decrease the risk of atrial fibrillation in younger patients with IHSS, at least during the early postoperative years. Longer term follow-up studies will be necessary to determine whether the reduction in left atrial dimension and diminished occurrence rate of atrial fibrillation persist in the late postoperative period.

References

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D C Watson, W L Henry, S E Epstein and A G Morrow

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