The Effects of Operation on the Echocardiographic Features of Idiopathic Hypertrophic Subaortic Stenosis

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SUMMARY
Simultaneous cardiac catheterizations and echocardiograms were performed before and 6-12 months following ventriculoseptomyectomy in 10 patients with idiopathic hypertrophic subaortic stenosis (IHSS) to define the effects of operation on the echocardiographic features of IHSS. Preoperatively, the resting peak systolic gradient ranged from 40-125 mm Hg and averaged 81 mm Hg. Postoperatively no gradient was present in nine patients and one patient had a 15 mm Hg residual gradient. Echocardiographic obstruction index averaged 54 m sec/mm (range 35-85) preoperatively and was reduced to 12 msec/mm (0-67) postoperatively. The markedly abnormal systolic anterior motion (SAM) of the anterior mitral leaflet present in all preoperatively was diminished or absent following operation. The preoperative left ventricular outflow tract dimension, calculated by echocardiogram at peak SAM, averaged 1.4 mm (range 0-5) and increased to 15 mm (3-25) following operation. Ventricular septal width averaged 18 mm (range 14-21) and posterior wall thickness averaged 11 mm (range 7-13) and were unchanged following operation. Mitral valve diastolic closing velocity, measured echocardiographically was not altered by operation (average 35 mm/sec before and after operation), suggesting that significant changes in left ventricular compliance did not occur. The echocardiogram in patients after ventriculoseptomyectomy demonstrates more normal mitral valve motion and increased left ventricular outflow tract dimension. In some patients uneven mitral leaflet-septal contact may produce significantly abnormal areas of SAM without obstruction.

Additional Indexing Words:
Mitrval valve motion
Ventriculoseptomyectomy
Left ventricular outflow obstruction
Hypertrophic obstructive cardiomyopathy

Recognition of idiopathic hypertrophic subaortic stenosis (IHSS) and the estimation of the severity of the obstruction is possible by employing the noninvasive technique of echocardiography.1-3 This technique has also been useful in the assessment of interventions employed in the treatment of the disease.4-8 The present study was designed to define the effects of operation on the echocardiographic features of IHSS.

Material and Methods
Simultaneous cardiac catheterizations and echocardiograms were performed before and 6-12 months following ventriculoseptomyectomy in 10 patients with IHSS. The operative techniques employed are described elsewhere but are a modification of the Morrow technique.7-8 The patients' ages ranged from 9 to 68 years. The diagnosis of IHSS was documented in each patient by retrograde and/or transseptal left ventricular catheterization.9 During the course of preoperative and postoperative catheterization, simultaneous echocardiograms and left ventricular inflow and central aortic pressures were recorded during resting basal conditions.

Echocardiographic studies were performed with the patients supine and the transducer at the third or fourth intercostal space near the left sternal edge. The transducer was positioned using the sector scanning method so that both anterior and posterior mitral valve leaflets were identified and maximal valve leaflet excursion was insured.10 The right and left heart catheterizations were performed by the percutaneous right femoral technique. Pressures were measured using Statham P23Db transducers and Electronics for Medicine Model DR-8 recorder. The echocardiograms were obtained with a Smith Kline Ekoline-20A ultrasonoscope interfaced to a Honeywell 1856 strip chart recorder using a 10 cm focused Aerotech transducer. The echo signals were recorded continuously on light sensitive paper and echocardiograms were processed for illustration by a photomechanical transfer process.

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The degree of outflow tract obstruction was quantitated echocardiographically using two techniques. The distance between the interventricular septum and anterior mitral leaflet at the point of maximal abnormal anterior systolic movement was determined preoperatively and postoperatively as a measure of the minimum left ventricular outflow tract dimension (fig. 1). The degree of obstruction was also assessed employing the obstruction index technique described by Henry et al.\(^3\) as the quotient of the duration of outflow tract narrowing and the mean interventricular septal-anterior mitral leaflet distance. Simultaneously the peak systolic subaortic pressure gradient was measured between the left ventricle and central aorta.

The anterior mitral valve diastolic closing velocity, or E to F slope, and ventricular septal and posterior wall thicknesses were determined before and following operation in each patient. The posterior left ventricular free wall and ventricular septal thickness were measured in ventricular diastole at the end of rapid ventricular diastolic filling (fig. 1).

**Results**

Preoperatively, left ventricular outflow obstruction was present in every patient (fig. 2); peak subvalvular gradient averaged 81 mm Hg and ranged from 40 to 125 mm Hg. Postoperatively, no gradient was observed in nine patients and one patient had a 15 mm Hg residual gradient. The preoperative echocardiographic findings in a typical patient with IHSS are illustrated in figure 3. The markedly abnormal systolic anterior motion of the mitral valve leaflets, the narrowed left ventricular outflow tract, the hypertrophied ventricular septum and the diminished diastolic descent rate of the anterior mitral leaflet are demonstrated simultaneously. A large left ventricular-aortic gradient is present. The findings in the same patient after operation are reproduced in figure 4. Marked diminution of systolic anterior motion of the anterior mitral valve leaflet and widening of the left ventricular outflow tract in systole are evident. The outflow tract dimension at the peak of abnormal mitral valve systolic motion averaged 1.4 mm (range 0-5) preoperatively. Postoperatively, the outflow tract

![Figure 1](image1)

**Figure 1**

Method of echocardiographic evaluation. The left ventricular outflow tract dimension (LVOT) is the distance between the interventricular septum and the anterior mitral leaflet at the point of maximum abnormal systolic movement. The obstruction index was calculated by dividing the duration of narrowing by the average septal-mitral distance. The E to F slope, or diastolic mitral valve closing velocity, and the septal and posterior left ventricular wall (L.V.) thicknesses were measured as illustrated.

![Figure 2](image2)

**Figure 2**

Peak systolic pressure gradient between the left ventricle and central aorta as recorded in 10 patients with idiopathic hypertrophic subaortic stenosis (IHSS) studied before and 6-12 months following operation.

![Figure 3](image3)

**Figure 3**

Preoperative echocardiogram and simultaneously recorded left ventricular (L.V.) pressure and aortic (Ao) pressure in a patient with IHSS. The anterior mitral leaflet is seen to move into close proximity with the septum during midsystole.

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IHSS BY POSTOP ECHOGRAM

Figure 4

Postoperative echocardiogram and simultaneously recorded pressures in the same patient as shown in figure 3. Note the diminution of systolic anterior motion of the anterior leaflet and the simultaneous absence of an intraventricular pressure gradient.

dimension increased to 14.9 mm (range 3-26 mm) (fig. 5); similar echocardiographic alterations were noted in five patients in whom echocardiograms were performed within 48 hours of operation.

Preoperatively, the echocardiographic obstruction index averaged 54 msec/mm (range 35-85 msec/mm). Postoperatively, the echocardiographic obstruction index average was reduced to 12 (range 0-67). In one patient, significant systolic anterior motion of the mitral valve leaflet persisted postoperatively with a residual obstruction index of 67 msec/mm; simultaneously measured left ventricular-aortic pressures revealed no gradient. This inconsistency may result from uneven septal apposition by the anterior mitral leaflet and has been described.11

The interventricular septal width averaged 18 mm (range 16-20) and posterior left ventricular free wall thickness averaged 11 mm (range 7-13) preoperatively. Postoperatively, septal width and posterior wall thickness were unchanged. Mitral valve systolic closing velocity averaged 35 mm/sec (range 10-60) preoperatively and was unchanged following operation.

Discussion

The effectiveness of ventriculoseptomyectomy in the relief of obstruction and mitral regurgitation in IHSS has been well documented by postoperative catheterization studies.12 Echocardiographic assessment of systolic mitral valve motion following successful ventriculoseptomyectomy in most instances correlates well with the relief of the outflow tract obstruction. The simultaneous disappearance of the obstruction and reduction in abnormal systolic mitral valve motion substantiates the role of the mitral valve apparatus in the genesis of the obstruction. Occasionally abnormal systolic anterior motion with apparent obstruction persists in the absence of a measurable gradient. This may be due to uneven anterior leaflet-ventricular septal contact as described by King et al.11

A decreased diastolic closing velocity of the mitral valve (E to F slope) by echocardiogram has been commonly observed in subaortic stenosis and other forms of left ventricular outflow tract obstruction.13 This reduced diastolic closing velocity appears to represent

Figure 5

Echocardiographically determined left ventricular outflow tract dimension at the peak of abnormal mitral valve systolic motion before and after operation. The numbers in parentheses indicate the group average.

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delayed atrial emptying and slow ventricular filling secondary to decreased left ventricular compliance. In the present study, the mitral valve diastolic closure rate was not significantly changed following operation suggesting that left ventricular compliance was not significantly altered 6 to 12 months following operation.

Detection of asymmetric septal hypertrophy by echocardiography appears to be valuable in the identification of patients with IHSS, particularly in those with latent obstruction. This study supports the observation of Henry et al. that the echocardiographically determined septal thickness in patients with IHSS is significantly greater than the posterior left ventricular free wall thickness.13 In the present study the echocardiographic measurement of septal and posterior wall thicknesses remained essentially unchanged postoperatively. Since the severity of the obstruction is independent of the relative degree of asymmetric hypertrophy, this finding is not unexpected.

When the postoperative echocardiograms were performed, there was no certainty that the area of septum scanned included the area of the ventriculoseptomyectomy. Since only 10 to 20 grams of tissue are removed, it is doubtful that this significantly alters the septal mass.

Ventriculoseptomyectomy relieves the abnormal systolic anterior motion of the mitral valve leaflets as well as left ventricular outflow tract obstruction. Since this occurs without echocardiographic evidence of early regression of septal or posterior left ventricular wall thickness or an alteration in ventricular compliance, the restoration of more normal mitral valve motion in systole appears to be the most important factor in establishing normal hemodynamics.

Conclusion

The abolition of obstruction and the simultaneously observed echocardiographic reduction of abnormal systolic mitral valve motion suggests that the mitral valve plays a very significant role in the genesis of the obstruction in IHSS. Ventriculoseptomyectomy abolishes outflow tract obstruction and ameliorates mitral regurgitation by restoring more normal mitral valve motion. Echocardiography provides a reliable and sensitive noninvasive means for serial evaluation of medical and surgical therapy in idiopathic hypertrophic subaortic stenosis.

References


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