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Treatment Modalities in Hypertrophic Obstructive Cardiomyopathy: Surgical Myectomy versus Percutaneous Septal Ablation

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ABSTRACT

Background: The aim of this study was to compare the results of percutaneous septal myocardial ablation (PSMA) and surgical myectomy (SM) for decreasing the left ventricular outflow tract (LVOT) gradient, septal thickness, ventricular dimensions, and mitral regurgitation (MR) in patients with symptomatic hypertrophic obstructive cardiomyopathy.

Methods: We treated 40 patients (mean age, 24.4 ± 6.8 years; 34 male and 6 female patients) between June 2002 and April 2006. Twenty-four patients underwent SM, and 16 patients underwent PSMA. All patients were symptomatic despite maximal medical treatment and had an LVOT gradient higher than 65 mm Hg. Their echocardiographic data were recorded before and after the procedure and then compared. The patients were followed up postoperatively for a mean of 13 months.

Results: There was no mortality in either group. One year after the procedure, the LVOT gradients for the 2 groups were not statistically different. During the follow-up, moderate MR was found in 4 patients (25%) in the ablation group and in 2 patients (8.3%) in the myectomy group. Exercise capacity and New York Heart Association class improved after PSMA, whereas postoperative MR severity and effort capacity were better in the surgical group.

Conclusion: The 2 approaches yielded similar results with regard to reducing the LVOT gradient. We conclude that SM is preferable to PSMA in cases with MR.

INTRODUCTION

Hypertrophic obstructive cardiomyopathy (HOCM) is a condition of unknown origin characterized by septal hypertrophy, a left ventricular outflow tract (LVOT) gradient, decreased exercise capacity, decreased quality of life, and, sometimes, sudden death [Spirito 1997]. When the disease is refractory to conventional medical treatment with beta-blocking agents, calcium channel blockers, and antiarrhythmic drugs, there remain several different approaches, including percutaneous septal myocardial ablation (PSMA) and surgical myectomy (SM) [Morrow 1975; Ivens 2004]. The advantages of PSMA over SM have not been sufficiently elucidated. The correction of systolic anterior motion (SAM) of the anterior mitral leaflet and the resulting mitral regurgitation (MR), if present, presents an important problem and can be addressed by surgical treatment [Wigle 1985, 1995; Maron 2002].

We compare the clinical and hemodynamic outcomes in HOCM patients 1 year after PSMA and SM.

MATERIALS AND METHODS

Demographics

A prospective clinical study was designed to compare the outcomes after PSMA and SM in patients with HOCM refractory to medical treatment. Patients with an LVOT gradient ≥50 mm Hg and a septal thickness ≥17 mm were included in the study.

Between June 2002 and April 2006, 40 patients (34 male and 6 female) with HOCM refractory to medical therapy were enrolled in either the PSMA or the SM group after their written consent to participate in this study was obtained. The preferences of the informed patients also played a role in the forming of these groups.

All patients were in New York Heart Association (NYHA) functional class II, III, or IV despite optimal medical therapy that consisted of beta-blockers in 22 patients (55%), calcium channel blockers in 18 patients (42%), and amiodarone in 16 patients (40%). The mean age (±SD) was 24.4 ± 6.8 years (range, 11-34 years). PSMA was performed in 16 (40%) of the patients (mean age, 25.0 ± 7.3 years; 14 male and 2 female patients), and 24 (60%) of the patients underwent SM (mean age, 24 ± 6.6 years; 20 male and 4 female patients). The demographic, clinical, and echocardiographic data are presented in Table 1. After the diagnoses, treatment options were explained to all of the patients.

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Table 1. Demographics and Clinical Characteristics of the Patients*

Characteristic	PSMA Group (n = 16)	SM Group (n = 24)
Age, y	25 ± 7.3	24 ± 6.6
Male/female sex, n	14/2	20/4
Dyspnea, n (%)	16 (100%)	20 (83.3%)
Palpitations, n (%)	16 (100%)	8 (33.3%)
Angina (CCS I-III), n	16 (100%)	22 (91.6%)
NYHA class (I-IV)	3.0 ± 0.8	3.1 ± 0.7
MR grade	1.6 ± 0.2	1.7 ± 0.4
Beta-blockers, n	8	14
Calcium channel blockers, n	15	3
Amiodarone, n	7	9

*Data for age, New York Heart Association (NYHA) class, and mitral regurgitation (MR) grade are presented as the mean ± SD. PSMA indicates percutaneous septal myocardial ablation; SM, surgical myectomy; CCS, Canadian Cardiovascular Society.

Clinical Data

All patients in the PSMA group were in NYHA class II, III, or IV and had dyspnea, palpitations, and exertional angina. In the SM group, 20 patients (83.3%) had dyspnea, 8 (33.3%) had palpitations, and 22 (91.6%) had exertional angina. One patient (4.2%) had right bundle branch block preoperatively. The mean LVOT gradient in the PSMA group was significantly lower than in the SM group (65 ± 16 mm Hg versus 72.5 ± 20 mm Hg; $P = .045$). Before the treatment, 6 patients in the PSMA group (37.5%) had grade I MR, and another 6 patients (37.5%) had MR of grade II or III. In the SM group, 4 patients (16.6%) had grade I MR preoperatively, 13 patients (54.1%) had MR of grade II or III, and 2 patients (8.3%) had grade IV MR. The mean MR grade in the SM group was significantly higher than that in the PSMA group ($P = .02$). Fifteen patients (62.5%) in the SM group also had SAM of the anterior mitral leaflet preoperatively in addition to varying degrees of MR. The SM group had higher degrees of MR before the procedure, because SM was recommended for patients if there was severe MR (grades III-IV).

PSMA Technique

The right and left femoral arteries were cannulated according to standard techniques. A 6F temporary pacing electrode catheter (Input TS; Medtronic, Minneapolis, MN, USA), later replaced by a 6F bipolar electrode catheter (TBII 2/6 F-J; Osypka Medical, Berlin, Germany), was positioned in the right ventricle. Simultaneous measurement of the pressures in the left ventricle (6F pigtail catheter) and in the ascending aorta (7F Judkins guiding catheter) allowed continuous monitoring of the LVOT gradient. We measured baseline hemodynamic data, including the LVOT gradient at rest and at provocation with the Valsalva maneuver. After identification of the septal branches of the left anterior descending coronary artery (LAD), a balloon of 1.5 to 2.5 mm × 10 mm was introduced over a 0.014-inch guidewire and positioned into the first septal branch. When the balloon position was satisfactory, the guidewire was removed, and the balloon was inflated. Subsequently, 1 mL of echo contrast agent (Ecovist; Bayer Schering Pharma AG, Berlin, Germany) was injected through the balloon catheter shaft. The myocardial territory supplied by this septal branch was identified with echocardiography, and retrograde spill of contrast into the LAD or the right ventricle was excluded. If satisfying images were obtained, 1 to 5 mL of concentrated ethanol was injected through the balloon catheter shaft under close echocardiographic surveillance. After 5 minutes, the balloon was deflated, and a coronary angiographic evaluation was repeated to confirm the patency of the LAD and discontinuation of the septal branch. If the LVOT gradient remained >30 mm Hg, which was observed in 1 patient in the present study, the result was considered suboptimal. Subsequently, the procedure was repeated in the same septal branch if the myocardial territory supplied by this branch was relatively large. After the procedure, the pacemaker lead was left in place for pacing if required.

SM Technique

SM was performed with the use of moderately hypothermic cardiopulmonary bypass under cardioplegic arrest via standard aortic and bicaval cannulation. A transaortic myectomy was carried out on the hypertrophic septum with sharp excision. Papillary muscle mobilization and/or anterior mitral leaflet plication was also performed whenever necessary [McIntosh 1992]. Abnormal attachments between the papillary muscle and the anterior lateral ventricular wall were divided, and a portion of the junction of the papillary muscle and the lateral wall was also resected. When this resection was completed, the papillary muscles with their reduced diameters were separated from the ventricular wall and from each other. All patients were examined intraoperatively with transesophageal echocardiography for residual gradients, valve conditions, or ventricular septal defect formation.

Pathologic Examination

For the patients who underwent SM, the resected myocardium was evaluated for the presence of left bundle branch tissue. Microscope slides were stained with hematoxylin and eosin.

Follow-up

All patients were followed up in the postprocedural period by clinical examination and echocardiography for septal thickness, LVOT gradient, ventricular dimension, MR, and SAM grade to document the outcomes for these 2 procedures. The mean follow-up time was 13 ± 2.2 months (range, 7-18 months). Echocardiography examinations were performed at the sixth and 12th months. The data for clinical and echocardiographic parameters obtained before and after the treatments are compared in Table 2.

Statistical Analysis

Continuous variables are presented as the mean ± SD. Univariate analysis was performed with the chi-square or Fisher exact test for categorical variables and the Student *t* test

Table 2. Clinical and Echocardiographic Data of the Patients (after 1 Year)*

	Before PSMA	After PSMA	Before SM	After SM
NYHA class, n				
I	0	10	0	16†
II-III	12 (75%)	6‡	18 (75%)	8§
IV	4 (25%)	2	6 (25%)	2
Angina class (CCS), n				
I	9 (56.2%)	15 (93.7%)	10 (41.6%)	11 (45.8%)
II	5 (31.2%)	1 (6.2%)	8 (33.3%)	2 (8.3%)
III	2 (12.5%)	0	4 (16.6%)	0
ESD, mm		1.3 ± 0.1‖		1.3 ± 0.2‖
LVOT gradient, mm Hg	65 ± 16	14 ± 5¶	72.5 ± 20#	16 ± 4¶
EDD, mm	42.4 ± 1.3	46.0 ± 2.2	42.7 ± 1.7	45.8 ± 2.1
ESD, mm	20.9 ± 0.9	24.4 ± 1.2	23.1 ± 1.2	26 ± 1.4
MR (grades 0-IV), n				
None	0	2	0	5
I	6 (37.5%)	6 (37.5%)	4 (16.6%)	17 (70.1%)
II-III	6 (37.5%)	4 (25%)	13 (54.1%)**	2 (8.3%)
IV	0	0	2 (8.3%)	0
SAM, n	7 (43.7%)	5 (31.7%)	15 (62.5%)	6 (25%)††
LBBB, n	1 (6.2%)	7 (43.7%)	0	2 (8.3%)
RBBB, n	0	2 (12.4%)	1 (4.2%)	1 (4.2%)
CHB, n	0	1 (6.2%)	0	0
PPM, n	0	1 (6.2%)	0	0

*End-systolic dimension (ESD), left ventricular outflow tract (LVOT), and end-diastolic dimension (EDD) data are presented as the mean ± SD. PSMA indicates percutaneous septal myocardial ablation; SM, surgical myectomy; NYHA, New York Heart Association; CCS, Canadian Cardiovascular Society; MR, mitral regurgitation; SAM, systolic anterior motion; LBBB, left bundle branch block; RBBB, right bundle branch block; CHB, complete heart block; PPM, permanent pacemaker. †P = .02; ‡P = .0001; §P = .009; ‖P = .000; ¶P = .001; #P = .045; **P = .02; ††P = .01.

for continuous variables. A P value <.05 was considered statistically significant.

RESULTS

There was no mortality in either treatment group. After PSMA, 1 patient (6.2%) needed reintervention, and another needed surgical treatment. Both interventions were required because of a high postprocedure pressure gradient (>30 mm Hg and >50 mm Hg, respectively). Left bundle branch block developed in 7 patients (43.7%), right bundle branch block developed in 2 patients (12.5%), and complete atrioventricular block necessitating permanent pacemaker implantation occurred in 1 patient (6.2%). The mean intensive care unit duration was 24 ± 2.8 hours (range, 16-27 hours), and the mean hospitalization duration was 4.3 ± 0.9 days (range, 3-6 days). Following SM, 1 patient (4.1%) underwent revision for postoperative bleeding in the early postoperative period. The mean mechanical ventilation duration in this group was 6.3 ± 2.8 hours (range, 3-18 hours). In addition to myectomy, 15 patients (62.5%) underwent mitral valve repair (anterior mitral leaflet plication) and papillary muscle release, and 1 patient (4.1%) required aortic cusp repair because of iatrogenic damage during retraction. The mean intensive care unit duration was 32.4 ± 9.5 hours (range, 23-51 hours), and the mean hospitalization duration was 6.5 ± 1.8 days (range, 5-11 days). The early postprocedural data are presented in Table 3.

The mean posttreatment LVOT gradient at 1 year was significantly decreased in both groups (from 65 ± 16 mm Hg to 14 ± 5 mm Hg in the PSMA group, P = .001; from 72.5 ± 20 mm Hg to 16 ± 4 mm Hg in the SM group, P < .001). The decreases in the LVOT gradient in the 2 groups were similar; however, conduction problems were more frequent in the PSMA group (P = .001). Such conduction disturbances were seen in 10 cases (62.5%) in the PSMA group, versus only 3 cases (12.5%) in the SM group (P = .01).

Table 3. Postprocedural Duration and Complications*

	PSMA Group	SM Group
Mechanical ventilation duration, h	—	6.3 ± 2.8
ICU duration, h	24 ± 2.8	32.4 ± 9.5†
Hospitalization duration, d	4.3 ± 0.9	6.5 ± 1.8‡
Reintervention, n	1 (6.2%)	—
Reoperation, n	—	1 (4.2%) (for bleeding)

*Mechanical ventilation, intensive care unit (ICU), and hospitalization durations are presented as the mean ± SD. PSMA indicates percutaneous septal myocardial ablation; SM, surgical myectomy. †P = .01; ‡P = .02.

The mean postprocedural NYHA class was improved to 1.5 ± 0.7 in the PSMA group ($P < .05$) and to 1.41 ± 0.6 in the SM group ($P < .05$)

After the procedure, moderate MR (grades II-III) was regressed in only 2 patients (33.3%) in PSMA group, whereas 11 patients (84.6%) in SM group experienced moderate MR regression ($P = .02$).

DISCUSSION

HOCM is a disease with a high rate of morbidity and mortality. In the classic form of this entity, the hypertrophy is maximal in the superior portion of the ventricular septum and is placed adjacent to the free edge of the anterior mitral leaflet [Zhu 2006]. Even in the absence of symptoms, HOCM patients are at high risk of sudden death. Sigwart and colleagues [Sigwart 2001] identified 5 risk markers in such patients: a family history of sudden death, unexplained syncope, nonsustained tachycardia on Holter monitoring, an abnormal blood pressure response to exercise, and severe left ventricular hypertrophy (>3 cm). Two or more of these risk markers may indicate an annual sudden-death rate of greater than 2% for these patients [Ferrari 2001; Sigwart 2001].

PSMA is a newly popular method for treating HOCM refractory to medical therapy. With Sigwart's [2001] and Ivens' [2004] pioneering studies, this percutaneous method was developed to decrease septal thickness by iatrogenic infarction. During this procedure, ethanol is injected into 1 or more septal branches of the LAD; this action sometimes may lead to conduction problems such as bundle blocks and even complete heart blocks. Injecting alcohol into the septal branches of coronary arteries creates a localized infarct in the basal septum and decreases the LVOT gradient. Accurate targeting of the right branches and injecting the alcohol into the correct spot in the myocardium are essential. This technique can be performed under local anesthesia in a short time and is considered a less invasive alternative to surgery. The main benefit of PSMA over surgery is the avoidance of sternotomy and cardiopulmonary bypass. Although PSMA can reduce the septal thickness and the LVOT gradient, it usually cannot correct SAM [Sitges 2003]. A residual MR often continues in the postprocedural period [Gietzen 1999; Seggewiss 1999; Lakkis 2000]. In addition, the rate of permanent pacemaker implantation is higher in patients who undergo PSMA. There may be an increased risk for ventricular arrhythmia following PSMA. This technique can be considered for a specific group of patients, such as elderly individuals or those with comorbid conditions that render surgical treatment risky [Lever 2006].

SM reduces septal thickness effectively and provides a satisfactory decrease in the LVOT gradient, thus allowing the correction of any mitral abnormality. It is the gold standard for treatment of severely symptomatic patients with HOCM refractory to medical therapy. Left ventricular outflow obstruction is usually associated with abnormal SAM of the anterior mitral leaflet, and this condition leads to MR. Mobilization of the papillary muscles is the most important step in the relief of SAM [Marwick 1992]. Data derived from echocardiographic studies support the contention that surgical plication can limit SAM [Schoendube 1995] by decreasing the size of the leaflet and the attendant drag forces and can reduce chordal and leaflet slack [Talreja 2004]. Intraoperative echocardiography is useful to ensure that an adequate degree of correction has been achieved with the surgical treatment [Cooley 1991; Schoendube 1995; Talreja 2004]. In the SM group, we performed anterior mitral leaflet plication and papillary muscle mobilization in 15 patients (62.5%) in order to avoid prosthetic valve replacement and its inherent long-term complications.

In 2 studies that compared the outcomes for PSMA and SM, the 2 treatments were found to be similar with respect to LVOT gradient reduction and symptom relief: the results for these 2 treatment modalities were nearly the same [Yoerger 2003; Ralph-Edwards 2005; Yacoub 2005]. However, surgical treatment seemed to be more successful in addressing SAM and MR. Surgery, according to some authors, may carry more mortality and morbidity compared with PSMA [van der Lee 2005]. Previous studies have reported SM mortality rates ranging from 0% to 6% [Roberts 2005]. In addition, iatrogenic ventricular septal defect formation is more frequent with SM.

In this study, the preprocedure LVOT gradient was higher in the SM group, and the slightly significant difference in LVOT gradient noted between the 2 groups may be due to septal thickness.

After 1 year of follow-up, the 2 groups were similar with respect to LVOT gradient reduction, NYHA class improvement, and reduction in septal thickness. In the PSMA group, however, conduction problems were more frequent. The correction of MR was more successful in the SM group. The LVOT gradient decreased early in the postprocedural period in the SM group, but decreased slowly in the PSMA group. Despite the use of anesthetics, sternotomy, and cardiopulmonary bypass, SM was more successful than PSMA in our small series of HOCM patients.

Our findings have shown that PSMA may be recommended for patients who are clinically less symptomatic, demonstrate a lower LVOT gradient, and have a lower MR grade.

In conclusion, the treatment of HOCM is still a challenge in cardiac surgery, even though the surgical method has been technically modified and has demonstrated good clinical results. Our experience suggests that symptomatic HOCM and MR are an indication for the surgical option.

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