Alcohol Septal Ablation Versus Surgical Septal Myectomy
Comparison of Effects on Atrioventricular Conduction Tissue

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OBJECTIVES

This study was designed to evaluate the effect of septal reduction therapies on the conduction system for patients with hypertrophic cardiomyopathy (HCM).

BACKGROUND

Heart block is a potential complication of both catheter-based and surgical procedures to relieve left ventricular outflow tract obstruction in HCM, but it is important to understand the different effects of these treatments on the conduction system.

METHODS

The electrocardiograms and postoperative course of patients who underwent percutaneous alcohol septal ablation or surgical myectomy at Mayo Clinic between 1999 and 2003 were reviewed.

RESULTS

For the 58 patients who underwent alcohol septal ablation, 21 (36%) developed right bundle branch block. Six patients (12%) developed complete heart block requiring permanent pacing, three of whom had left bundle branch block before the procedure. Among the 117 patients who underwent surgical septal myectomy, 47 (40%) developed left bundle branch block. Four patients (3%) developed heart block requiring permanent pacing after the procedure, three of whom had right bundle branch block preoperatively.

CONCLUSIONS

Percutaneous septal ablation selectively produces transmural infarction of the basal mid-septum and adjacent right bundle tissue, whereas surgical myectomy affects the endocardial portion of the basal anterior septum and adjacent left bundle tissue. These observations may help identify patients at risk for complete heart block after septal reduction procedures for HCM.

Surgical myectomy is the gold standard for treatment of severely symptomatic patients with hypertrophic cardiomyopathy (HCM) and obstruction who are refractory to medical therapy (1,2). Catheter-based alcohol injection into the septal coronary arteries to create a localized infarct in the basal septum has evolved as a less invasive alternative to surgery (3,4). These therapies relieve left ventricular outflow tract (LVOT) obstruction by ablating or removing myocardial tissue in the ventricular septum and can cause damage to the adjacent bundle branches, resulting in complete heart block (CHB) (5,6). Because specific, but different, portions of the ventricular septum are affected by each procedure, the risk of postprocedural heart block may depend on pre-existing conduction abnormalities as well as the type of intervention.

METHODS

Patient selection. Patients with HCM who underwent percutaneous alcohol septal ablation or surgical septal myectomy at Mayo Clinic between July 1999 and December 2003 were identified from the Mayo Clinic HCM database. All patients were severely symptomatic (New York Heart Association functional class III to IV) and had the diagnosis of HCM established by two-dimensional echocardiography with a dynamic LVOT obstruction (gradient >50 mm Hg at rest or with provocation). This study was approved by the Mayo Clinic Institutional Review Board, and informed consent was obtained from all patients.

Of the 65 patients who underwent septal ablation therapy, seven were paced before the procedure and were excluded from the study. The remaining 58 patients made up Group 1. Of the 131 patients who underwent surgical septal myectomy, 14 were paced before the procedure and were excluded. The remaining 117 patients made up Group 2.

Clinical data. Standard resting 12-lead electrocardiograms were recorded before and after the procedure (30 ± 100 days) and blindly reviewed. All patients underwent continuous electrocardiographic monitoring after their procedure for at least three days.

Catheterization procedure. Percutaneous alcohol septal ablation was performed as previously described (3,4). Ascending aortic pressure and high-fidelity measurements of left ventricular and left atrial pressures were continuously recorded throughout the procedure, and a temporary pacing catheter was placed in the right ventricle. Following coronary angiography, an angioplasty balloon was used to occlude the artery (or arteries) that supplied the basal ventricular septum identified by contrast fluoroscopy and echocardiography. One to 3 ml of ethanol was then injected...
over 5 to 15 min into the artery (or arteries) to cause a localized infarct. Abolition of the LVOT gradient and localization of the infarction by echocardiography were used as end points.

**Surgical procedure.** The septal myectomy operation was performed through a transaortic approach, creating a rectangular trough by making two parallel longitudinal incisions in the basal septum (2). Incisions were connected proximally below the aortic valve and extended distally just beyond the level of mitral–septal contact or, in some patients, to the base of papillary muscles (i.e., extended myectomy). Intraoperative transesophageal echocardiography was performed in all patients to document relief of obstruction and mitral regurgitation.

**Pathology.** For the patients who underwent the surgical procedure, resected myocardium was evaluated for the presence of left bundle branch block (LBBB) tissue as end points. Conduction tissue was seen in 20 (37%). Histologic analysis of resected myocardium revealed left bundle tissue in 44 patients (38%). Of the four patients who postoperatively developed LBBB, none (0%) developed RBBB, and 6 (12%) developed persistent CHB (Table 1). Of the four patients with a preoperative LBBB developed CHB. Of the six requiring PPM, three patients developed CHB during the procedure, which persisted at least several hours after the procedure, and underwent PPM implantation. Three patients had transient heart block during the injection of alcohol that lasted for 1 to 10 min with return of normal sinus rhythm but subsequently developed CHB, with implantation of a PPM at 1 (1 patient) and 3 (2 patients) days after the procedure. At follow-up, two of the patients who underwent implantation of a PPM remained pacemaker dependent. In the logistic regression analysis, LBBB was the only independent predictor of need for a PPM secondary to CHB.

**Group 2—surgical septal myectomy.** For the 117 patients who underwent surgical septal myectomy, the mean age was 49 years, and 65 were men. The average outflow tract gradient was 59 mm Hg preoperatively and 7 mm Hg postoperatively (p < 0.0001). Overall, 47 patients (40%) postoperatively developed LBBB, none (0%) developed RBBB, and 4 (3%) developed CHB (Table 1). Of the four patients requiring PPM, two developed atrial fibrillation two days postoperatively with transient episodes of CHB, underwent implantation of a PPM, and were not pacemaker dependent on follow-up. The remaining two patients developed CHB (Table 1) immediately postoperatively that persisted >2 days, underwent PPM placement, and were still pacemaker dependent at follow-up. Among the five patients with preoperative RBBB, three required a PPM after septal myectomy for CHB. For the 102 patients with a normal QRS preoperatively, only 1 (1%) developed CHB and the need for a PPM.

Histologic analysis of resected myocardium revealed left bundle tissue in 44 patients (38%). Of the four patients who developed CHB requiring a pacemaker, conduction tissue was found in two. Of the 57 patients with postoperative LBBB, conduction tissue was identified in 21 (37%). Of the 54 patients with normal conduction at the end of the procedure, conduction tissue was seen in 20 (37%).

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<thead>
<tr>
<th>Table 1. Pre- and Postprocedural Atrioventricular Conduction Patterns</th>
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<tr>
<td><strong>Alcohol Ablation</strong> (n = 58)</td>
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<tr>
<td><strong>Preoperative Conduction Pattern</strong></td>
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<tr>
<td>Normal (n = 52)</td>
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<tr>
<td>LBBB (n = 0)</td>
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<tr>
<td>RBBB (n = 21)</td>
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<td>CHB (n = 3)</td>
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<td>RBBB (n = 2)</td>
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<td>CHB (n = 0)</td>
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<td>LBBB (n = 4)</td>
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<td>CHB (n = 3)</td>
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CHB = complete heart block; LBBB = left bundle branch block; RBBB = right bundle branch block.
**DISCUSSION**

Conduction system defects are complications of both septal myectomy and septal ablation. The frequency of CHB requiring pacing after septal ablation has varied from 10% to 33% (4–6,8). In contrast, the rate of postprocedure CHB requiring pacing after surgical septal myectomy has remained low among experienced surgeons and, as shown herein, is <1% in the absence of a pre-existing RBBB (1,2). The high incidence of CHB in early series of alcohol septal ablation may have resulted from rapid administration of relatively large volumes of ethanol. In more recent studies, injection of smaller doses of ethanol (1 to 2 ml) over longer time periods (5 to 10 min) has decreased the incidence of CHB (6). Risk factors for CHB in other studies were LBBB, first-degree atrioventricular block, female gender, volume of alcohol, and number of septal perforators treated (5,6,8). These findings are supported by the data herein, where an underlying LBBB was the major risk factor for CHB.

The most common electrocardiographic change seen after alcohol septal ablation is the development of RBBB, as opposed to a LBBB, in patients after surgical septal myectomy. The different effects of alcohol septal ablation and surgical septal myectomy on the cardiac conduction system can be explained by differences in their mechanisms and locations for achieving septal remodeling and relief of outflow tract obstruction (Fig. 1). Percutaneous septal ablation creates a transmural septal infarct midway between the anterior and inferior free walls. Because this area also contains the cord-like right bundle, infarction commonly results in electrocardiographic RBBB. The total area of infarction, however, is dependent upon the region supplied by the varied course of the septal perforator arteries. Thus, if the left bundle is in the distribution of the targeted septal perforator artery, CHB cannot be avoided. In addition, if there is an underlying LBBB, the incidence of heart block is higher.

In contrast, the left bundle represents a broad subendocardial sheet of specialized conduction tissue. Surgical septal myectomy removes a large area of subendocardial tissue in the anterior portion of the septum, which can affect the left bundle conduction. Distortion and traction of the septal endomyocardium and left bundle may further impair electrical conduction, as may subsequent fibrosis along the incision surface (neo-endocardium) and adjacent left bundle fibers. The surgical technique avoids the deeper right bundle, which is located more in the middle and inferior portion of the septum.

**Study limitations.** Statistical analysis is limited by the sample size of the study. Although no patient in this study developed CHB after >72 h, the late development of CHB cannot be ruled out (5). There were patients who underwent implantation of a PPM for CHB in the perioperative period but were not pacemaker dependent upon follow-up. Further data are needed to determine the optimal timing and indication for a PPM after the onset of CHB following these procedures.

**Conclusions.** Patients with baseline RBBB are more likely to need long-term pacing after surgical septal myectomy, whereas those with LBBB are more likely to need pacing after alcohol septal ablation. An understanding of the mechanical effects of both procedures on the bundle branches should allow better prediction of the risk of CHB for individual patients. These data also support electrocardiographic monitoring for at least 72 h following septal reduction procedures.

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REFERENCES