Surgical Versus Alcohol Septal Ablation for Hypertrophic Obstructive Cardiomyopathy
The Pendulum Swings

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Since the original description of hypertrophic cardiomyopathy by Donald Teare and Lord Brock nearly 50 years ago, management of this condition has attracted the attention of surgeons, clinical and intervention cardiologists, epidemiologists, and, more recently, molecular biologists. To date, the emphasis has been directed toward symptomatic patients or those who are at high risk of dying or developing severe symptoms. The association between left ventricular outflow tract obstruction and poor outcome was recognized since the initial description of the condition, which resulted in Lord Brock attempting to surgically dilate the left ventricular outflow tract (LVOT). More recently it was shown that the LVOT obstruction is an independent predictor of progression to severe symptoms of heart failure and death, and this has stimulated additional intensive studies to define the exact pathophysiology of the obstruction. Although the main cause of the obstruction is the abnormal bulge of the interventricular septum into the outflow tract, the mitral valve plays an important role in producing the obstruction with echocardiographic demonstration of systolic anterior motion (SAM) of the mitral valve, SAM being an essential feature of diagnosing obstruction. The cause of SAM is multifactorial and is thought to be produced by the Venturi effect, which is produced by acceleration of blood secondary to the septal bulge and upward displacement of the line of coaptation of the posterior to the anterior leaflet of the mitral valve, ending in a more mobile distal part of the anterior leaflet. Other factors include anterior displacement of the anterior papillary muscle and fusion of the papillary muscle to the lateral left ventricular wall as well as other structural abnormalities. The close interaction between the mitral valve and LVOT stems from the fact that the 2 structures share the same orifice in the LV myocardium, with the subaortic curtain and anterior mitral leaflet separating them. The subaortic curtain is a dynamic structure that moves backward and forward during the cardiac cycle to allow maximal expansion of the LVOT during systole and the mitral orifice during diastole. The right and left fibrous trigones act as a hinge mechanism for this movement. In hypertrophic obstructive cardiomyopathy (HOCM), the subaortic curtain tends to be displaced forward and, importantly, occasionally may become partially immobilized by deposition of fibrous tissue over both trigones, interfering with their movement in a manner similar to that observed in congenital fixed aortic stenosis. With modern imaging techniques it is possible to define the exact anatomic abnormalities, which should guide treatment.

Surgical Relief of LVOT Obstruction in HOCM

Goodwin and colleagues, who suggested the term obstructive cardiomyopathy rather than asymmetric septal hypertrophy (used by Donal Teare), reported marked improvement in symptoms in 1 patient after excision of “subaortic hypertrophic muscle” using open heart surgery performed by Cleland in November 1958. Shortly afterward, Morrow and colleagues at the National Institutes of Health described myotomy, which gradually evolved into limited and then extensive guided myectomy. The operation consists of defining and excising the part of the septum responsible for obstruction; this usually extends from below the attachment of the right coronary cusp to a level below the anterior papillary muscle. Circumferentially the excised muscle extends from the level just to the right of the mid-point of the base of the right coronary cusp to the junction of the muscular septum to the subaortic curtain laterally with mobilization of the left fibrous trigone, if fused. The depth of the wedge of muscle is determined by measurements of thickness of the septum determined echocardiographically both before and intraoperatively. Perforation of the septum can therefore be avoided while ensuring complete or near-complete relief of obstruction. Similarly, the circumferential extent of resection should be wide enough but not encroach on the area of the junction of the membranous and muscular septum, leaving a margin of 6 mm, to avoid complete heart block. In addition, care should be taken not to injure or disturb the aortic valve. Fusion of the anterior papillary muscle to the left lateral wall is mobilized if present, and additional abnormalities of the mitral valve are then corrected. Some surgeons add plication of the anterior mitral leaflet or patch insertion (as reported by Van der Lee et al in this issue of Circulation) to correct the abnormal tension of the chordae and possibly increase the available LVOT space during systole. These 2 additional techniques are not widely used. Mitral valve replacement

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with a low profile valve has been advocated for severe cases, however, the long-term results of this procedure have been less than optimal. In contrast, guided myectomy has given excellent immediate results both in terms of relief of obstruction and abolished or improved mitral regurgitation. The mortality rate from this operation in experienced centers is 0% to 2% for patients undergoing the operation without additional procedures. Rapid relief of LVOT obstruction, initial regurgitation, and symptoms occurs and is maintained for long periods—≥30 years with low incidence of reoperation, which could have been caused by inadequate relief of obstruction during the first operation. The effect of the operation on sudden death and progression to left ventricular dysfunction is difficult to ascertain in the absence of randomized trials. Complete heart block and need for permanent pacing are rare: ~2%; similarly, postoperative trivial or mild aortic regurgitation have been reported. The operation is believed to reduce the incidence of atrial fibrillation and the size of the left atrium, which are known to be poor prognostic indicators in these patients. New serious ventricular arrhythmias or sudden death have not been reported. The main disadvantages of the operation are its invasiveness (including the use of cardiopulmonary bypass) and the cost of and need for access to an experienced surgical team with a deep interest in the condition.

## Alcohol Septal Ablation

In 1995, Sigwart introduced the ingenious percutaneous technique of producing a localized septal infarct by defining, isolating, and then injecting alcohol into ≥1 septal arteries supplying the part of the hypertrophied septum believed to be producing the obstruction. This resulted in immediate partial relief of the obstruction, followed by gradual diminution in the outflow gradient during a period of up to 1 year. This technique is associated with improvement in symptoms and, importantly, the degree of mitral regurgitation. This procedure has captured the imagination of both clinicians and patients, with an extremely rapid increase in the application of the procedure. During the subsequent 6 years, >2000 such procedures were performed, which is thought to be more than the total number of the surgical procedures performed during the last 45 years. It is estimated that in the present era, alcohol ablation accounts for ~90% of procedures performed for the relief of LVOT obstruction in HOCM. Although the indications for alcohol ablation should be the same as those for surgery, there is a suspicion that certain groups have widened the use of medications because of the relatively noninvasiveness of the procedure and its perceived benign nature. Cumulative experience has shown that the procedure has some limitations and is not without complications. Although at least some of the complications are avoidable, others may not be. The main limitation of alcohol ablation is the lack of precision in targeting the whole area of myocardium causing the obstruction, without injuring the surrounding myocardium. For example, although myectomy produces left bundle-branch block, alcohol ablation tends to produce right bundle-branch block. The procedure is also associated with a relatively high incidence of complete heart block (between 10% and 20%), as well as serious ventricular arrhythmias in the first few days after the operation and possibly later. This is thought to be caused by narcotic infarct and later scarring. The influence of a large septal infarct on global left ventricular function needs to be defined further. Targeting the area of myocardium by contrast echo and injecting smaller amounts of alcohol could prevent or reduce the incidence of many of the complications. Another important limitation of the procedure is the inability to cope with additional cardiac lesions.

## Comparative Studies

To date, there have been no prospective randomized trials designed to formally compare the results of surgery versus alcohol ablation. A small number of observational retrospective studies in 1 or 2 centers have been reported. In this issue of Circulation, Van Der Lee and colleagues report the 1-year outcome of 44 patients undergoing alcohol ablation as compared with 29 historical controls who had surgical myectomy combined with patch enlargement of the anterior leaflet of the mitral valve. The 2 groups were chosen to undergo enlargement of the anterior leaflet of the mitral valve. Although this produces better matching of the 2 groups before the procedures, it does introduce a potential source of error in interpreting the results and to some extent limits the applicability of the results to all patients requiring relief of LVOT. Nevertheless, this article is a welcome addition to the literature because it originates from an extremely experienced coronary intervention laboratory, and the authors, after a detailed analysis, were prepared to publish relatively negative results for alcohol ablation, which can only help progress in the field. Their analysis showed an early mortality rate of 5% caused by refractory ventricular fibrillation during the procedure after induction of the infarct in one patient and caused by cardiac tamponade resulting from perforation of the right ventricle by the pacing wire in another. Interestingly, 5 (10%) other patients developed ventricular fibrillation during the first 24 hours and another patient developed late serious ventricular tachyarrhythmias requiring insertion of an implantable cardioverter-defibrillator. Other series of septal ablation have reported ventricular arrhythmias at different stages, but the exact incidence, time, causes, and treatment require further study. In contrast, long experience with surgical myectomy did not show either early or late incidence of increased arrhythmias, which suggests that removal of the muscle as opposed to leaving an infarct could be responsible for these arrhythmias. Another patient in the Van Der Lee et al series developed a large anterior infarct, thought to be caused by spilling alcohol into the left anterior descending coronary artery. The incidence of complete heart block was 10%, which is similar to other series of septal ablations and is higher than that reported after myectomy (~2%). With regards to efficacy and the need for further intervention after alcohol ablation, patients developed considerable symptomatic benefit with NYHA class at 1 year changing from a preprocedure level of 2.4±0.5 to 1.5±0.7; however, this level was less than that after myectomy (NYHA class moving from 2.8±0.4 to 1.3±0.4). This was mirrored by the changes in SAM and to some extent the LVOT gradients, and severity of mitral regurgitation. In addition, 4 patients (10%) in the septal...
ablation group required reintervention within 1 year for inadequate relief of obstruction, whereas only 1 patient in the surgical group required reoperation for partial detachment of the mitral patch. As the authors mention, the timing of improvements in LVOT gradient is different in patients undergoing septal ablation, which tends to evolve over time, as opposed to surgical treatment, which results in immediate change. Whether these differences are of clinical importance requires additional studies. Finally, the authors report increases in left ventricular and systolic volume after septal ablation but not in the surgical group: Whether this is useful to enhance stroke volume or represents the beginning of progressive systolic left ventricular dysfunction is unknown.

Conclusion and Future Directions
Available evidence has shown that both surgical and alcohol ablation can produce significant improvement in symptoms, hemodynamic status, and structural abnormalities in symptomatic patients with LVOT obstruction. The extent of improvement is more marked after surgical treatment. In addition, the incidence and range of complications after both procedures are different. Surgical treatment is presently the preferred option for young patients with severe disease and for those with additional structural changes in the mitral valve or coronary arteries. For the remaining patients, there is a pressing need for initiating a prospective randomized trial to establish the place of each form of therapy rather than allow the pendulum to continue to swing. Intensive efforts to recognize the disease at population level and establish the relationship between the genotype and phenotype of the disease should also help in optimizing the treatment of these patients.

References