

EDITORIAL COMMENT

To Ablate or Operate? That Is the Question!*

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In this modern era of management of various cardiovascular disorders, surgical therapy has virtually always preceded the development of percutaneous techniques. This has been the case with myocardial revascularization (aortocoronary bypass surgery vs. angioplasty), procedures for mitral stenosis (surgical commissurotomy vs. balloon valvuloplasty) as well as for the management of certain congenital heart defects such as patent ductus arteriosus or atrial septal defect (surgical closure vs. percutaneous device closure). In each instance, surgery has proven the value of these procedures; subsequently, the percutaneous techniques have attempted to match the surgical results. With all of these techniques, there is obviously a learning curve involved in both the surgical and interventional procedures.

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This same sequence has now occurred in the management of hypertrophic obstructive cardiomyopathy (HOCM). Surgical myectomy for severely symptomatic patients with subaortic obstructive hypertrophic cardiomyopathy (HCM) has been performed for some 40 years (1–5), and several centers have been continuously involved in this type of surgery for this entire period of time (3–9). Even medical therapy followed the surgical approach in the management of HOCM (10). Subsequently, atrioventricular (AV) sequential pacing has been used to reduce the severity of the obstruction in HOCM. Although initial results suggested that pacing was a panacea for the management of these patients (11), randomized controlled trials provided less favorable results, in that there was incomplete gradient reduction, and objective evidence of symptomatic improvement was lacking (12–14). One study (15) demonstrated that surgery provided greater benefit than pacemaker therapy.

In 1995, Sigwart (16) first described the effect of occluding a septal perforator artery with ethanol on the pressure

gradient in HOCM. The procedure, which results in a localized septal infarction, was referred to as nonsurgical septal reduction therapy (NSRT). Subsequently, two German centers have reported extensive experience in many hundreds of patients (17,18). Seggewiss and associates (17) have referred to the procedure as percutaneous transluminal septal myocardial ablation (PTSMA), while Gietzen and associates (18) have termed the procedure transcatheter ablation of septal hypertrophy (TASH). The largest North American experience with septal ethanol ablation has been that of Spencer and colleagues from Baylor College of Medicine in Houston (19).

Evidence has been accumulating that the amount of ethanol used and the number of septal perforator arteries ablated determine the height of the creatine kinase (CK) rise (the size of the induced infarction), the degree of acute gradient reduction, the incidence of complete heart block and mortality (17–19). The introduction of myocardial contrast echocardiography by Faber et al. (20) allows for the correct identification of the appropriate septal perforator to be occluded and the avoidance of occluding septal perforators that supply distant areas of the myocardium such as the papillary muscles or the free wall of the left or right ventricle. The observation that there is further gradient reduction in the year following the procedure (17) has led to a less aggressive approach in terms of the amount of ethanol used and the number of vessels ablated during the procedure, with a resultant decrease in the incidence of heart block (9,17–19).

In this issue of the *Journal*, Nagueh et al. (9) report on the first attempt to compare the results of ethanol septal reduction therapy with surgical myectomy in the treatment of HOCM. Although several centers with extensive surgical experience are also now performing alcohol ablation procedures (21,22), no one center has extensive experience with both techniques. Thus, to compare the results of the two techniques, the investigators have compared the results of the Baylor Group with the largest North American experience using alcohol ablation, with age and gradient (but not gender)-matched patients from the surgical experience at the Mayo Clinic (9). At baseline the two groups were well matched as to age, symptomatic status, severity of obstruction and related mitral regurgitation and the types of medication. Both groups contained a significant number of patients with permanent pacemakers implanted for the therapy of HOCM (not for heart block). The fact that so many of these patients with implanted pacemakers subsequently required a second intervention speaks for itself.

The results in the two groups at one year of follow-up were remarkably similar in terms of mortality, gradient reduction, symptomatic benefit, objective measures of improved exercise tolerance, and echocardiographic parameters, including the degree of mitral regurgitation (9). After NSRT, the incidence of pacemaker implantation for com-

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plete heart block was significantly higher than in the surgical cohort (22% vs. 2%). However, seven of nine pacemakers in the NSRT group were implanted prior to the procedural modifications previously mentioned, which involve the use of myocardial contrast echocardiography to correctly identify the target vessel, and to bring about slower injections and smaller amounts of ethanol, and acceptance of a higher residual gradient immediately following the procedure, knowing that the gradient progressively lessens over the first year of follow-up (17).

One NSRT patient had an implantable cardioverter-defibrillator (ICD) implanted for sustained ventricular tachycardia, following the procedure, whereas four surgical patients had an ICD implanted postoperatively; one for preoperative ventricular fibrillation and three for ventricular arrhythmias and risk factor profiles.

In the surgical group, there was a higher postoperative incidence of mild (10 patients) or moderate (1 patient) aortic regurgitation and a greater use of beta-blockers and calcium blockers that was said to be institution-specific and not related to gradient reduction. Postoperative atrial fibrillation occurred only in the surgical group, but all patients were discharged in normal sinus rhythm.

COMMENTS

It is important to stress that all patients in this study (9) suffered from subaortic obstructive HCM and not midventricular obstruction. The severity of the subaortic obstruction and the concomitant mitral regurgitation are directly related to the severity of the mitral leaflet systolic anterior motion (23-26). Previous surgical (22-26) and ablation (16-19,22) studies have demonstrated that thinning of the septum and widening of the outflow tract are associated with a decrease or abolition of systolic anterior motion, the pressure gradient and mitral regurgitation. In approximately 20% of patients, there is a structural abnormality of the mitral valve such as anomalous papillary muscle or mitral valve prolapse, which can cause mitral regurgitation (23) and which is often anteriorly or centrally directed into the left atrium, allowing distinction from the posteriorly directed mitral regurgitation, related to systolic anterior motion (25,26). Patients with structural abnormalities of the mitral valve or with midventricular obstruction were excluded from the present study. Patients with latent or provokable obstruction were also excluded because the techniques to provoke the obstruction in the two institutions were not comparable.

CONTRIBUTIONS OF THE STUDY

The essential contribution of this study (9) is the comparability of the results of NSRT and myectomy surgery for the treatment of severely symptomatic medically refractory subaortic obstructive HCM, when each procedure is carried out by experienced operators.

COMPLICATIONS

Nonsurgical septal reduction therapy. CORONARY ARTERY DISSECTION. Several major complications of NSRT were encountered in the Nagueh et al. study. There was one death due to coronary artery dissection that occurred with the use of a standard guide wire. Subsequently, the operators used a high-torque, floppy wire in an attempt to avoid this complication.

VENTRICULAR CONDUCTION DEFECTS AND HEART BLOCK. The occurrence of ventricular conduction defects with alcohol ablation (especially right bundle branch block) and complete heart block has been well recognized and requires the introduction of a temporary pacemaker wire prior to the procedure (16-19). With a refined and less aggressive technique, the incidence of dense heart block has significantly lessened but remains significant and is greater than that caused by myectomy surgery (9).

VENTRICULAR ARRHYTHMIAS. The third complication of alcohol ablation reported in this study was the occurrence of sustained ventricular tachycardia requiring ICD implantation. Several investigators have expressed concern about the possibility of inducing ventricular arrhythmias by causing a myocardial infarction in HCM patients, who are known to already have an arrhythmogenic milieu (27). At present, the risk of ventricular arrhythmias post-NSRT is unclear.

UNWANTED MYOCARDIAL INFARCTION. A fourth and dreaded complication of alcohol ablation, which did not occur in this study, is the occurrence of unwanted myocardial infarction distant from the planned septal infarction. An anterior infarction may occur if alcohol leaks back into the left anterior descending coronary artery, resulting in occlusion of that vessel (28). This is a well-recognized complication and has resulted in the death of some patients. Less well recognized is the occurrence of left ventricular free-wall or papillary muscle infarction, or right ventricular free-wall infarction, which can occur when a septal perforating artery supplies regions of the heart distant from the septum. Such vessels may be recognized and ethanol injection avoided by the use of myocardial contrast echocardiography (20). Mortality can occur from any of these complications of NSRT.

Surgery. VENTRICULAR CONDUCTION DEFECTS AND HEART BLOCK. Whereas the myotomy operation for HOCM produced a left anterior hemi-block in the majority of patients (4), myectomy surgery produces left bundle branch block in the majority and rarely causes complete heart block (7,8). In this series (9), 1 in 41 patients (2.4%) required a pacemaker for heart block, which is similar to other large surgical series (8). Thus, surgery has an advantage over NSRT in this respect.

AORTIC REGURGITATION. The incidence of postprocedure aortic regurgitation was greater (27%) in the surgical group than in the NSRT group (7%). We have previously reported

on the occurrence of aortic regurgitation following myectomy (29). It is almost always mild and has not been a clinical problem in 333 consecutive cases operated upon in this center over the past 23 years (8). We have speculated that the aortic regurgitation may result from the surgical removal of the immediate subaortic muscle, which may act as a support for the aortic valve. It is not due to valve damage at the time of surgery. Often, NSRT leaves a ridge of noninfarcted muscle in the immediate subaortic area, possibly explaining the reduced incidence of aortic regurgitation.

POSTOPERATIVE ATRIAL FIBRILLATION. Transient postoperative atrial fibrillation occurred in 20% of the surgical patients and in none of the NSRT patients. All surgical patients, however, were discharged in normal sinus rhythm. Atrial fibrillation in HCM is almost always related to left atrial enlargement, which is most frequently encountered in HOCM, possibly because of the concomitant mitral regurgitation (23-26). Both surgery (7,8) and NSRT (17-19) have been shown to reduce left atrial size postprocedure, which represents good atrial antiarrhythmic therapy for these patients. In our surgical series, left atrial size and the occurrence of early postoperative atrial fibrillation was a predictor of late postoperative atrial fibrillation (8).

Other complications that have previously been reported following myectomy and that did not occur in this series are surgically induced ventricular septal defect or mitral regurgitation (7,8).

Study limitations. The investigators have drawn attention to the fact that their study (9) was not a randomized trial and that the results are not generally applicable as both centers are experienced and expert in their respective procedures (9). The fact that no one center in the world today is equally experienced in both techniques makes randomized trials problematic. However, experienced surgical centers with moderate experience in alcohol ablation may represent the best opportunity for randomized studies in the future.

Additional considerations. The investigators (9) report only the follow-up data after one year. There are some very careful studies following ethanol ablation that indicate an acute reduction but not abolition of the resting and provoked gradient at the time of the procedure, with further progressive reduction in both resting and provoked gradients up to one year following the procedure (17). In our experience, surgery usually produces immediate abolition of the resting and provoked pressure gradient at the time of the procedure (4,7,8).

In the Nagueh et al. study, more than 40% in both groups had a permanent pacemaker at follow-up and 81% of the surgical patients and 30% of the NSRT patients were on negative inotropic drug therapy. Thus, the observed results of the procedures themselves are compromised by these additional treatment modalities, which also have the potential to reduce the obstruction. In addition, no information is provided on whether or not provokable gradients were

present in either group at follow-up. Provokable gradients are often still present one year after ablation therapy (17). In a surgical series, the best clinical results were obtained when there was no resting or provokable gradient postoperatively in the absence of pacemaker or drug therapy (4,7,8).

Nagueh and colleagues (9) have attributed the improved exercise performance following these procedures to a decrease in mitral regurgitation and improved diastolic function. Because the investigators report a high incidence of presyncope and syncope (presumably with exertion) before the procedures, and a markedly reduced incidence following the procedures, it would seem that relief of the outflow obstruction also played a significant role in explaining the improved exercise performance and relief of symptoms.

There have been reports of performing ethanol ablation following unsuccessful myectomy (17) and myectomy following unsuccessful ethanol ablation. Because myectomy almost always causes left bundle branch block and ethanol ablation causes right bundle branch block in 60% of cases (17,18), one would expect a very high incidence of complete heart block if both procedures were required in any given patient.

Advantages of ethanol ablation. These advantages include:

- 1) avoidance of cardiopulmonary bypass with attendant risks, especially in elderly patients;
- 2) shorter hospital stay in this series, although two large German series reported longer hospital stays to observe for delayed heart block (17,18);
- 3) shorter recovery time; and
- 4) less expense.

Advantages of myectomy surgery. These advantages include:

- 1) more immediate and complete relief of resting and provoked obstruction and concomitant mitral regurgitation;
- 2) smaller incidence of complete heart block, requiring pacemaker;
- 3) excellent long-term results (>20 to 30 years vs. 5 years for ablation);
- 4) no risk of coronary dissection or unwanted myocardial infarction;
- 5) no evidence in long-term studies that myectomy is arrhythmogenic;
- 6) ability to deal with concomitant problems such as mid-ventricular obstruction, constricting muscle bridges over the left anterior descending coronary artery, aortocoronary bypass surgery, right ventricular outflow obstruction, mitral valve repair or replacement for additional valvular problems; and
- 7) in a small but significant percent of patients, it is not possible to carry out NSRT for technical reasons, and NSRT may be less effective in younger patients with thicker septa (30) and in other specific circumstances.

Summary. This report (9), comparing the one-year follow-up results of septal ethanol ablation by the Baylor Group and the surgical myectomy results at the Mayo Clinic in the management of subaortic obstructive HCM, indicates that appropriate basal septal thinning by either technique provides comparable results. Although a nonrandomized study and not generally applicable because of the specialized experience with one technique in each center, the Nagueh et al. (9) study should provide the groundwork for future randomized trials. Such trials are most likely to occur in a number of surgical centers that have extensive experience with myectomy and that now have several years of experience with ethanol ablation. Finally, one cannot help but comment that there no longer appears to be any debate about the significance of the subaortic pressure gradient in HOCM. Now the debate is whether to ablate or operate!

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REFERENCES

- Cleland WP. The surgical management of obstructive cardiomyopathy. *J Cardiovasc Surg (Torino)* 1963;4:489-91.
- Morrow AG, Brockenbrough EC. Surgical treatment of idiopathic hypertrophic subaortic stenosis. Technic and hemodynamic results of subaortic ventriculomyotomy. *Ann Surg* 1961;154:181-9.
- Kirklin JW, Ellis FH Jr. Surgical relief of diffuse subvalvular aortic stenosis. *Circulation* 1961;24:739-42.
- Wigle ED, Chrysohou A, Bigelow W. Results of ventriculomyotomy in muscular subaortic stenosis. *Am J Cardiol* 1963;11:572-86.
- Schulte HD, Bircks WH, Loesse B, Godehardt EAJ, Schwartzkopff B. Prognosis of patients with hypertrophic obstructive cardiomyopathy after transaortic myectomy. *J Thorac Cardiovasc Surg* 1993;106:709-17.
- Beahrs MM, Tajik AJ, Seward JB, et al. Hypertrophic obstructive cardiomyopathy: 10-21-year follow-up after partial septal myectomy. *Am J Cardiol* 1983;51:1160-6.
- Williams WG, Wigle ED, Rakowski H, Smallhorn J, LeBlanc J, Trusler GA. Results of surgery for hypertrophic obstructive cardiomyopathy. *Circulation* 1987;76:104-8.
- Choi R, Woo A, Wigle ED, Rakowski P, Williams WG, Rakowski H. Long-term clinical follow-up of surgical myectomy for hypertrophic obstructive cardiomyopathy (abstr). *Circulation* 2000;102:II-694.
- Nagueh SF, Ommen SR, Lakkis NM, et al. Comparison of ethanol septal reduction therapy with surgical myectomy for the treatment of hypertrophic obstructive cardiomyopathy. *J Am Coll Cardiol* 2001;38:1701-6.
- Wigle ED, Adelman AG, Felderhof CH. Medical and surgical treatment of the cardiomyopathies. *Circ Res* 1974;34:II-196-207.
- Fananapazir L, Epstein ND, Curiel RV, Panza JA, Tripodi D, McAreavery D. Long-term results of dual-chamber (DDD) pacing in obstructive hypertrophic cardiomyopathy: evidence for progressive symptomatic and hemodynamic improvement and reduction of left ventricular hypertrophy. *Circulation* 1994;90:2731-42.
- Nishimura RA, Trusty JM, Hayes DL, et al. Dual-chamber pacing for patients with hypertrophic cardiomyopathy: a prospective randomized double-blind crossover trial. *J Am Coll Cardiol* 1997;29:435-41.
- Kappenberger L, Linde C, Daubert C, et al., for the PIC study group. Pacing in hypertrophic obstructive cardiomyopathy. *Eur Heart J* 1997;18:1249-56.
- Maron B, Nishimura R, McKenna WJ, Rakowski H, Josephson ME, Kievit RS. Assessment of permanent dual-chamber pacing as a treatment for drug-refractory symptomatic patients with obstructive hypertrophic cardiomyopathy (M-PATHY trial). *Circulation* 1999;22:2927-33.
- Ommen SR, Nishimura RA, Squires RW, Schaff HV, Dancielson GK, Tajik AJ. Comparison of dual-chamber pacing versus septal myectomy for the treatment of patients with hypertrophic obstructive cardiomyopathy: a comparison of objective hemodynamic and exercise end points. *J Am Coll Cardiol* 1999;34:191-6.
- Sigwart U. Non-surgical myocardial reduction for hypertrophic obstructive cardiomyopathy. *Lancet* 1995;346:211-4.
- Seggewiss H, Faber L, Gleichmann U. Percutaneous transluminal septal ablation in hypertrophic obstructive cardiomyopathy. *Thorac Cardiovasc Surg* 1999;47:94-100.
- Gietzen FH, Leuner CJ, Raute-Kreinsen U, et al. Acute and long-term results after transcatheter ablation of septal hypertrophy (TASH). Catheter interventional treatment for hypertrophic obstructive cardiomyopathy. *Eur Heart J* 1999;20:1342-54.
- Lakkis NM, Nagueh SF, Dunn JK, Killip D, Spencer WH. Nonsurgical septal reduction therapy for hypertrophic obstructive cardiomyopathy: one-year follow-up. *J Am Coll Cardiol* 2000;36:852-5.
- Faber L, Seggewiss H, Gleichmann U. Percutaneous transluminal septal myocardial ablation in hypertrophic obstructive cardiomyopathy. Results with respect to intraprocedural myocardial contrast echocardiography. *Circulation* 1998;98:2415-21.
- Woo A, Rakowski H, Ross J, et al. Percutaneous transluminal septal myocardial ablation for hypertrophic obstructive cardiomyopathy: initial results and clarification of mechanism of benefit (abstr). *Can J Cardiol* 1999;15:174D.
- Sitges M, Shiota T, Lever HM, et al. Evaluation of left ventricular outflow tract area after septal reduction in hypertrophic obstructive cardiomyopathy: a real-time three-dimensional echocardiographic study (abstr). *J Am Coll Cardiol* 2001;37 Suppl A:200A.
- Wigle ED, Sasson Z, Henderson MA, et al. Hypertrophic cardiomyopathy: the importance of the site and the event of hypertrophy: a review. *Prog Cardiovasc Dis* 1985;28:1-83.
- Wigle ED, Rakowski H, Kimball BP, Williams WG. Hypertrophic cardiomyopathy. Clinical spectrum and treatment. *Circulation* 1995;92:1680-92.
- Grigg LE, Wigle ED, Williams WG, Danie LB, Rakowski H. Transesophageal Doppler echocardiography in obstructive hypertrophic cardiomyopathy: clarification of pathophysiology and importance in intraoperative decision making. *J Am Coll Cardiol* 1992;20:42-52.
- Yu EHC, Omran AS, Wigle ED, Williams WG, Siu SC, Rakowski H. Mitral regurgitation in hypertrophic obstructive cardiomyopathy: relationship to obstruction and relief with myectomy. *J Am Coll Cardiol* 2000;36:2219-25.
- Spirito P, Maron BJ. Perspectives on the role of new treatment strategies in hypertrophic obstructive cardiomyopathy. *J Am Coll Cardiol* 1999;33:1071-5.
- Ruzyllo W, Chojnowska L, Demkow M, et al. Left ventricular outflow tract gradient decrease with non-surgical myocardial reduction improves exercise capacity in patients with hypertrophic obstructive cardiomyopathy. *Eur Heart J* 2000;21:770-7.
- Sasson Z, Prieur T, Skrobik Y, et al. Aortic regurgitation: a common complication after surgery for hypertrophic obstructive cardiomyopathy. *J Am Coll Cardiol* 1989;13:63-7.
- Seggewiss H, Faber L, Ziemssen P, et al. Age related acute results of percutaneous septal ablation in hypertrophic obstructive cardiomyopathy (abstr). *J Am Coll Cardiol* 2000;35 Suppl A:188A.