CASE REPORT

Endocardial septal ablation for hypertrophic obstructive cardiomyopathy

Hipertrofik obstruktif kardiyomiyopati için endokardiyal septal ablasyon

Tolga Aksu, M.D., Tümer Erdem Güler, M.D., Kıvanç Yalın, M.D.,# Şükriye Ebru Gölcük, M.D.,# Kazım Serhan Özcan, M.D.

Department of Cardiology, Kocaeli Derince Training and Research Hospital, Kocaeli, Turkey

#Department of Cardiology, Bayrampasa Kolan Hospital, İstanbul, Turkey

Summary– Septal reduction therapy (SRT) is the accepted therapeutic option for symptomatic hypertrophic obstructive cardiomyopathy (HOCM). At this time, surgical septal myectomy is the gold standard method, but alcohol septal ablation is an acceptable alternative treatment for patients with suitable anatomy. Endocardial septal ablation (ESA) therapy is a little-known method of SRT. Presently described is case of successful ESA procedure performed for HOCM.

Özet– Septumu inceltici tedavi (SAT) semptomlu hipertrofik obstrüktif kardiyomiyopati (HOKM) için kabul edilen tedavi seçeneğidir. Bugün için cerrahi septal miyoktemi altın standart yöntem olup, alkol ile septal ablasyon uygun anatomili hastalarda kabul edilebilir bir seçenektir. Endokardiyal septal ablasyon (ESA) ise SAT olarak az bilinen bir yöntemdir. Bu yazıda, HOKM için başarılı ESA işlemine giden bir olgu sunuldu.

Abbreviations:

ESA	*Endocardial septal ablation*
HOCM	*Hypertrophic obstructive cardiomyopathy*
ICD	*Intracardiac defibrillator*
LV	*Left ventricle*
LVOT	*Left ventricular outflow tract*
SAM	*Systolic anterior motion*
SRT	*Septal reduction therapy*
TASA	*Transcoronary alcohol septal ablation*
TTE	*Transthoracic echocardiography*

Hypertrophic obstructive cardiomyopathy (HOCM) presents with increased left ventricular outflow tract (LVOT) gradient. In most cases, basal septal hypertrophy and systolic anterior motion (SAM) of the anterior mitral leaflet are the key components to LVOT obstruction. The goal of septal reduction therapy (SRT), an accepted treatment modality, is to overcome this obstruction. Although myectomy is a well-established, effective surgical technique for SRT, transcoronary alcohol septal ablation (TASA) is an alternative for patients who have refused surgery or who are high risk for surgery.[1–3] However, a significant limitation of TASA is reliance on coronary anatomy to provide access to ablation target. The ratio of septal vessel anatomy unsuitable for TASA procedure varies from 1% to 2% up to 15% in the relevant literature.[4,5]

Endocardial septal ablation (ESA) of anterior mitral leaflet and septal contact point has been used as an alternative SRT in a small number of patients. However, precise targeting of SAM-septal contact area is imperative for success of the procedure. Presently described is successful management of HOCM in a 49-year-old man who underwent ESA.

CASE REPORT

A 49-year-old male presented at the clinic with complaints of dyspnea (New York Heart Association [NYHA] functional class III) and angina (Canadian Cardiovascular Society grade III). He had been in follow-up with symptomatic HOCM for 5 years despite maximum doses of metoprolol. Resting transthoracic echocardiography (TTE) (E33 xMATRIX; Philips Healthcare, Inc., Andover, MA, USA) revealed asymmetrical septal hypertrophy (Figure 1a). In addition,

Received: March 22, 2016 *Accepted:* May 11, 2016

Correspondence: Dr. Tolga Aksu. Kocaeli Derince Eğitim ve Araştırma Hastanesi, Kardiyoloji Kliniği, Kocaeli, Turkey.
Tel: +90 262 - 319 50 79 e-mail: aksutolga@gmail.com

typical SAM of the anterior mitral leaflet to interventricular septum was detected. Moderate mitral regurgitation due to SAM was also observed. There was no structural abnormality in the mitral valve. Baseline gradient in LVOT measured by continuous-wave Doppler echocardiography was greater than 100 mmHg (Figure 2a). Gradient increased to 200 mmHg after submaximal exercise electrocardiography.

Patient had undergone dual intracardiac defibrillator (ICD) implantation for primary prevention due to massive septal hypertrophy (32 mm) 1 year previously. We programmed ICD with short A-V delay to cause negative inotropic effect and some outflow tract opening due to delayed activation of the basal septum with 100% dyssynchronous pacing from right ventricle. Gradient reduction or symptomatic improvement

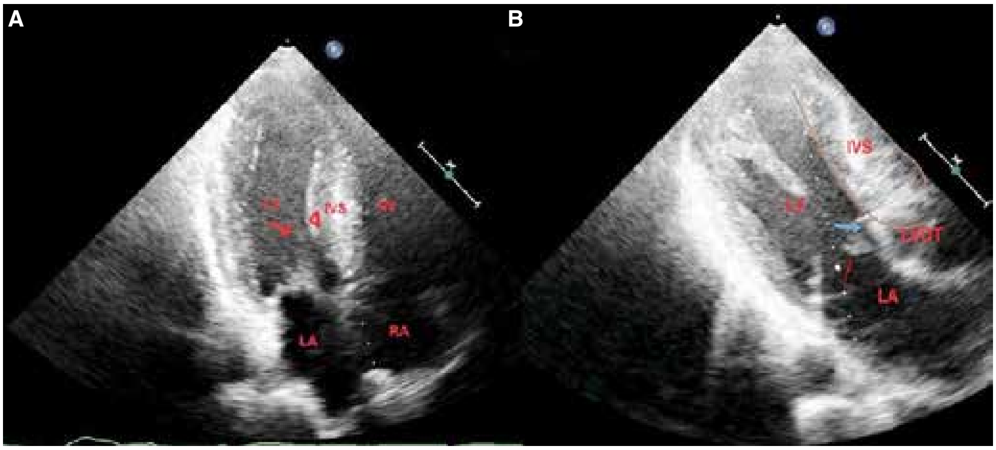

Figure 1. (A) Four-chamber view of asymmetrical septal hypertrophy and anterior mitral leaflet-interventricular contact. **(B)** Modified apical 4-chamber view demonstrating closeness of the ablation catheter to interventricular septum-anterior mitral leaflet contact point. **(A)** The arrow and arrowhead indicate anterior mitral leaflet and contact point of anterior mitral leaflet and interventricular septum. **(B)** Blue and red arrows indicate the ablation catheter and anterior mitral leaflet, respectively. Brown lines show the boundaries of the septum. IVS: Interventricular septum; LA: Left atrium; LV: Left ventricle; RA: Right atrium; RV: Right ventricle.

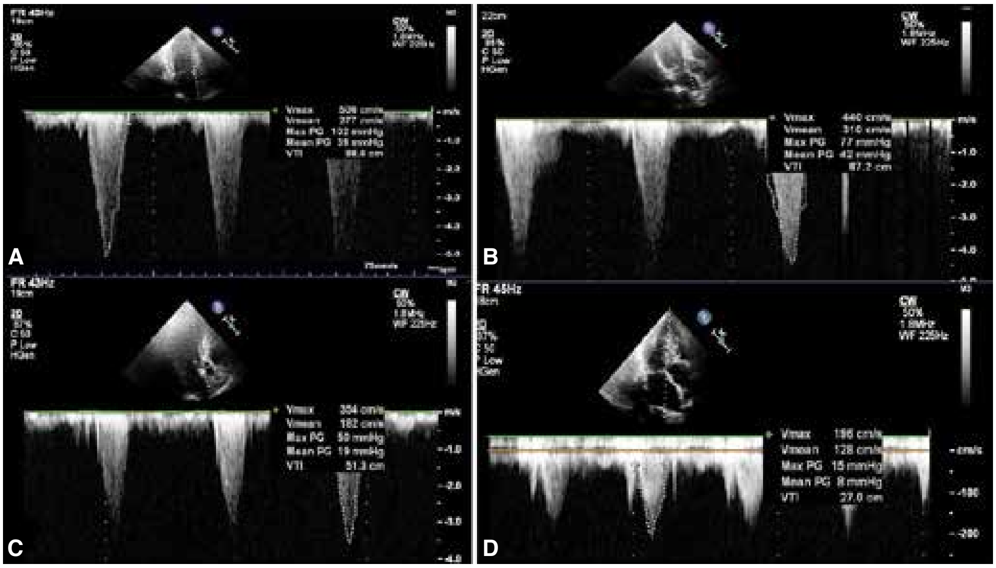

Figure 2. Reduced left ventricular outflow tract obstruction at rest. Gradient in the left ventricular outflow tract (continuous-wave Doppler) at rest **(A)** before (102 mmHg), **(B, C)** during, and **(D)** after (< 20 mmHg) the procedure.

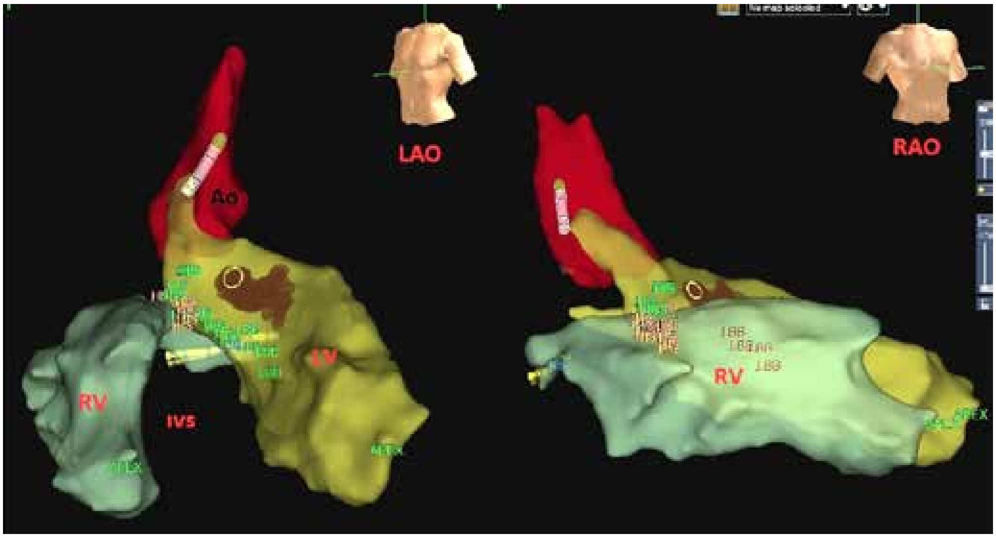

Figure 3. EnSite NavX system 3-dimensional maps of right and left ventricles. Three-dimensional maps of right ventricle (RV) and left ventricle (LV) created using Ensite NavX system. His and LBB labels indicate the bundle of His and left bundle branch, respectively. Brown points indicate ablation sites. The "empty space" between endocardial RV and LV maps represents the thickened interventricular septum.

was not achieved. Surgical myectomy was offered; however, the patient declined the procedure. Although angiographic and contrast echocardiographic evaluations revealed significant spillover of contrast medium into collateral branches, TASA procedure was proposed. Due to refusal of TASA, we then decided to perform ESA. The patient was informed in detail and gave his consent in written form.

Ablation procedure

Procedure was performed under local anesthesia. Following placement of 2 venous and 1 arterial sheaths, the patient was heparinized (100 U/kg) and dosage was adjusted to maintain activated clotting time of between 250 and 300 seconds. Both ventricles were mapped using EnSite NavX system (St Jude Medical, Inc., St. Paul, MN, USA) (Figure 3). First, coronary sinus catheter was inserted via the right femoral vein as reference point for electroanatomic mapping system. Quadripolar catheter was inserted via the right femoral vein into the right ventricular apex for backup pacing. To prevent inverting induction of complete heart block or bundle branch block, we navigated the tip of the ablation catheter as far away as possible from His-bundle and left bundle branch regions, marked with a "tag" in the EnSite NavX system.

Radiofrequency ablation was performed with 4-mm, irrigated-tip ablation catheter (Therapy Cool Flex; St. Jude Medical Inc., St Paul, MN, USA) at flow rate of 20 mL/min. Ablation via left ventricle (LV) was chosen with the idea that LV gradient reduction would be best achievable by ablating contact point of the anterior mitral leaflet and left side of the interventricular septum. Retrograde, transaortic approach was used for the ablation procedure.

Location of the ablation catheter was defined using TTE guidance (Figure 1b). When ablation catheter approached contact points, "tag" was used to mark sites in the mapping system as ablation targets. A total of 38 radiofrequency pulses were delivered to the left ventricular septum (impedance range: 98–117 Ohm;

Table 1. **Peak myocardial enzyme rise after radiofrequency ablation**

Myocardial enzyme	Creatine kinase-MB mass (ng/mL)	Troponin I (ng/mL)	Myoglobin (ng/mL)
Patient's value	3.44	1.47	39.30
Normal reference value	0–5	0.00–0.06	0–113

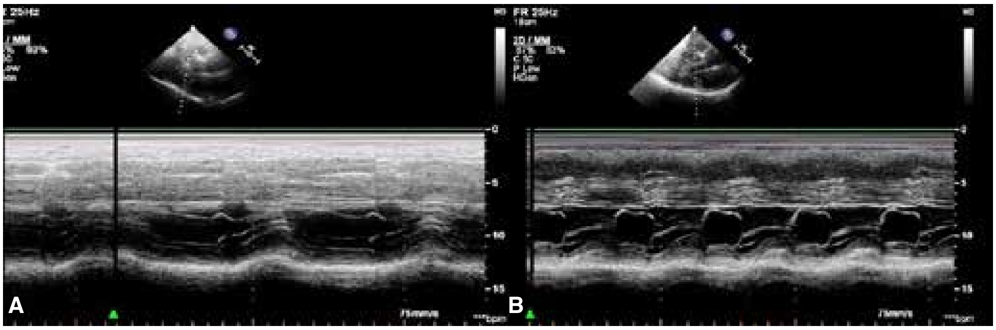

Figure 4. The total disappearance of systolic anterior motion on M-mode echocardiography. The systolic anterior motion on M-mode echocardiography **(A)** before, and **(B)** 3 months after the procedure.

temperature range: 30–35°C; energy range: 50–55 watts) in septal area of about 2 cm^2.

Gradient recovered to baseline value within 10 seconds after every pulse. After 20 pulses, resting gradient was reduced from 100 to 20 mmHg (Figure 2a-d). Although no further decrease was seen in gradient, ablation area was expanded to 2 cm^2. Gradient in LVOT remained constant after waiting for a period of 30 minutes the last radiofrequency pulse. Total procedure time and fluoroscopy time were 125 minutes and 13 minutes, respectively. No left bundle branch block or atrioventricular block occurred during or after procedure. Myocardial enzyme levels were significantly increased at 24 hours after procedure (Table 1). Gradient in LVOT was 35 mmHg at rest and 75 mmHg after exercise stress test on first day after the procedure. At the end of 5 days of follow-up, the patient was discharged with gradient of 40 mmHg. In first and third months of follow-up, LVOT gradient was calculated at 40 mmHg and 20 mmHg, respectively. At the end of 3 months, SAM had entirely disappeared in M-mode echocardiography, and NYHA functional class had improved from III to I (Figure 4).

DISCUSSION

Elevated LVOT gradient (usually defined as peak gradient ≥30 mmHg) is present in 20% to 30% of hypertrophic cardiomyopathy cases at rest, and in up to 70% with exercise provocation.[6] It is associated with higher mortality when compared with matched hypertrophic cardiomyopathy patients without gradient.[6] In a recently published study, it was demonstrated that removing gradient may have beneficial effect on survival.[7]

In most cases, narrowing of LVOT by asymmetric septal hypertrophy is exacerbated by contact of the anterior mitral valve leaflet with the interventricular septum due to SAM of the anterior mitral leaflet. Contact between anterior mitral valve leaflet and interventricular septum has amplifying effect on LVOT gradient. This SAM-septal contact area is the target of ESA procedure.

It is well known that radiofrequency lesion size is a function of radiofrequency power level and exposure time.[8,9] Furthermore, irrigated-tip catheters may allow for creation of larger lesions by increasing the power that can be delivered without coagulum formation.[10] To interrupt the SAM-septal feedback mechanism and reduce LVOT gradient, small amount of damage created by radiofrequency energy may be enough. However, the location of tissue damage seems to be at least as important as size.

In the first human experience, Lawrenz et al.[11] performed ESA on 3 highly symptomatic HOCM patients. In this case series, they used fluoroscopy guidance to detect obstructed septal area. Emmel et al.[12] performed a similar procedure on 2 children via LV approach. In addition, they tried to localize the His bundle and left bundle branch using LocaLisa mapping system (Medtronic, Inc., Minneapolis, MN, USA). As an alternative ablative energy source, cryoenergy was used by Keane et al.[13] Acute procedural success was achieved in 2 of the 3 cases. Similar successful results have been presented by other authors, too.[14,15]

In 2011, Lawrenz et al.[14] presented the results of ESA in 19 adult patients with HOCM. In that study, they navigated the tip of the ablation catheter using the CARTO (Biosense Webster, Inc., Diamond Bar, CA, USA) electroanatomical mapping system. Procedure was performed via right ventricular approach in 10 patients and LV approach in 9 patients. They found similar procedural results with both left-sided and right-sided approach for gradient reduction. After 6 months, NYHA functional class improved from 3.0±0.0 to 1.6±0.7 ($p<0.01$), 6-minute walking distance improved by 58 m (413±129 m at baseline; 458±108 m immediately after ESA; 471±139 m after 6 months; $p<0.019$). As a remarkable finding, complete heart block occurred in 4 patients (21%) with permanent pacemaker dependency. All patients received dual-chamber pacemaker and were still pacemaker-dependent after 6 months. Results of this study show that heart block risk may be greater in ESA than in TASA procedure.

Exact localization of SAM-interventricular septum contact point is the most important part of ESA procedure. Although transesophageal or intracardiac echocardiography was used in previous studies, our case demonstrates that TTE may provide images of sufficient quality for ESA. On the basis of published studies, left-sided approach seems to be reasonable for targeted ablation of contact point of anterior mitral leaflet and interventricular septum. Results of present case support this hypothesis. At the end of 3 months follow-up, there was clear decrease in intraventricular gradient both at baseline (reduction by 80%) and after postextrasystolic provocation (30%). SAM due to LVOT obstruction was totally resolved on M-mode echocardiography, which corresponded to a remarkable widening of LVOT. In addition, similar to the after septal reduction procedures, there was significant improvement in functional capacity (from NYHA class III to class I). Significant postprocedural increase in cardiac enzymes may be evidence of endomyocardial injury induced by radiofrequency energy, which results in similar release of creatine kinase compared with alcohol septal ablation.

Clinical worsening and significant increase in LVOT gradient observed 2 days after the procedure may be proof that ablation was given the targeted site. Results of present case may be interpreted to indicate that ERSFA could create localized myocardial scar on contact point of anterior mitral leaflet and interventricular septum using TTE guidance. Also, electroanatomical mapping used in this case may preserve atrioventricular and bundle branch conduction, as well as enable exact lesion placement. This approach is the first in the relevant literature. Although significant reduction of septal mass was not observed after ESA procedure, severe decrease in LVOT gradient may be attributed to localized reduction of endomyocardial tissue at contact point, which is the primary mechanism responsible for dynamic obstruction of LVOT.

Conclusion

Although there are some published articles, the nature of these studies is not enough to make a suggestion for routine clinical usage of ESA. Further large-scale studies are needed to clarify this issue. Furthermore, it should be noted that ESA should only be considered when surgical myectomy is not an option for the patient after unsuccessful TASA procedure.

Acknowledgments

The EnSite Patch and all catheters used for electroanatomical mapping and ablation procedure were donated by Opakim Medical Products Inc., Istanbul, Turkey.

Conflict-of-interest issues regarding the authorship or article: None declared.

REFERENCES

1. Morrow AG, Brockenbrough EC. Surgical treatment of idiopathic hypertrophic subaortic stenosis: technic and hemodynamic results of subaortic ventriculomyotomy. Ann Surg 1961;154:181–9. Crossref
2. Schaff HV, Dearani JA, Ommen SR, Sorajja P, Nishimura RA. Expanding the indications for septal myectomy in patients with hypertrophic cardiomyopathy: results of operation in patients with latent obstruction. J Thorac Cardiovasc Surg 2012;143:303–9. Crossref
3. Steggerda RC, Damman K, Balt JC, Liebregts M, ten Berg JM, van den Berg MP. Periprocedural complications and long-term outcome after alcohol septal ablation versus surgical myectomy in hypertrophic obstructive cardiomyopathy: a single-center experience. JACC Cardiovasc Interv 2014;7:1227,34.
4. Faber L, Welge D, Fassbender D, Schmidt HK, Horstkotte D, Seggewiss H. One-year follow-up of percutaneous septal ablation for symptomatic hypertrophic obstructive cardiomyopathy in 312 patients: predictors of hemodynamic and clinical response. Clin Res Cardiol 2007;96:864–73. Crossref
5. Chan W, Williams L, Kotowycz MA, Woo A, Rakowski H, Schwartz L, et al. Angiographic and echocardiographic correlates of suitable septal perforators for alcohol septal ablation in hypertrophic obstructive cardiomyopathy. Can J Cardiol 2014;30:912–9. Crossref

6. Maron MS, Olivotto I, Betocchi S, Casey SA, Lesser JR, Losi MA, et al. Effect of left ventricular outflow tract obstruction on clinical outcome in hypertrophic cardiomyopathy. N Engl J Med 2003;348:295–303. Crossref
7. Veselka J, Krejčí J, Tomašov P, Zemánek D. Long-term survival after alcohol septal ablation for hypertrophic obstructive cardiomyopathy: a comparison with general population. Eur Heart J 2014;35:2040–5. Crossref
8. Hoyt RH, Huang SK, Marcus FI, Roger S. Factors influencing trans-catheter radiofrequency ablation of the myocardium. J Appl Cardiol 1986;1:469,86.
9. Wittkampf FH, Hauer RN, Robles de Medina EO. Control of radiofrequency lesion size by power regulation. Circulation 1989;80:962–8. Crossref
10. Ruffy R, Imran MA, Santel DJ, Wharton JM. Radiofrequency delivery through a cooled catheter tip allows the creation of larger endomyocardial lesions in the ovine heart. J Cardiovasc Electrophysiol 1995;6:1089–96. Crossref
11. Lawrenz T, Kuhn H. Endocardial radiofrequency ablation of septal hypertrophy. A new catheter-based modality of gradient reduction in hypertrophic obstructive cardiomyopathy. Z Kardiol 2004;93:493–9.
12. Emmel M, Sreeram N, deGiovanni JV, Brockmeier K. Radiofrequency catheter septal ablation for hypertrophic obstructive cardiomyopathy in childhood. Z Kardiol 2005;94:699–703.
13. Keane D, Hynes B, King G, Shiels P, Brown A. Feasibility study of percutaneous transvalvular endomyocardial cryoablation for the treatment of hypertrophic obstructive cardiomyopathy. J Invasive Cardiol 2007;19:247–51.
14. Lawrenz T, Borchert B, Leuner C, Bartelsmeier M, Reinhardt J, Strunk-Mueller C, et al. Endocardial radiofrequency ablation for hypertrophic obstructive cardiomyopathy: acute results and 6 months' follow-up in 19 patients. J Am Coll Cardiol 2011;57:572–6. Crossref
15. Cooper RM, Shahzad A, Hasleton J, Digiovanni J, Hall MC, Todd DM, et al. Radiofrequency ablation of the interventricular septum to treat outflow tract gradients in hypertrophic obstructive cardiomyopathy: a novel use of CARTOSound® technology to guide ablation. Europace 2016;18:113–20.

Keywords: Ablation; alcohol septal ablation; hypertrophic obstructive cardiomyopathy; radiofrequency; septal myectomy.

Anahtar sözcükler: Ablasyon; alkol septal ablasyon; hipertrofik obstrüktif kardiyomiyopati; radiyofrekans; septal miyektomi.