

Focal AF-ablation after Pulmonary Vein Isolation in a Patient with Hypertrophic Cardiomyopathy Using Cryothermal Energy

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A 42-year-old man, with a history of hypertrophic cardiomyopathy (HCM), an electrocardiogram pattern of ventricular preexcitation typical for mutations in the PRKAG2 gene, and highly symptomatic paroxysmal drug-resistant atrial fibrillation (AF), underwent successful circumferential isolation of his pulmonary veins using a 28-mm double lumen cryoballoon. Because AF was still inducible with programmed stimulation, fractionated signals were targeted in the left atrium with a conventional cryocatheter. Ablation of an endocardial focus with fractionated potentials at the base of the left appendage terminated the episode and rendered AF noninducible. No recurrence of AF was observed during a 10-month follow-up period. (PACE 2008; 31:1358–1362)

hypertrophic cardiomyopathy, atrial fibrillation, ablation

A 42-year-old man, with a history of hypertrophic cardiomyopathy (HCM) and highly symptomatic paroxysmal drug-resistant atrial fibrillation (AF) was referred for pulmonary vein isolation. He had required cardioversion on two occasions over the last 12 months. His electrocardiogram (ECG) (Fig. 1) showed a preexcitation pattern, however, a previous electrophysiology (EP) study had excluded the presence of an accessory pathway. Genetic testing revealed the patient to be carrying an unclassified variant in the PRKAG2 gene (c.1004 T > C). Family screening showed the father to be of the same phenotype, also carrying the unclassified variant. Mutations in the PRKAG2 gene typically cause an accumulation of cardiac glycogen, leading to left ventricular hypertrophy, mimicking preexcitation on the surface ECG.¹

Transthoracic echocardiography revealed a left atrial diameter of 40 mm (measured in a parasternal long axis) and a septum measuring 25 mm without left ventricular outflow tract (LVOT) gradient. Three-dimensional computed tomography (CT) reconstruction of the left atrium showed four individual pulmonary veins with a normal anatomy.

The procedure was performed under general anesthesia after transesophageal echocardiography. Both femoral veins were punctured and an uncomplicated transseptal puncture was performed with an 8-F sheath. A 20-polar circular

catheter revealed pulmonary vein (PV) potentials in all the veins during sinus rhythm. The transeptal sheath was exchanged for a 12-F steerable sheath, and a 28-mm double lumen cryoballoon catheter (Arctic front®, Cryocath, Kirkland, Canada) was advanced into the left atrium using an over-the-wire technique. Each vein was catheterized with the wire in every major side branch and the inflated balloon was positioned in the ostial region aiming to achieve complete occlusion of the targeted vein (Fig. 2). Several cryoapplications were given, each lasting for 5 minutes in different veins (left superior pulmonary vein [LUPV] : 2, left inferior pulmonary vein [LIPV] : 2, right superior pulmonary vein [RUPV]: 4, right inferior pulmonary vein [RIPV]: 1). After this, the balloon catheter was removed and the pulmonary veins were checked for electrical activity with the 20-polar circular catheter. As PV potentials could be detected at the ridge between LUPV and LIPV, two more applications were given in the left atrial appendage. After confirmation of isolation of the veins, pacing inside the veins proved exit block to the left atrium. Induction of AF was then performed by burst pacing during 5 seconds with a cycle length of 200 ms. This was done at the anterior and posterior aspects of the left atrium (LA), the lateral wall of the right atrium (RA) and inside the coronary sinus (CS). Persistent AF could be induced from inside the CS. Electrical cardioversion was performed and the induction protocol was repeated, confirming the induction from the CS without the ability to induce elsewhere. During AF, an 8-mm conventional cryocatheter (Freezor Max®, Cryocath) was introduced into the left atrium. It was positioned in the inferior and anterior aspect of the left atrium, showing local potentials fluctuating between clearly separated nearly regular activation

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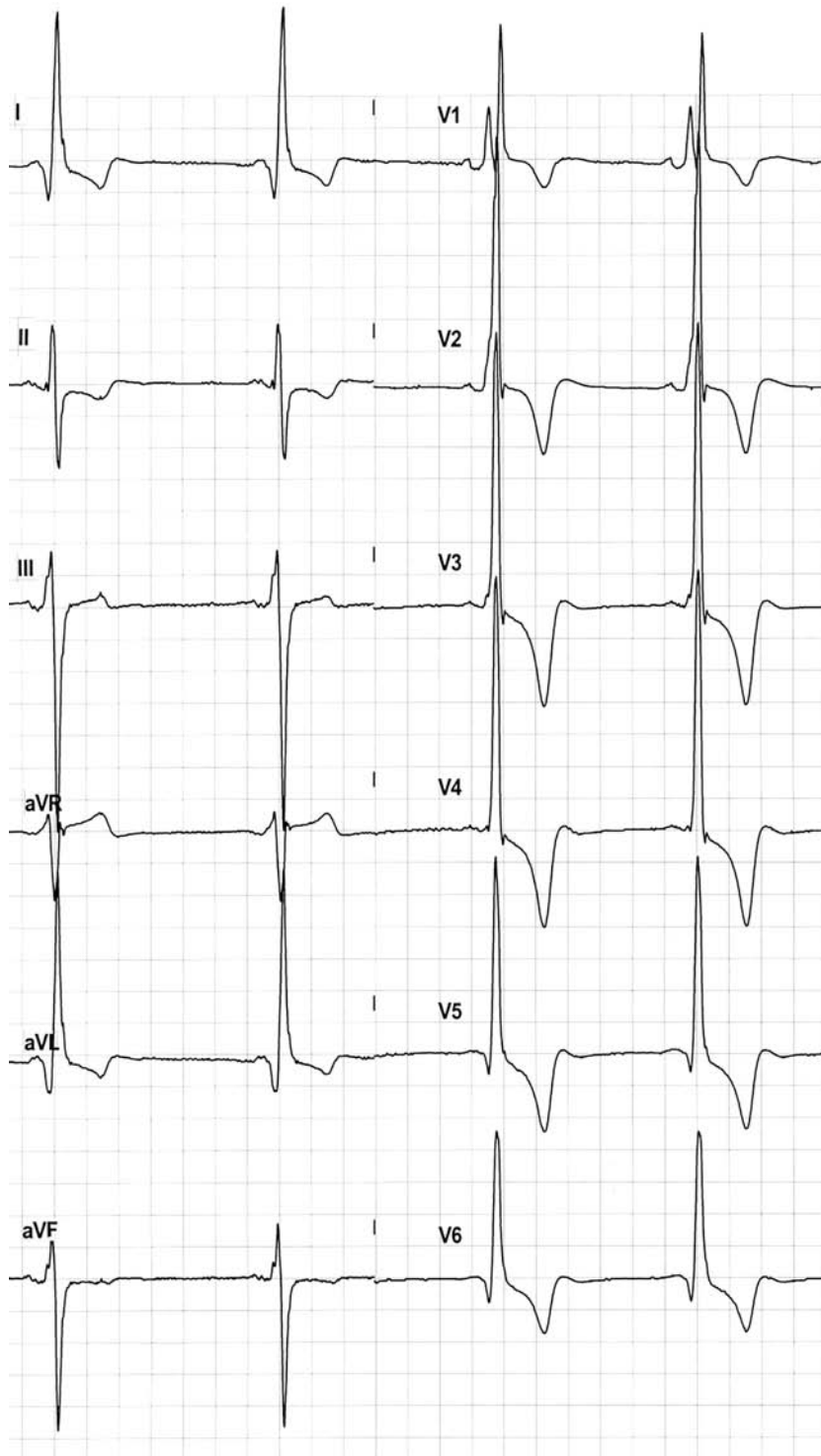


Figure 1. 12-lead ECG with the typical PRKAG2 pattern. The PR interval is 125 ms.

and high-frequency continuous activity. When positioned at the anterolateral atrium near the mitral valve, below the ostium of the auricle, a continuous fragmented and high-frequency activation pat-

tern was locally observed (Fig. 3). A 5-minute application was given at the site with a termination of AF after 26 seconds (Fig. 4). After this application the induction protocol was repeated at different

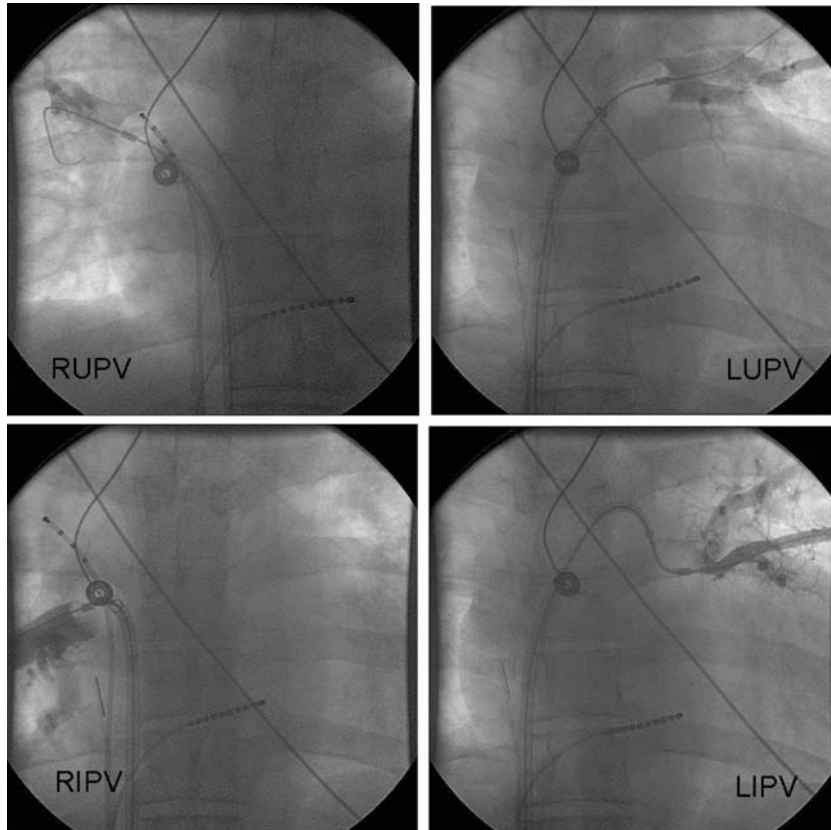


Figure 2. Consecutive balloon occlusion of all four pulmonary veins (LUPV : left superior pulmonary vein, LIPV = left inferior pulmonary vein, RUPV = right superior pulmonary vein, RIPV = right inferior pulmonary vein).



Figure 3. Continuous fragmented signal with a high frequency of activation on the mapping catheter near the ostium of the left atrial auricle during atrial fibrillation. Surface leads I, aVF, and V1, mapping catheter (Abl), and CS leads (CS) are shown.

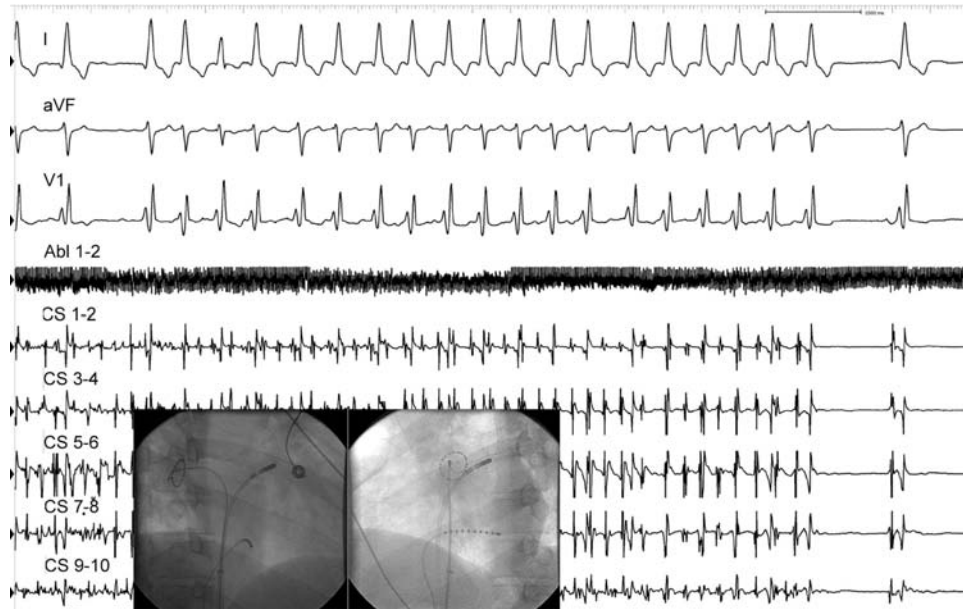


Figure 4. Termination of atrial fibrillation during application of cryoenergy at the site of fragmented potentials. The insert shows the ablation catheter in RAO and LAO. Abl = ablation; CS = coronary sinus.

sites, but burst pacing from the CS could no longer induce AF on eight separate attempts. The procedure was terminated. Oral anticoagulation was continued and he was discharged the next day with a transtelephonic monitoring device. Daily rhythm strips were sent for 3 months. The patient visited regularly at the outpatient clinic and a 24-hour holter monitoring was performed. After a follow-up period of 10 months, no AF recurrence could be detected and the patient has remained free of arrhythmia symptoms, while he suffered from daily episodes before ablation.

Discussion

In this patient with left ventricular hypertrophy and an ECG pattern of ventricular preexcitation, typical for mutations in PRKAG2, AF was the main manifestation of his cardiac disease. No ventricular preexcitation was present.²⁻⁴ It proved to be possible to treat his AF with catheter ablation.

This case is highly suggestive of the fact that a perpetuator of AF was present in the proximity of the distal CS. The localization of both the inducing burst pacing and the successful application tend to suggest that the ligament of Marshall or the CS itself was responsible in this case. The fact that the ablation was performed from the endocardium of the LA, on the other hand, rather suggests a myocardial origin of the initiating focus, which would fit with the notion that AF occurs in HCM as an indicator of disease progression to the atria.⁵

The ablation of fragmented signals has gained interest as an invasive therapy of AF.⁶

Noninducibility after pulmonary vein isolation was confirmed and was associated with the long-term maintenance of sinus rhythm, as recently shown in literature.⁷

In our case, a novel technique for circumferential cryoablation of the pulmonary veins by cryoballoon combined with focal cryoablation of a reentrant source has proven to be successful in this patient with HCM.⁸ Whether the driver originated from a focal region of diseased atrial myocardium or a nearby anatomical structure, remains the question. Whether this was associated with this particular storage disease is another question.

AF is the most common arrhythmia in patients with HCM and occurs in 20% to 25%, predicting morbidity and mortality.⁹ Therefore, maintaining sinus rhythm is highly desirable in these patients. There are several reports describing the value of AF ablation for maintenance of sinus rhythm in patients with HCM. In a limited series (four patients), the effectiveness of pulmonary vein isolation for symptomatic paroxysmal AF was reported with a very high success rate (100%).¹⁰ In two later reports, describing HCM populations with paroxysmal and persistent AF (27 and 26 patients), the freedom of AF during long-term follow-up was 70%¹¹ and 77%,¹² respectively. In addition, it has been shown that sinus rhythm after AF ablation improves functional status and reduces the need for pharmacological treatment.¹² Therefore, we

believe invasive management of HCM patients presenting with AF is highly recommendable. The most efficient ablation strategy remains to be determined, since it seems plausible that in this group

of patients, left atrial disease progression may be an important factor in the mechanism of AF, warranting extensive substrate modification on top of antral pulmonary vein isolation.

References

1. Arad M, Maron BJ, Gorham JM, Johnson WH, Jr., Saul JP, Perez-Atayde AR, Spirito P, et al. Glycogen storage diseases presenting as hypertrophic cardiomyopathy. *N Engl J Med* 2005; 352:362–372.
2. Gollob MH, Seger JJ, Gollob TN, Tapscott T, Gonzales O, Bachinski L, Roberts R. Novel PRKAG2 mutation responsible for the genetic syndrome of ventricular preexcitation and conduction system disease with childhood onset and absence of cardiac hypertrophy. *Circulation* 2001; 104:3030–3033.
3. Vaughan CJ, Hom Y, Okin DA, McDermott DA, Lerman BB, Basson CT. Molecular genetic analysis of PRKAG2 in sporadic Wolff-Parkinson-White syndrome. *J Cardiovasc Electrophysiol* 2003; 14:263–268.
4. Sternick EB, Oliva A, Magalhaes LP, Gerken LM, Hong K, Santana O, Brugada P, et al. Familial pseudo-Wolff-Parkinson-White syndrome. *J Cardiovasc Electrophysiol* 2006; 17:724–732.
5. McKenna WJ, Franklin RC, Nihoyannopoulos P, Robinson KC, Deanfield JE. Arrhythmia and prognosis in infants, children and adolescents with hypertrophic cardiomyopathy. *J Am Coll Cardiol* 1988; 11:147–153.
6. Nademanee K, McKenzie J, Kosar E, Schwab M, Sunsaneewitayakul B, Vasavakul T, Khunnawat C, et al. A new approach for catheter ablation of atrial fibrillation: Mapping of the electrophysiologic substrate. *J Am Coll Cardiol* 2004; 43:2044–2053.
7. Chang SL, Tai CT, Lin YJ, Wongcharoen W, Lo LW, Tuan TC, Udyavar AR, et al. The efficacy of inducibility and circumferential ablation with pulmonary vein isolation in patients with paroxysmal atrial fibrillation. *J Cardiovasc Electrophysiol* 2007; 18:607–611.
8. Van Belle Y, Janse P, Rivero-Ayerza MJ, Thornton AS, Jessurun ER, Theuns D, Jordaens L. Pulmonary vein isolation using an occluding cryoballoon for circumferential ablation: Feasibility, complications, and short-term outcome. *Eur Heart J* 2007; 28:2231–2237.
9. Maron BJ, McKenna WJ, Danielson GK, Kappenberger LJ, Kuhn HJ, Seidman CE, Shah PM, et al. American College of Cardiology/European Society of Cardiology Clinical Expert Consensus Document on Hypertrophic Cardiomyopathy. A report of the American College of Cardiology Foundation Task Force on Clinical Expert Consensus Documents and the European Society of Cardiology Committee for Practice Guidelines. *Eur Heart J* 2003; 24:1965–1991.
10. Liu X, Ouyang F, Mavrakis H, Ma C, Dong J, Ernst S, Bansch D, et al. Complete pulmonary vein isolation guided by three-dimensional electroanatomical mapping for the treatment of paroxysmal atrial fibrillation in patients with hypertrophic obstructive cardiomyopathy. *Europace* 2005; 7:421–427.
11. Kilicaslan F, Verma A, Saad E, Themistoclakis S, Bonso A, Raviele A, Bozbas H, et al. Efficacy of catheter ablation of atrial fibrillation in patients with hypertrophic obstructive cardiomyopathy. *Heart Rhythm* 2006; 3:275–280.
12. Gaita F, Di Donna P, Olivetto I, Scaglione M, Ferrero I, Montefusco A, Caponi D, et al. Usefulness and safety of transcatheter ablation of atrial fibrillation in patients with hypertrophic cardiomyopathy. *Am J Cardiol* 2007; 99:1575–1581.