

Successful bipolar radiofrequency catheter ablation of ventricular premature complexes arising from the anterolateral papillary muscle of the left ventricle



Marina Arai, MD, Seiji Fukamizu, MD, PhD, Iwanari Kawamura, MD, Satoshi Miyazawa, MD, Takeshi Kitamura, MD, Rintaro Hojo, MD, PhD

From the Department of Cardiology, Tokyo Metropolitan Hiroo Hospital, Tokyo, Japan.

Introduction

Ventricular premature complexes (VPCs) originating from the papillary muscle (PM) have high recurrence rates; 71% of anterolateral PM (ALPM) and 50% of posteromedial PM (PMPM) ventricular tachycardias (VTs), respectively.¹ The main reasons for this difficulty may be poor catheter stability and its deep origin.¹ To reduce symptoms and preserve left ventricular systolic function of patients with ventricular arrhythmias (VAs) arising from the PM, it is necessary to improve outcomes in PM VA ablation. Owing to the limited ability of creating transmural lesions with unipolar radiofrequency catheter ablation (RFCA), bipolar RFCA and RFCA guided by intracardiac echocardiography (ICE) and/or cryoablation^{2,3} are considered the treatment options for PM VAs. Cryoablation has the advantage of catheter stability^{2,3}; on the other hand, bipolar RFCA allows deep lesion formation.⁴ Although concern remains that bipolar RFCA increases the risk of steam pops,⁵ Good and colleagues⁶ showed that the incidence of steam pops with bipolar RFCA with externally irrigated ablation catheter is lower than with sequential unipolar ablation. Besides, Nguyen and colleagues⁵ reported that large and deep lesions can be produced using externally irrigated ablation catheters as both the active and the ground. However, they also stated that when using an 8-mm-tip catheter as the active and an externally irrigated ablation catheter as the ground, the risk of steam pops will increase. We report a successful case of ALPM VPCs that was treated by bipolar RFCA.

Case report

An 84-year-old man visited our clinic, complaining of palpitations. He had a past history of conventional RFCA of frequent VPCs arising from the ALPM of the left ventricle

KEYWORDS Bipolar catheter ablation; Externally irrigated ablation catheter; Papillary muscle; Radiofrequency energy; Ventricular arrhythmia (Heart Rhythm Case Reports 2019;5:472–475)

Address reprint requests and correspondence: Dr Marina Arai, Department of Cardiology, Tokyo Metropolitan Hiroo Hospital, 2-34-10 Ebisu, Shibuya-ku, Tokyo, Japan 150-0013. E-mail address: marinaarai314@gmail.com.

KEY TEACHING POINTS

- Ventricular premature complexes (VPCs) arising from the anterior papillary muscle can be effectively and safely eliminated by bipolar radiofrequency catheter ablation with an externally irrigated ablation catheter and an 8-mm-tip nonirrigated ablation catheter.
- Visualization of the ablation site with intracardiac echocardiography and the gradual output increase made it possible to eliminate the targeted VPCs effectively and safely.
- A papillary muscle (PM) VPC often exhibits multiple QRS morphologies, with subtle changes seen spontaneously or during ablation. These subtle morphologic changes are thought to be caused by preferential conduction to different exit sites or multiple regions of origin within the complex structure of the PM. Even if a good pace map was not acquired at the ablation site, radiofrequency energy is effective as far as transmural lesion is created.

(LV). A 24-hour Holter electrocardiogram revealed the occurrence of 13,000 VPCs/day with right bundle branch block and inferior axis morphology (Figure 1A), and a second session for VPCs arising from the ALPM was planned.

Electrophysiological study and RFCA procedure were performed using a 3-dimensional mapping system (CARTO UNIV; Biosense Webster, Diamond Bar, CA). The LV geometry was obtained by ICE (SOUNDSTAR; Biosense Webster), followed by insertion of a 20-electrode mapping catheter (PENTARAY; Biosense Webster) into the LV via a transaortic approach. Careful pace mapping was performed at the ALPM of the LV. The pace map with PASO 0.951 of the targeted VPCs recorded at the body of the ALPM was better than at the

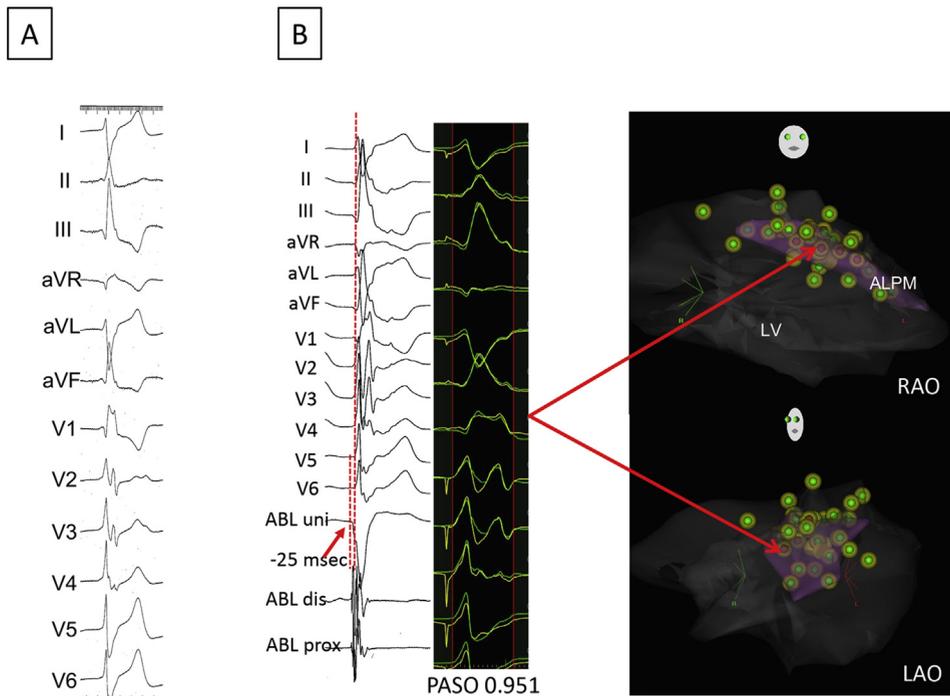


Figure 1 A: Target ventricular premature complex with right bundle branch block and inferior axis. B: At the body of the anterolateral papillary muscle (ALPM), a good pace map (PASO 0.951) was recorded. A prepotential preceded the surface QRS at 25 ms at the pacing site, and the local unipolar lead revealed a QS pattern. LAO = left anterior oblique; LV = left ventricle; RAO = right anterior oblique.

tip. An ablation catheter recorded a prepotential preceding the surface QRS at 25 ms at the pacing site of the body; in addition, a QS pattern was recorded by a local unipolar lead during the VPCs (Figure 1B). However, with regard to the other aspects of the body of the ALPM, a pace map was not satisfactory, and a local unipolar lead used during the VPCs recorded an rS pattern. This was considered one of the characteristics of the PM VPC. The targeted area was almost the same as that used in the first session.

Two externally irrigated ablation catheters, THERMOCOOL SMARTTOUCH SF (Biosense Webster) and FlexAbility ablation catheter (St. Jude Medical, St. Paul, MN), were inserted into the LV via a transeptal and transaortic approach, respectively. Visualization by ICE demonstrated that the catheters had sandwiched the ALPM. However, as the impedance was too high (>200 ohms) to apply radiofrequency (RF) energy, the ground catheter, FlexAbility, was changed to an 8-mm-tip nonirrigated catheter, Ablaze Fantasista (Japan Lifeline, Tokyo, Japan) (Figure 2).

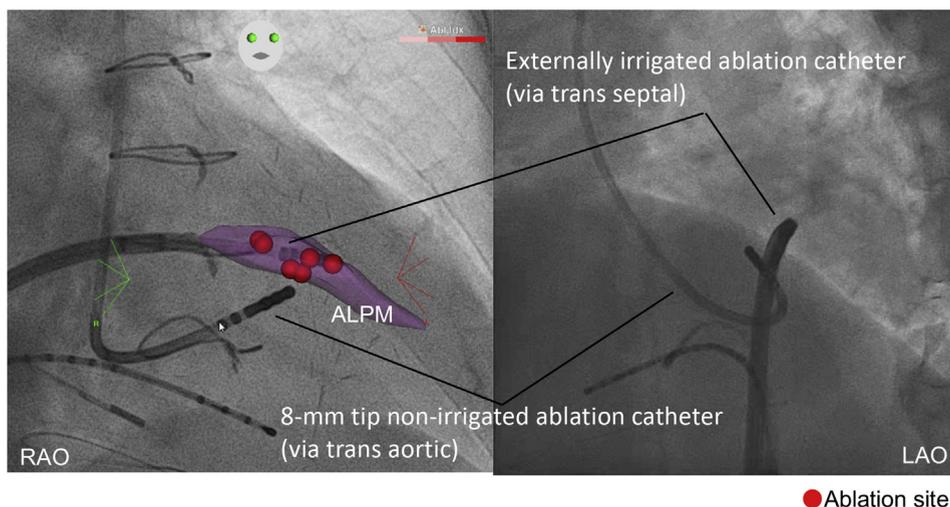


Figure 2 An externally irrigated ablation catheter was inserted into the left ventricle via a transeptal approach, and an 8-mm-tip nonirrigated ablation catheter was inserted via a transaortic approach. Radiofrequency energy was administered 3 times. The output was increased from 30 W to 50 W gradually, and each application was continued for 60 s. ALPM = anterolateral papillary muscle; LAO = left anterior oblique; RAO = right anterior oblique.

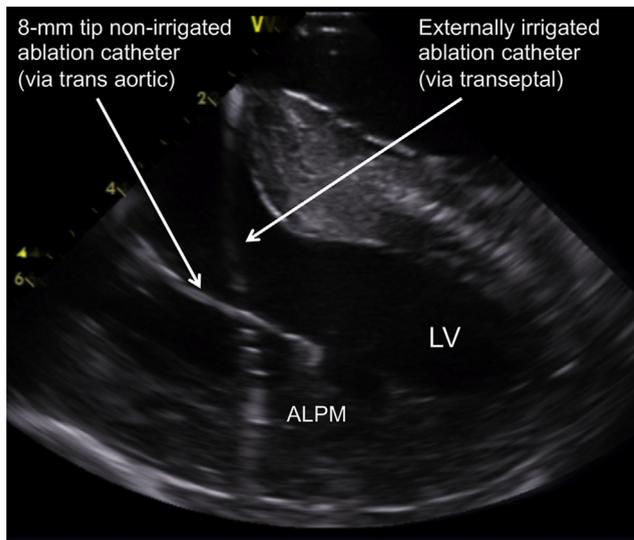


Figure 3 Intracardiac echography demonstrated that the catheters sandwiched the anterolateral papillary muscle (ALPM) during ablation. LV = left ventricle.

Subsequently, the impedance declined to approximately 180–190 ohms stably, which was sufficient for the application of RF energy. After verification that the activated coagulation time was over 300 s, RF energy was administered under ICE, which displayed the ablation site (Figure 3). The contact force vector oriented toward the ALPM, with an average force of 10 g. Bipolar ablation at generator power settings was titrated from 30 W to a maximum of 50 W, with observation of local electrogram, impedance drop, and ICE, limiting ablation catheter tip temperature to 41°C, at an irrigation rate of 17 mL/min, delivered to ALPM. We could not obtain information for the ground catheter because a custom cable was used (Supplemental Figure 1). The procedure lasted 240 minutes with 6-time bipolar ablation (total time 402 s, mean time 65 s, mean power 32 W, mean impedance of 181 ohms with average impedance drop of 31 ohms per application). After the applications, isoproterenol, phenylephrine administration, or an awakening showed it was impossible to induce targeted VPCs anymore. There was no complication, including steam pop. During the 14-month follow-up period, there was no documentation of VPC, and only trivial mitral regurgitation was observed.

Discussion

PM VAs occur in approximately 7% of patients with idiopathic VTs.⁶ PM VTs originate more commonly from the PMPM than from the ALPM.⁷ Peichl and colleagues⁸ reported that two-thirds of PM VPCs originated from the tip of the PM, although varied distribution of PM VA origin has been reported.^{3,9} The recurrence rates of ALPM and PMPM VTs are 71% and 50%, respectively, and may be due to poor catheter stability, as a result of PM contractions and their deep origins.¹ Moreover, a PM VT often exhibits multiple QRS morphologies, with subtle changes seen spontaneously or during ablation.^{10,11} These

subtle morphologic changes are thought to be caused by preferential conduction to different exit sites or multiple regions of origin within the complex structure of the papillary muscles.^{10,11} In this case, the QRS morphology of the V₁ lead during VPC presented similar characteristics, and the findings of pace mapping and intracardiograms showed that the targeted VPC originated from deep within the ALPM.

The ability to create transmural lesions with unipolar RFCA is limited. It is one of the reasons that certain VTs remain difficult to eradicate.⁴ Therefore, bipolar RFCA might provide the necessary advantage required to ablate the intramural site by creating transmural lesions.⁴ A report by Nguyen and colleagues⁵ stated that using externally irrigated ablation catheters as the active and the ground tips can produce the largest and deepest lesions. An 8-mm-tipp nonirrigated ablation catheter can deliver high power (>50 W); however, it increases the risk of steam pops when used alongside other types of catheters as the ground tip.⁷ In our case, it was difficult to use externally irrigated ablation catheters as the active and the ground tips owing to high impedance. Therefore, an 8-mm-tip nonirrigated ablation catheter was used for grounding, as it facilitated the delivery of RF energy. In addition, visualization of the ablation site with ICE and the gradual output increase made it possible to eliminate the targeted VPCs effectively and safely. Encouraging our case, Futyma and colleagues¹² reported a case of VPC originating from a posterosuperior process that was successfully treated by bipolar RFCA with an externally irrigated ablation catheter and 4-mm-tip nonirrigated ablation catheter. They mentioned that temperature monitoring of the ground electrode may increase safety of the procedure. Another option to improve the outcomes of PM VA ablation is obtaining good catheter stability. Cryoablation has an advantage of catheter stability, and there are some reports of PM VTs treated by cryoablation successfully and safely.^{2,3} Considering the ability of creating transmural lesion, bipolar RFCA remains superior to cryoablation.^{4,6,13} Moreover, contact force can make up catheter stability.

Conclusion

Our findings in this case suggest that VPCs arising from the ALPM can be effectively and safely eliminated by ICE-guided bipolar RFCA with an externally irrigated ablation catheter and an 8-mm-tip nonirrigated ablation catheter. It is possible to eliminate VPCs arising from ALPM effectively and safely by ICE-guided bipolar RFCA with an externally irrigated ablation catheter and an 8-mm-tip nonirrigated ablation catheter.

Appendix

Supplementary data

Supplementary data associated with this article can be found in the online version at <https://doi.org/10.1016/j.hrcr.2019.07.002>.

References

1. Yamada T, McElderry HT, Okada T, et al. Idiopathic focal ventricular arrhythmias originating from the anterior papillary muscle in the left ventricle. *J Cardiovasc Electrophysiol* 2009;20:866–872.
2. Rivera A, Rikapito M, Espinoza J, et al. Cryoablation for ventricular arrhythmias arising from the papillary muscles of the left ventricle guided by intracardiac echocardiography and image integration. *JACC Clin Electrophysiol* 2015;1:509–516.
3. Rivera S, Rikapito M, Tomas L, et al. Results of cryoenergy and radiofrequency-based catheter ablation for treating ventricular arrhythmias arising from the papillary muscles of the left ventricle, guided by intracardiac echocardiography and image integration. *Circ Arrhythm Electrophysiol* 2016;9:509–516.
4. Kouth JS, Dukkipati S, Miller MA, Neuzil P, d'Avila A, Reddy VY. Bipolar irrigated radiofrequency ablation: a therapeutic option for refractory intramural atrial and ventricular tachycardia circuits. *Heart Rhythm* 2012;9:1932–1941.
5. Nguyen DT, Tzou WS, Brunnquell M, et al. Clinical and biophysical evaluation of variable bipolar configurations during radiofrequency ablation for treatment of ventricular arrhythmias. *Heart Rhythm* 2016;13:2161–2171.
6. Good E, Desjardins B, Jongnarangsin K, et al. Ventricular arrhythmias originating from a papillary muscle in patients without prior infarction: a comparison with fascicular arrhythmias. *Heart Rhythm* 2008;5:1530–1537.
7. Crawford T, Mueller G, Good E, et al. Ventricular arrhythmias originating from papillary muscles in the right ventricle. *Heart Rhythm* 2010;7:725–730.
8. Peichl P, Baran J, Wichterle D, et al. The tip of the muscle is a dominant location of ventricular ectopy originating from papillary muscles in the left ventricle. *J Cardiovasc Electrophysiol* 2018;29:64–70.
9. Proietti R, Rivera S, Dussault C, et al. Intracardiac echo-facilitated 3D electroanatomical mapping of ventricular arrhythmias from the papillary muscles: assessing the 'fourth dimension' during ablation. *Europace* 2017;19:21–28.
10. Yamada T, Doppalapudi H, McElderry HT, et al. Electrocardiographic and electrophysiological characteristics in idiopathic ventricular arrhythmias originating from the papillary muscles in the left ventricle: relevance for catheter ablation. *Circ Arrhythm Electrophysiol* 2010;3:324–331.
11. Yamada T, Doppalapudi H, McElderry H, et al. Idiopathic ventricular arrhythmias originating from the papillary muscles in the left ventricle: prevalence, electrocardiographic and electrophysiological characteristics, and results of the radiofrequency catheter ablation. *J Cardiovasc Electrophysiol* 2010;21:62–69.
12. Futyma P, Gluszczyk R, Futyma M, Kulakowski P. Right atrial position of a return electrode for bipolar ablation of the left posterolateral process ventricular tachycardia. *Pacing Clin Electrophysiol* 2019;42:474–477.
13. Hashimoto K, Watanabe I, Okumura Y, et al. Comparison of endocardial and epicardial lesion size following large-tip and extra-large-tip transcatheter cryoablation. *Circ J* 2009;73:1619–1626.