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Original Article

Evaluation of the Delayed Disappearance of Idiopathic Premature Ventricular Beats After Unsuccessful Ablation

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ABSTRACT

Background: Radiofrequency catheter ablation (RFCA) is an effective and successful approach to the treatment of symptomatic, idiopathic premature ventricular contractions (PVCs); however, some patients experience the delayed disappearance of the arrhythmia.

Methods: The current prospective cohort study was conducted on 28 patients who suffered from idiopathic PVCs whose RFCA was primarily unsuccessful and who were followed up on for 6 months. Forty-six patients were examined, and 18 of them were lost to follow-up. Characteristics, including age, sex, arrhythmic foci, and left ventricular ejection fraction (LVEF) at the end of RFCA, were recorded. Additionally, 24-hour cardiac Holter monitoring was performed for the patients within 6 months after the intervention.

Results: Fifteen patients (53.57%) did not respond to the treatment, while among the others, PVCs ceased within 3 and 6 months after the intervention in 11 (84.61%) and 2 (15.39%). Most PVCs originated from the LV summit (35.71%), followed by the septal part of the right ventricle (RV) (21.42%), the right ventricular outflow tract (RVOT) (14.28%), and the LVOT (7.14%). The success rate assessment revealed the best outcomes in patients with PVCs originating from the septal part of the RV (83.3%) and the RVOT (75%). There were insignificant associations between the age, sex, and the mean LVEF of patients with unsuccessful ablation therapy.

Conclusions: Ventricular arrhythmias with left-sided origins had a worse response to RFCA considering unresponsiveness or delayed arrhythmia elimination. We found no association between the age, sex, and LVEF of the patients who never experienced successful arrhythmia cessation compared with those with delayed idiopathic PVC cessation. ***(Iranian Heart Journal 2023; 24(4): 6-13)***

KEYWORDS: Delayed disappearance, Idiopathic premature ventricular contraction, Unsuccessful ablation

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Premature ventricular contractions (PVCs) are one of the most frequent arrhythmias originating from the ventricles in individuals with or without structural heart disease. [1] This phenomenon mostly results from premature depolarization arising from ventricle-derived myocardial cells; however, other origins such as conduction tissue distal to the His bundle bifurcation, the bundle branches, the fascicles, and the Purkinje fibers are the other potential sites for these arrhythmias. [2]

Idiopathic PVCs occur with mechanisms unrelated to structural heart diseases. PVCs commonly originate from diverse areas, including the right or left ventricular outflow tract (RVOT and LVOT, respectively), aortomitral continuity, and epicardial structures, such as the LV summit. [3]

Radiofrequency catheter ablation (RFCA) is one of the most effective and successful approaches to the treatment of symptomatic, idiopathic PVCs, and studies have revealed its efficacy in improving cardiac function in patients suffering from PVC-mediated cardiomyopathies. [4] The outcomes of RFCA can be optimized using activation mapping to localize the site of idiopathic arrhythmia origination and to guide successful ablation. The overall success rate of response to RFCA in recent investigations revealed excellent results, ranging from 67% to 93%. [1,5]

Despite the high success rate of RFCA in controlling PVCs, some patients experience the delayed disappearance of the arrhythmia at the ablated site due to the evolution of marginal inflammatory lesions to necrosis and fibrosis, leading to lesion extension. [6,16]

Accordingly, the current study aimed to evaluate the potential characteristics of subjects with a delayed response to RFCA for PVC management.

METHODS

The current prospective cohort study was conducted on 46 patients suffering from idiopathic PVCs whose RFCA was primarily unsuccessful. Forty-six patients were evaluated, but 18 of them were lost to follow-up .Due to the COVID-19 pandemic, many patients failed to return for Holter follow-ups; consequently, only 28 patients completed the follow-up. The demographic characteristics of the 28 patients were analyzed. The patients were followed up on for 6 months. The study was performed on patients admitted to the Electrophysiology Department of Rajaie Cardiovascular Medical and Research Center, affiliated with Iran University of Medical Sciences, from January 2019 through May 2020.

The study protocol, which met the tenets of the Helsinki Declaration, was approved by the Ethics Committee of Iran University of Medical Sciences (code: IR.IUMS.FMD.REC.1399.742). The study protocol was explained to the subjects, who were informed about the use of their information in the study and were reassured regarding the confidentiality of their personal information. Written informed consent was obtained from the entire study population.

The present investigation recruited patients older than 18 years with a documented diagnosis of idiopathic PVC who were candidates for RFCA. The exclusion criteria consisted of structural heart diseases, a previous history of myocardial infarction, rheumatic diseases, cardiomyopathies, a history of ablation therapy, and a diagnosis with more than 1 arrhythmic foci. In addition, patients who were compatible for participation in the study but refused to attend or had more than 20% defects in their medical records were excluded.

Patients were recruited through convenience sampling and were followed up on for 6 months to assess their responsiveness to RFCA.

The study checklist contained the patients' demographic characteristics, including age and sex.

Arrhythmic foci were recorded in medical records and categorized as the LV summit, the LVOT, the RVOT, the septal part of the RV, the para-Hisian accessory pathway, between the RVOT and the right-left commissure, the LV mid-septal portion, the LV fascicles, between the RVOT and the left coronary cusp, and the anterobasal part of the LV.

By the end of ablation therapy, the patients were transferred to the ward, where they stayed for 1 day before discharge. Transthoracic echocardiography was performed on all the patients to measure left ventricular ejection fraction (LVEF).

Additionally, 24-hour cardiac Holter monitoring was performed for the patients within 6 months after the intervention. Patients with more than a 50% decrease in PVC rates or fewer than 5000 PVC counts in 24 hours were considered RFCA respondents.

The gathered data were entered into the Statistical Package for Social Sciences (SPSS Inc, Chicago, IL, USA), version 23. Categorical data were presented in absolute numbers and percentages and were compared using the χ^2 test. Continuous variables were presented as mean ± standard deviations and compared using the Student *t* test. A *P* value of less than 0.05 was considered the level of significance.

RESULTS

The current study was conducted on 28 patients who underwent RFCA for the treatment of PVCs. The mean age of the studied population was 48 ± 14.5 years old (range =20-78 y), and the study population consisted of 14 males and 14 females.

Fifteen patients did not respond to the treatment at all, while among the others, PVCs ceased within 3 to 6 months after the intervention in 11 (84.61%) and 2 (15.39%).

Figure 1 shows the distribution of LVEF in the studied subjects: 16 patients (57.14%) had the normal range (≥55%). The mean LVEF in the studied population was 44.11 ± 12.47 (%).

Most PVCs originated from the LV summit (35.71%), followed by the septal part of the RV (21.42%), the RVOT (14.28%), and the LVOT (7.14%). Detailed data are demonstrated in Figure 2.

The patients were followed up on for 6 months. Thirteen patients (46.42%) experienced successful ablation. The success rate assessment revealed that the least successful ablation was at the LV summit (1 out of 10; 10%) and the LVOT (0 out of 2; 0%), while most cases with the septal portion of the RV (83.3%) and the RVOT (75%) experienced successful ablation (Fig. 3).

The mean LEVF of the patients with unsuccessful ablative therapy was 42.69 ± 13.78, while those who did not respond to the treatment had a mean LVEF of 45.33 ± 11.56 (P = 0.67) (Fig. 4). A sex-based assessment of ablation therapy success also showed insignificant differences (P = 0.70) (Table 1). The mean age of patients with PVC termination by ablation was 50.5 ± 17.4 years, while those with an unsuccessful response had a mean age of 45.9 ± 11.7 years (P = 0.4).

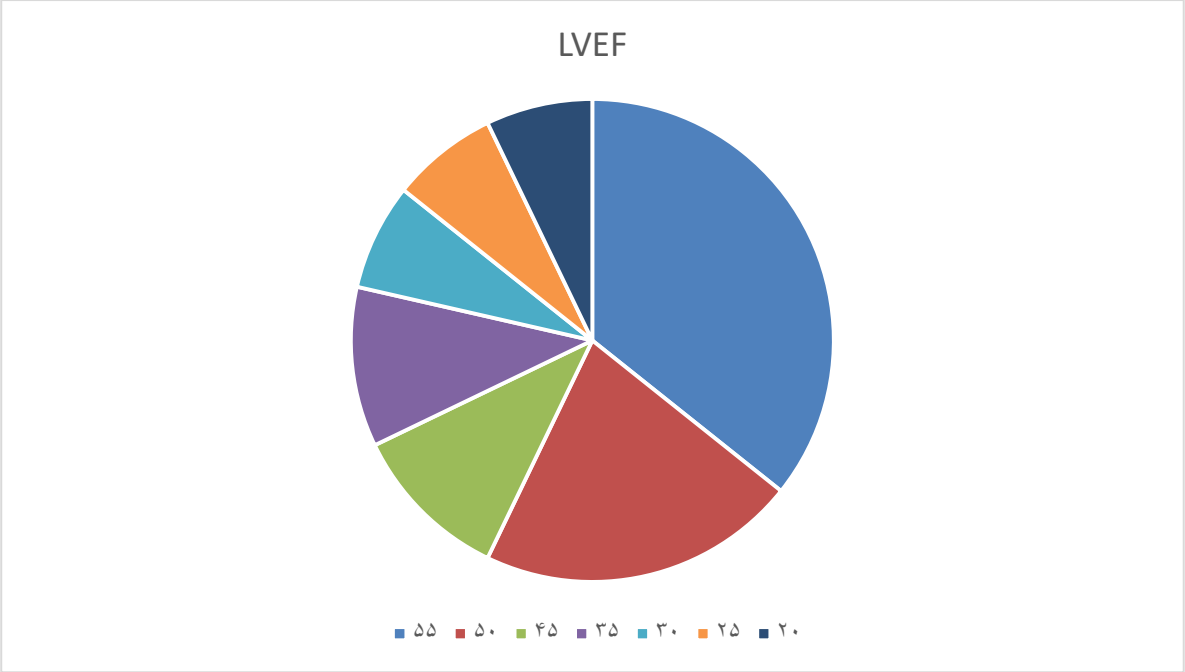

Figure 1: The figure illustrates the distribution of the LVEF among the studied population.

LVEF: left ventricular ejection fraction

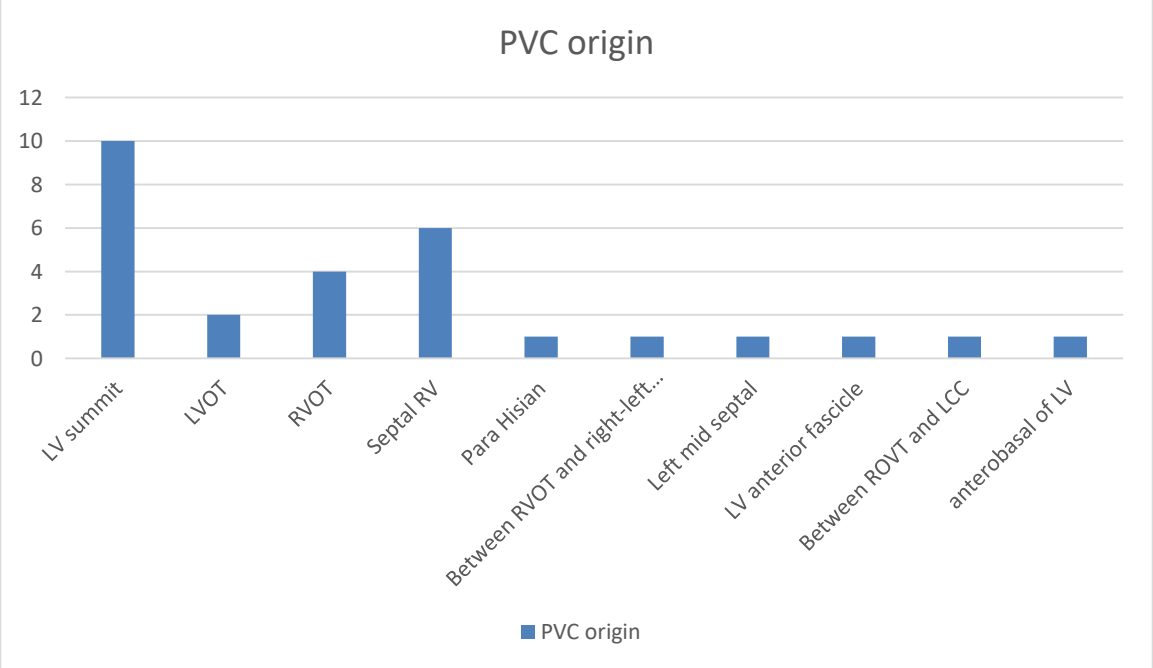

Figure 2: The figure demonstrates the origination of PVCs in the studied population.
PVCs: premature ventricular contractions

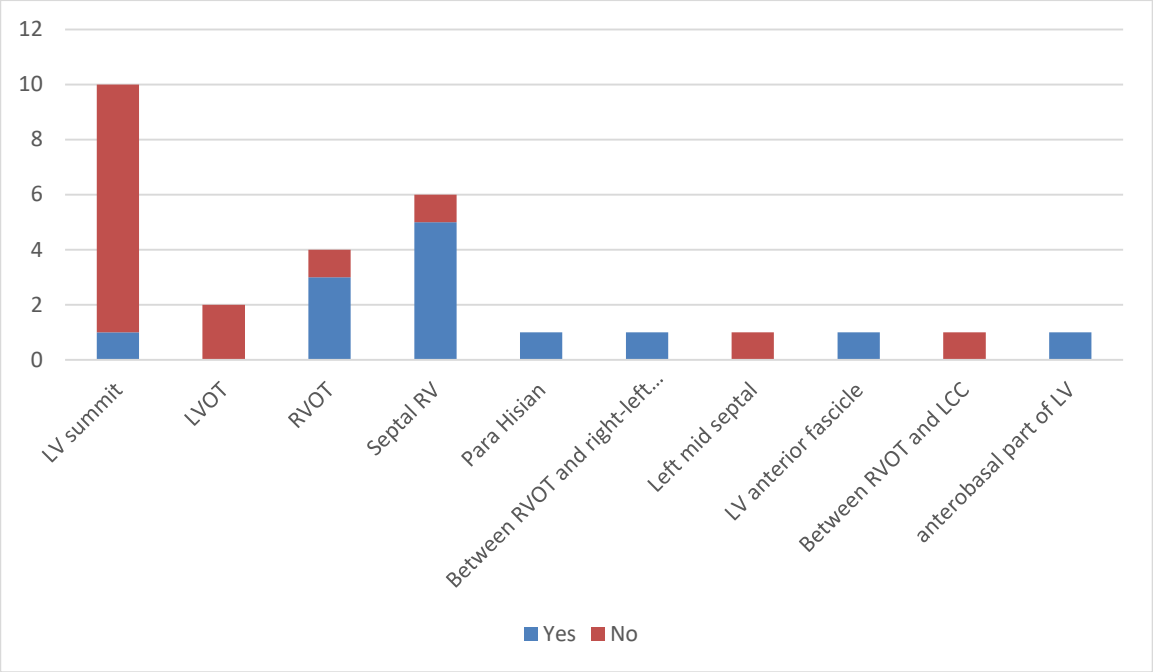

Figure 3: The image presents the success rate of ablation in different PVC origins.
PVC: premature ventricular contraction; LV: left ventricle; RV: right ventricle; RVOT: right ventricular outflow tract; LVOT: left ventricular outflow tract; LCC: left coronary cusp

Table 1: The assessment of ablation therapy success according to sex

Sex	No.	Persistent PVCs	PVC Termination	*P* value
male	14	7(50%)	7(50%)	0.7
female	14	8(58%)	6(42%)	
Sum	28	15(53%)	13(47%)	

PVCs: premature ventricular contractions

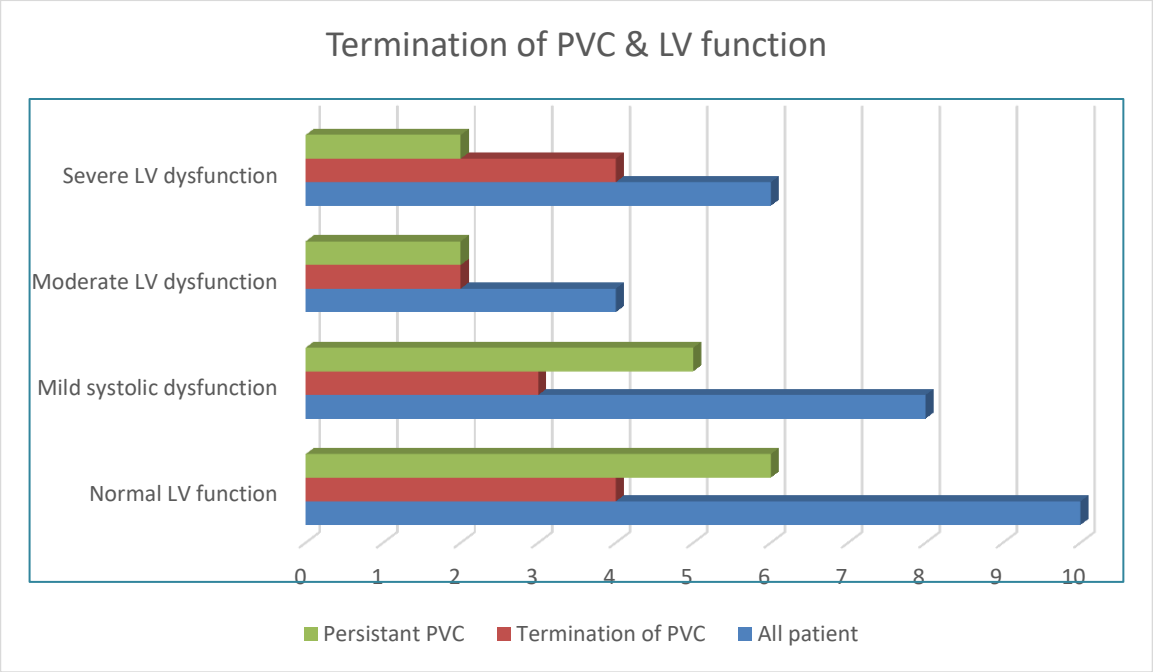

Figure 4: The image presents the assessment of ablation therapy success according to LV ejection fraction. LV: left ventricle; PVCs: premature ventricular contractions

DISCUSSION

The current study sought to assess factors associated with the incidence of a delayed response to RFCA in subjects suffering from idiopathic PVCs, a phenomenon described in the literature for both supraventricular and ventricular arrhythmias. [7] The delayed disappearance of ventricular arrhythmias presents within 6 hours to 4 months after ablation therapy. [8] Nevertheless, we evaluated a period of 6 months among RFCA non-respondents, but not among all patients undergoing RFCA.

Our findings revealed that the arrhythmia did not stop in 53.57% of the studied patients who were primarily unresponsive to the intervention during the 6 months of follow-up. The most delayed successful arrhythmia termination occurred in those with RV septal and RVOT foci of ventricular arrhythmia, while the worst condition was noted in the LV summit and the LVOT. We also found no association between a delayed RFCA response and the age, sex, and the LVEF of the assessed individuals.

Our results chime with previous investigations concerning the least desirable response of left-sided arrhythmias to RFCA. Accordingly, the arrhythmia continues in most primarily unresponsive patients whose foci of arrhythmia originate from the left side or are eliminated in a delayed manner. [7,9] The exact reasons remain unclear; however, numerous hypotheses have been raised. Lesions produced by RF energy are well-demarcated areas of coagulative necrosis. [10] Gathering of the cells responsible for the inflammatory response can cause fibrosis extension to the peripheral zone and expand the lesion. Another theory refers to the potential vascular injury to the surrounding parts of the central ablated zone and the expansion of the lesion. [11] Another condition that justifies the higher success rate of RV lesion ablation is the thickness of the chamber. In this regard, the transient disappearance of the arrhythmia during the ablation procedure might represent that the exact site of the arrhythmia is located

inside the peripheral area. Therefore, the temperature is high enough to achieve a physiologic effect but not adequate for permanent necrosis. This fact shows the significance of the muscular thickness and depth of arrhythmia foci. Given that, the secondary inflammatory response or ultrastructural damage to the myocardium initiates, and the injury might extend to the posterior sites. [12]

While we found that none of the evaluated parameters affected the probability of a delayed response to RFCA, prior investigations have presented factors, including the number of ablated foci, ablation near the coronary sinus, the response time to ablation therapy, and the preceding time at earliest sites, as factors associated with a delayed response to ablation therapy. [13]

One of the remarkable findings in our study is the successful rate of RFCA in only 10% (1 out of 10) of patients whose ventricular arrhythmia originated from the LV summit. Generally, the ablation of PVCs from this site is a challenge worldwide as the LV summit not only is an epicardial structure but also is bounded by important anatomical structures, such as the major coronary arteries. The difficulties of the LV summit access via the endocardial route have favored epicardial accessibility to this site either by the subxiphoid pericardial access or by the distal coronary venous system. [14] It has been demonstrated that the LV summit unresponsiveness to ablation therapy might potentially occur because of the epicardial approach, by which the adequate heat to appropriate tissue necrosis cannot be achieved, whereas other studies have presented significant successful outcomes by the endocardial approach for the ablation of the sites anatomically near the LV summit, such as the left and right coronary cusps and the RVOT. [11,12,15] On the other hand, these studies have insisted on the significance of the transmural ablation of the arrhythmia site or the creation of a circumferential conduction block in the exit sites of ventricular arrhythmias if ablative therapy cannot produce transmurality, if the sites are not well-approachable due to anatomic obstacles, or if the RF ablation should be ceased because of close contact with the coronary arteries.[16,17] Generally, we assume that our approach to LV summit lesions or the quality of RF in regard to the duration or depth of penetration was responsible for this low rate of responsiveness.

Limitations:

The small study sample population was the salient limitation of this study. Moreover, due to the COVID-19 pandemic, it was not possible to follow up on all the patients who entered the study. In addition, a more comprehensive study design is required to assess more detailed clinical characteristics and procedural aspects with a view to offering a better insight into RFCA failure.

CONCLUSIONS

According to the findings of the present study, ventricular arrhythmias with a left-sided origin had a worse response to RFCA considering unresponsiveness or delayed arrhythmia elimination. We found no association between the age, sex, and LVEF of the patients who never experienced successful arrhythmia cessation compared with those with delayed idiopathic PVC cessation.

REFERENCES

1. Lee A, Walters TE, Gerstenfeld EP, Haqqani HM. Frequent ventricular ectopy: implications and outcomes. Heart, Lung and Circulation. 2019; 28(1):178-90.

2. Penela D, Martínez M, Fernández-Armenta J, Aguinaga L, Tercedor L, Ordóñez A, et al. Influence of myocardial scar on the response to frequent premature ventricular complex ablation. Heart. 2019; 105(5):378-83.

3. Yamada T. Idiopathic ventricular arrhythmias: relevance to the anatomy, diagnosis and treatment. Journal of Cardiology. 2016; 68(6):463-71.

4. Shirai Y, Liang JJ, Santangeli P, Supple GE, Riley MP, Garcia FC, et al. Catheter ablation of premature ventricular complexes with low intraprocedural burden guided exclusively by pace-mapping. Journal of Cardiovascular Electrophysiology. 2019; 30(11):2326-33.

5. Latchamsetty R, Yokokawa M, Morady F, Kim HM, Mathew S, Tilz R, et al. Multicenter outcomes for catheter ablation of idiopathic premature ventricular complexes. JACC: Clinical Electrophysiology. 2015; 1(3):116-23.

6. Im SI, Voskoboinik A, Lee A, Higuchi S, Moss JD, Hsia H, et al. Predictors of long-term success after catheter ablation of premature ventricular complexes. Journal of Cardiovascular Electrophysiology. 2021; 32(8):2254-61.

7. Ding L, Hou B, Wu L, Qiao Y, Sun W, Guo J, et al. Delayed efficacy of radiofrequency catheter ablation on ventricular arrhythmias originating from the left ventricular anterobasal wall. Heart Rhythm. 2017; 14(3):341-9.

8. Yao Y, Zhang S, He DS, Zhang K, Hua W, Chu J, et al. Radiofrequency ablation of the ventricular tachycardia with arrhythmogenic right ventricular cardiomyopathy using non-contact mapping. Pacing and clinical electrophysiology. 2007; 30(4):526-33.

9. Candemir B, Baskovski E, Duzen V, Coskun F, Vurgun K, Goksuluk H, et al. Late elimination of challenging idiopathic ventricular arrhythmias originating from left ventricular summit by anatomical ablation. Indian Pacing and Electrophysiology Journal. 2019; 19(3):114-8.

10. Futyma P, Wysokińska A, Sander J, Futyma M, Kułakowski P. Bipolar endo-epicardial radiofrequency ablation of arrhythmia originating from the left ventricular summit. Circulation Journal. 2017:CJ-17-0782.

11. Yamada T, Yoshida N, Doppalapudi H, Litovsky SH, McElderry HT, Kay GN. Efficacy of an anatomical approach in radiofrequency catheter ablation of idiopathic ventricular arrhythmias originating from the left ventricular outflow tract. Circulation: Arrhythmia and Electrophysiology. 2017; 10(5):e004959.

12. Yamada T, Doppalapudi H, Maddox WR, McElderry HT, Plumb VJ, Kay GN. Prevalence and electrocardiographic and electrophysiological characteristics of idiopathic ventricular arrhythmias originating from intramural foci in the left ventricular outflow tract. Circulation: Arrhythmia and Electrophysiology. 2016; 9(9):e004079.

13. Lin C-Y, Chung F-P, Lin Y-J, Chong E, Chang S-L, Lo L-W, et al. Radiofrequency catheter ablation of ventricular arrhythmias originating from the continuum between the aortic sinus of Valsalva and the left ventricular summit: electrocardiographic characteristics and correlative anatomy. Heart rhythm. 2016; 13(1):111-21.

14. Enriquez A, Malavassi F, Saenz LC, Supple G, Santangeli P, Marchlinski FE, et al. How to map and ablate left ventricular summit arrhythmias. Heart Rhythm. 2017; 14(1):141-8.

15. Muser D, Santangeli P, Castro SA, Pathak RK, Liang JJ, Hayashi T, et al. Long-term outcome after catheter ablation of ventricular tachycardia in patients with nonischemic dilated cardiomyopathy. Circulation: Arrhythmia and Electrophysiology. 2016; 9(10):e004328.

16. Fenelon G, Brugada P. Delayed effects of radiofrequency energy: mechanisms and clinical implications. Pacing and Clinical Electrophysiology. 1996; 19(4):484-9.

17. Inoue Y, Shirota K, Ishii H, Tsunoda F, Mimura A, Kondo T, et al. Delayed success following radiofrequency catheter ablation of ventricular premature contractions originating from right ventricular mid septum. Journal of Arrhythmia. 2011; 27(Supplement):PE4_128-PE4_.