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10-year follow-up after radiofrequency ablation of idiopathic ventricular arrhythmias from right ventricular outflow tract



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ABSTRACT

Background: The aim of this study was to examine the effect of radiofrequency ablation (RFA) of ventricular arrhythmias from right ventricular outflow tract (RVOT) during long-term follow-up.

Methods: A follow-up analysis was conducted using an in-house questionnaire, as well as a qualitative assessment of the patients' medical records. The study population of 34 patients had a previous diagnosis of idiopathic VT or frequent PVCs from the RVOT, and received RFA treatment between 2002 and 2005.

Results: The main symptoms prior to RFA were palpitations (82.4%) and dizziness (76.5%). A reduction in symptoms following RFA was reported by 91.2% of patients ($p < 0.001$). Furthermore, there was a reduced use of antiarrhythmic medication after RFA ($p < 0.001$). General health perception classified on a scale of 1 (poor) to 4 (excellent), improved from median class 1 to 3 ($p < 0.001$) during long-term follow-up. The fitness to work increased from median class 3 to class 5 (1 = incapacitated, 5 = full time employment, $p = 0.038$), while the rate of patients in full time employment increased from 26.5% to 55.9% after RFA ($p = 0.02$).

Conclusions: A reduction of symptoms and use of antiarrhythmic medication, as well as an improvement in the general health perception and fitness to work after RFA of idiopathic ventricular arrhythmias can be demonstrated at ten-year follow-up.

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1. Introduction

Idiopathic ventricular tachycardia (VT) or frequent premature ventricular contractions (PVCs) from the right ventricular outflow tract (RVOT) occur in patients without structural heart disease. Although the patients with these arrhythmias can be highly symptomatic, these arrhythmias tend to follow a benign clinical course [1,2]. The aim of the treatment is therefore to reduce symptoms and improve quality of life [3]. Radiofrequency ablation (RFA) is a safe and effective treatment to reduce symptoms and eliminate VT and PVCs [4]. As many of the patients are young and healthy individuals, a single intervention with RFA may be

preferred over the lifelong use of antiarrhythmic drugs. In patients with frequent PVCs from RVOT it may also improve cardiac function [5]. Some patients experience recurrent tachycardia, which potentiates the development of cardiomyopathy and heart failure. These patients could also benefit from RFA treatment [6,7]. RFA is generally more successful in patients with VT and PVCs originating from the RVOT than from other heart structures [8]. A high success rate of RFA treatment is well documented at mid- and short-term follow-up (FU), but knowledge about long-term FU is still limited [9]. The aim of this retrospective study is to examine the effect of the RFA treatment at long-term FU, measured by the patient's symptomatic complaints, use of antiarrhythmic medication, general health perception and their reported fitness to work.

2. Materials and methods

2.1. Study population

The study population consisted of patients recruited from a local quality register at our hospital. All patients suffered from idiopathic

Abbreviations: ECG, electrocardiography; FU, follow-up; PVCs, premature ventricular contractions; RFA, radiofrequency ablation; RVOT, right ventricular outflow tract; VT, ventricular tachycardia.

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VT or frequent PVCs from RVOT and had been treated with RFA in the time period from 2002 to 2005. The patients had been examined by echocardiography, magnetic resonance images/computer tomography and/or coronary angiography prior to the procedure to rule out structural heart disease, as such patients were excluded from the study. The study was approved by the regional ethical committee and informed consent was obtained from all patients.

2.2. Electrophysiological study and ablation procedure

All patients were fasting and under mild sedation to avoid potential suppression of clinical VT or PVCs. If spontaneous VT or PVCs was not observed, they were induced by pace and/or isoproterenol infusion. This was registered on a 12-lead surface electrocardiography (ECG) and used as template for pace mapping (BARD, electrophysiology, Lowell, USA). Activation mapping was used with ($n = 18$) or without ($n = 16$) a 3-dimensional mapping system (EnSite array, Endocardial Solutions, SJ Medical, St. Paul, USA) in addition to pace mapping in all procedure. Radiofrequency ablation was performed using a 4 mm-cool tip ablation catheter (Biosense Webster Cordis, Diamond Bar, USA) in all procedures except one, where a 4 mm non-irrigated tip catheter was used. The ablation was performed at the best achievable pace map and/or the site of earliest local activation. After ablation, all patients were kept under observation for 30 min. The elimination of spontaneous clinical VT or PVCs via isoproterenol administration and non-inducibility of the clinical ventricular arrhythmias was the procedural endpoint. A pericardial effusion was ruled out in all patients 24 h post intervention.

2.3. Follow-up

The patients were examined using an in-house questionnaire comprising a self-evaluation score. The patients were asked to report on all symptoms commonly experienced from these arrhythmias. They also rated their overall general health perception as a consequence of their arrhythmia on a scale from 1 (poor) to 4 (excellent), as well as their fitness to work on a scale from 1 (incapacitated) to 5 (full time employment) prior to RFA, immediately after treatment with RFA and at long-term FU. The antiarrhythmic drugs were listed in the questionnaire. All patients were contacted by telephone and given sufficient information to avoid any misinterpretation of the self-evaluation scores. A qualitative assessment of the patients' medical records was also performed. A 12-lead ECG recording was performed in patients who were able to sustain an outpatient examination, either in the ambulatory clinic at our hospital or at their local hospital. All follow-ups and ECG were conducted at long-term FU, 10 years after the RFA procedure.

2.4. Statistical analyses

Statistical analyses were performed using SPSS version 22 (SPSS, Chicago, IL, USA). Discrete variables were reported as percentages and continuous variables as mean \pm SD, and compared using the paired Student's *t*-test and nonparametric Wilcoxon Rank test. Median and range values were also presented. *P* values < 0.05 were considered statistically significant.

3. Results

Of the 36 patients originally included in the study, one patient pulled out of the study whilst one patient died during the RFA procedure, leaving 34 patients eligible for analysis. 11 participants suffered from idiopathic VT whilst 23 patients experienced frequent PVCs from the RVOT. The final study population that

participated in a long-term-follow-up program comprised 18 females and 16 males with an average age of 56.3 ± 12.6 (range 32–81) years.

3.1. Electrophysiological study and ablation procedure

The RFA procedure was performed using activation mapping, with ($n = 18$) or with out additional 3D mapping system ($n = 16$), and pace mapping. X-ray duration in the 3D group was significantly higher compared to the pace mapping group (56.4 ± 30.5 versus 24.3 ± 18.6 min, $p < 0.05$). Prior to the ablation procedure, VT was induced in 11 patients, whilst PVCs occurred spontaneously or was induced in the remaining 23 patients. VT or PVCs could not be induced in 30 patients after the ablation procedure, while four patients had considerably fewer episodes of PVCs, resulting in an immediate success rate of 88.2% from the RFA treatment. One of the initially unsuccessfully treated patients underwent further successful ablation after 2005, resulting in a long-term success rate of 91.2% overall. During long-term follow-up three patients who had an initial successful RFA had recurrence of arrhythmia (10%). Two of those patients underwent further successful ablation after 2005, but the last patient chose treatment with antiarrhythmic medication instead of a new RFA.

3.2. Follow-up

The time from the RFA procedure to follow-up had a mean of 10.9 years and a range of 9–12 years. The response rate was 97%.

3.3. Twelve-lead electrocardiogram analysis

A 12-lead ECG was performed on 17 patients (50%). ECG readings from 12 patients (70.6%) showed a normal ECG without any PVCs. Three patients (17.6%) displayed continuous PVCs on ECG post intervention. One patient (5.9%) presented with Q waves in the precordial leads and one patient (5.9%) developed asymptomatic first-degree atrioventricular block.

3.4. Effect of RFA on symptoms and antiarrhythmic medications

The main symptoms prior to RFA treatment were palpitations (82.4%) and dizziness (76.5%). Reported symptoms are listed in Table 1. A statistically significant reduction in symptoms following RFA treatment was reported by 91.2% of patients ($p < 0.001$) at long-term follow-up. Out of these patients, 55.9% reported no clinical symptoms and 35.3% experienced a reduction in their symptomatic burden. Antiarrhythmic drugs such as sotalol, beta-blockers, potassium channel blockers and amiodarone were used in 26 patients prior to RFA. Ten patients used antiarrhythmic medication after RFA at long-term FU, and a significant reduction of antiarrhythmic medication could be demonstrated ($p < 0.001$). The

Table 1
Reported symptoms prior to RFA.

Reported symptoms prior to RFA	Percentage (%)
Palpitations	82.4
Diaphoresis	35.3
Dyspnoea	47.1
Dizziness	76.5
Syncope	38.2
Chest pain	35.3
Other	41.2
No reported symptoms	2.9

RFA, radiofrequency ablation.

mean medication use prior to RFA was 1.76 ± 0.43 compared to 1.29 ± 0.46 after RFA at long-term FU ($p < 0.001$).

3.5. Effect of RFA on general health perception and fitness to work

General health perception improved significantly from median class 1 to 3 ($p < 0.001$) immediately after RFA and remained stable at long-term follow-up (Fig. 1). The mean general health perception was 1.7 ± 1.1 prior to RFA, 2.95 ± 0.95 immediately after RFA and 3.18 ± 0.80 at long-term follow-up. There was no statistically significant ($p = 0.19$) improvement in general health perception at long-term follow-up compared to short-term follow-up. The fitness to work showed a statistically significant increase ($p = 0.038$) from median class 3 prior to RFA to class 5 at long-term FU. The mean fitness to work was 2.65 ± 1.23 prior to RFA, and 3.50 ± 1.86 at long term FU. Fig. 2 presents percentages of patients in full time employment.

4. Discussion

This study documents the long-term follow-up (>10 years) after RFA treatment on patients with idiopathic ventricular arrhythmias originating from the RVOT. The purpose of this study was to examine patient's clinical outcome. This as extensive research focusing on rhythm surveillance and ECG morphology previously had been documented, and the clinical aim of RFA treatment was to eliminate symptoms and improve quality of life [10,11]. Our major findings included both a reduction of symptoms and use of antiarrhythmic medication. Furthermore, patients reported an improvement in both their general health perception and fitness to work.

Our study showed an immediate success rate of 88.2% from RFA treatment. Reasons for unsuccessful RFA treatment were either that the arrhythmia foci were anatomically inaccessible, or that the arrhythmias were non-inducible prior to the procedure. Three of the patients with unsuccessful RFA undertook a new RFA in the time period from 2002 to 2005 or later. The second attempt proved successful for all three patients. The last patient with an unsuccessful ablation chose antiarrhythmic drug therapy instead of a new RFA, and reported no symptomatic burden at ten years follow up. The overall recurrence rate in the study population was 10%. A similar recurrence rate was also documented by Buxton et al. [12].

Palpitations and dizziness were the most commonly reported symptoms. Dizziness is a common medical symptom that can

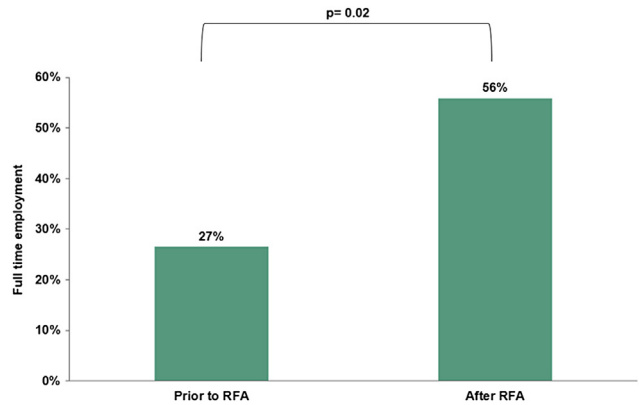


Fig. 2. Percentage of patients in full time employment prior to RFA and after RFA at long-term follow-up. RFA, radiofrequency ablation.

significantly affect the patient's daily activities [13] and can be caused by factors other than cardiac arrhythmias [14]. It is thus difficult to determine whether the dizziness was caused by VT or PVCs, and not from other common causes. However, our study showed that 91.2% of patients reported a statistically significant improvement in ailments related to heart rhythm disorder immediately after RFA treatment and during long-term FU, supporting the suspicion that ailments actually was related to the heart rhythm disorder. Of these patients, 35.3% experienced a decrease in their symptomatic burden. Although they still suffered from ailments related to their VT or PVC after RFA treatment, it did not affect their fitness to work and general health perception during long-term FU.

Our study showed a significant reduction in the use of antiarrhythmic medication after RFA at long-term FU. However, ten patients were still using antiarrhythmic medication at long-term FU. This is not unexpected, as 35.3% of patients experienced a decrease in symptomatic burden only, and 8.8% of patients reported no improvement in ailments overall. For patients who used antiarrhythmic medicine before and not after RFA, and got an improvement in ailment after RFA we can assume that the improvement is due to RFA. For patients using antiarrhythmic medication before and after RFA, but still got an improvement in ailments after RFA, we cannot rule out that the improvement of the ailments are partially placebo effect. Use of antiarrhythmic medication is still the preferred first choice of treatment of idiopathic VT or PVC [15,16].

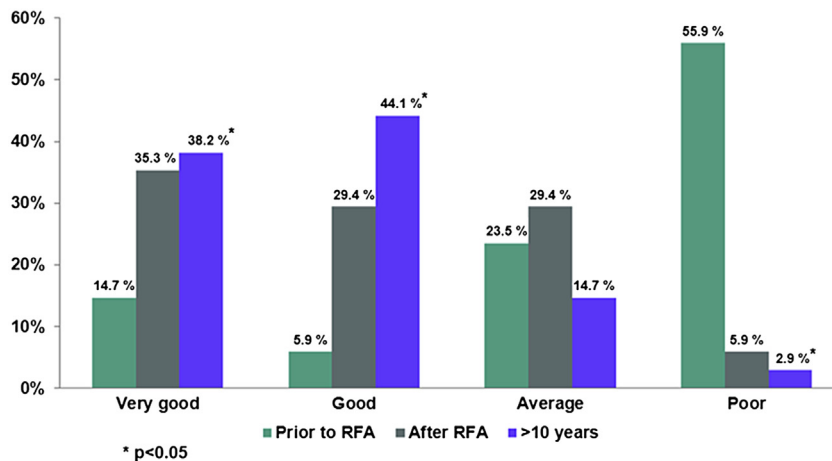


Fig. 1. Percentage reported general health perception of total study group prior to RFA, after RFA and during long-term follow-up. RFA, radiofrequency ablation. *Indicates a statistically significant improvement in health perception, at 5%, when comparing prior to RFA and long-term follow-up.

However, undergoing RFA treatment may prevent many patients from the lifelong need of antiarrhythmic medication, with their potential side effects, as well as the risk of polypharmacy. The potential medical and financial implications could make RFA the preferred treatment among the patients.

General health perception improved significantly following RFA treatment. General health, symptoms and employability are all interlinked factors affecting a patient's quality of life. Although there was no statistically significant improvement in general health perception at long-term follow-up compared to immediately after RFA treatment, an improving trend was observed. Approximately 21% of the patients reported that their general health was very good or good prior to RFA. This perception was due to limited or no symptomatic burden, which was consistent with previous studies [1]. They documented that some patients with idiopathic VT or PVCs are asymptomatic. The percentage of patients in full time employment more than doubled at long-term follow up to 55.9% compared to 26.5% prior to RFA, demonstrating the medical and social benefits of RFA. Whilst one patient (2.9%) was incapacitated due to arrhythmia, the remaining 41.2% of the patients are not in full time employment due to retirement, incapacitation or sick leave for other reasons than the heart rhythm disorder. This supports our finding that RFA positively affects fitness to work during long-term FU.

None of the patients had clinically developed heart failure, malignant clinical arrhythmia or sudden arrhythmogenic death at long-term follow-up. However, we have no data available concerning the echocardiographic findings in our patient population.

The average x-ray duration in the 3D mapping group was higher compared to the pace mapping group. This might be explained by the use of the 3D system in an early stage of development whereas pace mapping has been a part of clinical routine for several years.

The results of this study can be influenced by the population size and the number of patients lost to follow-up. The small sample size may have reduced the power of the statistical analysis resulting in non-significant results. Furthermore, if the patients lost to follow up had answered significantly different from the average population it would affect the results. According to Isaac and Michael [17] a response rate of at least 80% is necessary to obtain good estimates. Of all patients who were given the questionnaire only one patient chose not to participate in the study. The response rate in the patient population was thus 97%, and the results are unlikely to have been skewed by this absence. This is evident as previous studies on RFA treatment of VT or PVC (including non-idiopathic arrhythmia) use similar sample sizes [5,18–20].

4.1. Limitations

This is a descriptive study of a relatively small number of patients without a control group. As there was no validated template questionnaire available for the main purpose of this study, an in-house questionnaire with disease specific questions was considered the most appropriate approach to identify patients' overall burden of arrhythmia. To ensure that the answers were reliable an additional follow-up was completed via telephone to avoid any misunderstanding about the questionnaire. As it could be challenging to accurately recall details from events occurring ten years previously, the patient's medical records were used as supporting documentation, allowing for possible recall bias. No long-term rhythm surveillance (Holter) was obtained, as the patients were geographical spread across the country. However, a 12-lead ECG can reveal some PVCs. The procedural records do not include procedure time and radiofrequency time that might be of interest.

5. Conclusions

In conclusion, a reduction in the use of antiarrhythmic medication and symptoms, as well as an improvement in general health perception and fitness to work, after RFA treatment of idiopathic VT or PVCs can be demonstrated after a long-term follow up of ten years.

Conflict of interest

None declared.

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