Outcomes of Catheter Ablation of Ventricular Tachycardia in
Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy (ARVD/C)

Running title: Philips et al.; Efficacy of Catheter Ablation of VT in ARVD/C

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cardiomyopathy disease; [22] Ablation/ICD/surgery
Abstract:

**Background** - Prior reports evaluating the efficacy of catheter ablation of VT among patients with arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C) have reported varied outcomes. More recently, studies have suggested that an epicardial ablation is necessary for improved outcomes after catheter ablation of VT. The overall objective of the study was to assess the efficacy of radiofrequency catheter ablation (RFA) of ventricular tachycardia (VT) in ARVD/C with particular focus on newer ablation strategies including epicardial catheter ablation.

**Methods and Results** - The study population included 87 ARVD/C patients who underwent a total of 175 RFA procedures between 1992 and 2011 at 80 different electrophysiology centers. Recurrence of VT following RFA, and effect of RFA on the burden of VT were assessed. Mean age of the cohort was 38 ± 13 years. Over a mean follow up of 88.3 ± 66 months, the overall freedom from VT of the total 175 procedures was 47%, 21%, and 15% at 1, 5, and 10 years, respectively. The cumulative freedom from VT following epicardial RFA was 64% and 45% at 1 and 5 years which was significantly longer than endocardial RFA (p=0.021). Survival free of VT among procedures with 3D-electroanatomical mapping was significantly longer compared to procedures without 3-D electroanatomical mapping (p=0.016). Burden of VT was reduced irrespective of the ablation strategy (p<0.001).

**Conclusions** - While VT recurrences are common, RFA results in a significant reduction in the burden of VT in ARVD/C patients. Although the use of 3D-electroanatomic mapping systems and epicardial ablation strategies are associated with longer survival free of VT, recurrence rates remain considerable.

**Key words:** arrhythmogenic right ventricular dysplasia; catheter ablation; ventricular tachycardia

**Abbreviations:** ARVD/C = Arrhythmogenic right ventricular dysplasia/cardiomyopathy; DLP = Discrete late potentials; EGM = Electrocardiogram; EP = Electrophysiology; ICD = Implantable Cardioverter Defibrillator; RFA = Radiofrequency catheter ablation; RV = Right ventricle; VT = Ventricular tachycardia
Introduction

Arrhythmogenic right ventricular dysplasia/cardiomyopathy (ARVD/C) is an inherited cardiomyopathy characterized by progressive fibro-fatty replacement of the right ventricular (RV) myocardium. Structural abnormalities can be diffuse\(^1\) and provide a substrate for re-entrant ventricular tachycardia (VT). Studies have shown a significantly high incidence of ventricular arrhythmias\(^2-4\) among patients with ARVD/C. Although the risk of sudden death is mitigated by implantable cardioverter defibrillator (ICD) implantation, recurrent ICD firings due to rapid ventricular arrhythmias are common\(^5\) and often a cause of significant morbidity in these patients.

Radiofrequency catheter ablation (RFA) is increasingly used in the management of VT in ARVD/C. Early studies evaluating the efficacy of catheter ablation of VT among ARVD/C patients reported varied outcomes using an endocardial based ablation strategy and have mostly reported outcomes performed in referral centers specialized in VT ablation\(^6-9\). However, there have been recent advances in the technology related to catheter ablation and better understanding of the VT substrate in ARVD/C. The reasons for failure after catheter ablation of VT are attributed to predominant epicardial distribution of the disease, existence of multiple re-entrant pathways, and possibly a progressive disease process. In keeping with these findings, several recent studies have reported significantly lower VT recurrence among ARVD/C patients who underwent an epicardial substrate based ablation strategy\(^10,11\).

The purpose of this study was to report multi-center outcomes of catheter ablation of VT in a large series of patients with ARVD/C who were enrolled in the Johns Hopkins ARVD Registry (ARVD.COM). There were three main goals of our study. First, we sought to determine whether catheter ablation outcomes for ARVD/C have improved with use of electroanatomic mapping systems and epicardial VT ablation. Secondly, we sought to evaluate
the complications associated with VT ablation in ARVD/C patients. And lastly, we sought to determine the impact of catheter ablation on the burden of VT.

**Methods**

**Study population**

The study population included 87 patients enrolled in the Johns Hopkins ARVD registry who were classified as having the diagnosis of definite ARVD/C according to the 2010 Revised Task Force Criteria and had undergone 1 or more attempts at RFA for treatment of VT. The result of RFA in 24 of these subjects was included in an earlier investigation. A total of 175 RFA procedures were performed in this cohort between 1992 and 2011 at 80 different electrophysiology (EP) centers throughout the United States and Canada. The majority of the total RFA procedures (55%) were performed in 33 academic centers that were affiliated with a medical school. Among the procedures performed at academic centers, 44% were performed at the Brigham and Women’s Hospital, Johns Hopkins Hospital, and the Hospital of the University of Pennsylvania.

Of the entire cohort, 23 ARVD/C patients underwent 26 epicardial catheter ablation procedures which were performed in 8 referral centers specialized in catheter ablation of VT. Nineteen of the 23 patients had previously failed at least one endocardial catheter ablation procedure. In these cases, the decision to proceed with an epicardial ablation procedure was based on the findings from the prior EP study in which endocardial mapping suggested an epicardial VT circuit and endocardial ablation was unsuccessful. The decision to perform an epicardial ablation as the first procedure among 4 patients was guided both by recent publications in this field and the discretion of the electrophysiologist. 10 procedures were solely...
epicardial with the remainder being endo/epicardial procedures.

All patients included in this registry provided written informed consent, which was approved by the Johns Hopkins School of Medicine Institutional Review Board.

**Data collection**

Detailed clinical information regarding non-invasive and invasive testing was available for each patient. Electrophysiology (EP) procedure reports for all RFA procedures were obtained. Details of electroanatomic mapping, type of ablation catheter, as well as the particular ablation strategy and acute outcomes of the RFA procedure were recorded.

**Electrophysiology study, mapping, and ablation techniques**

EP testing and RFA procedures including conventional mapping and ablation techniques and substrate based ablation targeting isolated late potentials have been previously described\textsuperscript{13,14}. Clinical VT(s) were defined by comparison of a 12 lead ECG of spontaneous and induced VT, and when not available, by comparison of induced and spontaneous VT cycle lengths and/or stored ICD electrograms (EGMs)\textsuperscript{15}. Conventional endocardial mapping and ablation techniques included pace mapping, activation mapping, and entrainment mapping. Electroanatomic mapping, including activation and voltage mapping, facilitated ablation during many of the ablation procedures. Epicardial mapping and ablation was performed in a subset of patients by accessing the pericardium via a percutaneous subxiphoid puncture, as previously described\textsuperscript{16}.

Catheters used for mapping and ablation included the standard 4-mm tipped deflectable ablation catheter or the 3.5-mm externally irrigated-tip catheter (Thermocool, Biosense Webster, Diamond Bar, California). Acute procedural success was defined as “total”, if all VTs remained non-inducible during programmed stimulation, “partial”, if clinical VT was non-inducible but other VT morphologies remained inducible, and “failure”, if clinical VT remained inducible at
the end of the ablation.

Follow-up

All patients were followed routinely by their treating electrophysiologist and contacted at yearly intervals. In patients with ICDs, the interrogation reports were reviewed by an experienced electrophysiologist (HC). Recurrence of VT and appropriateness of ICD therapy were determined based on review of the stored EGMs\textsuperscript{17}. In patients without ICDs, VT recurrence was based on documented sustained VT on event monitoring or clinical presentation with sustained VT. Any VT recurrence during follow up, whether symptomatic, treated, or untreated was considered as failure. Arrhythmia burden was determined in a subset of patients in whom complete ICD interrogation information was available for detailed review and analysis, for one year before and after the ablation. In rare cases in which there were multiple procedures within a year, the rate of sustained VT per month was extrapolated from a shorter time period.

Definitions

Sustained VT was defined as tachycardia originating in the ventricle with rate > 100 beats/minute and similar QRS morphology from beat to beat lasting \( \geq 30 \) seconds or that requires an intervention for termination\textsuperscript{18}. VT recurrence was defined as appropriate ICD intervention or spontaneous, sustained VT based on the analysis of a 12 lead ECG, event monitor, or 24-h Holter monitor subsequent to the ablation procedure. VT burden was defined as the rate of appropriate ICD intervention per month and compared between the one year interval before and after catheter ablation.

Survival Data and Statistical Analysis

Continuous variables are expressed as mean ± SD, and categorical variables as frequency (%). Follow-up time was determined from the time of procedure until the occurrence of a VT event,
loss of follow-up, heart transplant, or death. Kaplan-Meier survival analysis was used to determine the cumulative VT recurrence and ICD shock free survival in the study population.

The individuals who had more than 1 procedure re-entered the survival analysis after their initial recurrence and were followed up until they experienced an event or were censored again. To include the subsequent procedures in the survival analysis, a staggered entry approach was used. This process was repeated for each time that a new RFA procedure was performed on the same patient. Repeated procedures performed on the same patient were assumed to be independent. Comparisons in the cumulative event-free survival were made using the log-rank test. The burden of VT before and after an ablation procedure was compared using the Wilcoxon signed-rank test.

All data analyses for research aims were performed using Statistical Analysis Software version 9.2 (SAS 9.2). A p value of <0.05 was considered to be significant.

Results

Patient characteristics

The patient population consisted of 87 patients who underwent RFA for VT. The baseline characteristics of the study population are listed in Table 1. The mean age at first procedure was 38 ± 13 years and 45 (52%) patients were male. The majority of patients (95%) had ICD implantation except for 5 (5%) patients who did not have ICD implantation at the end of follow up. All patients met the revised diagnostic criteria for definite ARVD/C.

Of the 87 patients, 18 required a single procedure, with the remainder requiring on average 2.3 procedures (range 2-5 procedures). Thirty eight percent of patients had failed at least one Class 1 or 3 antiarrhythmic medication prior to their first ablation procedure while 59% of
patients had failed at least one antiarrhythmic drug prior to their last ablation procedure. Fifty six percent of patients remained on an antiarrhythmic medication following their most recent ablation procedure. Among patients who had undergone an epicardial catheter ablation, 63% patients were on antiarrhythmic drug therapy prior to catheter ablation while 41% patients remained on antiarrhythmic drug therapy during the follow up period. Sotalol was the most frequently used antiarrhythmic medication followed by amiodarone.

**Electrophysiology study, mapping, and ablation**

Three-dimensional electroanatomic mapping was used to facilitate ablation in 114 (69%) of the 166 total procedures in which information on the use of a mapping system was available. Radiofrequency energy was delivered via an irrigated-tip catheter during 50 procedures (29%) and through a standard 4-mm tipped deflectable ablation catheter in the remainder of procedures. The clinical VT was successfully ablated in 82% of the procedures. Total acute success was observed in 47%, partial success in 38%, and procedural failure in 15% of 160 procedures (this information was unavailable for 12 procedures). Forty six (53%) of the 87 patients underwent repeat procedures.

**Impact of Catheter Ablation on VT Recurrence**

The mean follow up duration was 88.3 ± 66.1 months (median 72.1 months). VT recurrence-free survival for the 175 procedures in 87 patients is shown in Figure 1. Freedom from VT after a single RFA procedure was 47% (95% CI 39.9 -54.9), 31% (95% CI 24.0-38.6), 21% (95% CI 15.0-29.1), and 15% (95% CI 7.8-23.9) at 1, 2, 5, and 10 years, respectively. The cumulative VT free survival after a single RFA procedure was 75% at 2.4 months, 50% at 10.8 months, and 25% at 37.2 months. The mean time to VT recurrence following catheter ablation was 12.7 ± 23.3 (median 4.8 months; range 1.2 – 150) months among all RFA procedures.
Figure 2 compares cumulative VT recurrence free survival among endocardial and epicardial catheter ablation procedures. Cumulative freedom from VT following a single endocardial RFA was 45% (95% CI 36.6-52.6), 29% (95% CI 21.6-36.6), and 19% (95% CI 12.7-26.7) compared to 64% (95% CI 44.1-82.8), 45% (95% CI 23.9-72.3), and 45% (95% CI 23.7-71.0) following a single epicardial RFA at 1, 2, and 5 years, respectively (p=0.021). The cumulative VT free survival after a single endocardial ablation procedure was 75% at 2.4 months, 50% at 8.4 months and 25% at 33.6 months. The cumulative VT free survival after a single epicardial RFA was 75% at 9.6 months and 50% at 16.8 months. Additionally, there were 10 epicardial procedures and 8 endocardial procedures matched by age, 3D mapping technique, repetition of procedure, and center performing RFA among 18 individuals with catheter ablation after 2005. VT free survival was significantly longer after epicardial RFA as compared to endocardial RFA among this matched cohort (p=0.003; figure not shown).

VT free survival was significantly longer among patients in whom a 3-dimensional electroanatomic mapping system was used to facilitate the ablation procedure (Figure 3). Freedom from VT following a single ablation procedure facilitated by 3D-electroanatomical mapping was 50% (95% CI 40.5-58.9), 34% (95% CI 25.5-44.4), and 24% (95% CI 15.4-34.7) compared to 36% (95% CI 23.3-49.3), 16% (95% CI 7.2-27.1), and 8% (95% CI 2.2-16.9) following a single ablation procedure not facilitated by 3-D electroanatomical mapping at 1, 2, and 5 years, respectively (p=0.016).

Survival analysis showed no significant differences in freedom from VT based on acute procedural success (total success, partial success, or failure of ablation procedure), repetition of ablation procedure, type of ablation catheter (standard vs. irrigated), and the facility where the ablation was performed (academic vs. community hospitals) (all p>0.05; figures not shown).
Impact of Catheter Ablation on VT Burden

Forty three patients had detailed data on the frequency of VT 1 year prior to, and after the RFA procedure. Figure 4 illustrates VT burden 1 year before and after all RFA procedures. The mean frequency of VT was significantly lower after VT ablation [0.2 ± 0.4 (median 0.08) VT episodes/month (2 ± 5 episodes/year)] as compared with the VT frequency prior to ablation [0.4 ± 0.5 (median 0.16) VT episodes/month (5 ± 6 episodes/year)] (Figure 4a, p<0.001). Among epicardial catheter ablation procedures, the mean VT burden was reduced from 0.42 ± 0.4 (median 0.2) episodes/month prior to RFA to 0.05 ± 0.1 (median 0.0) episodes/month after RFA (Figure 4b, p<0.001).

Complications

There were two major complications in this cohort and both were associated with epicardial mapping and ablation. One patient developed incessant VT with associated hypotension during the procedure refractory to pharmacologic and mechanical support resulting in emergent thoracotomy. He later died from postoperative pulmonary complications. The other major complication was delayed myocardial infarction ten days after an epicardial mapping and ablation procedure. The patient had an occlusion of the distal posterior descending branch of the right coronary artery which was not intervened upon.

Discussion

This comprehensive study reports the outcomes among 87 patients with definite ARVD/C undergoing catheter ablation of VT at 80 different centers in the US and Canada. To date, this represents the largest cohort of ARVD/C patients who have undergone catheter ablation of VT and most closely reflects the outcomes achieved in widespread clinical practice. There are
several main findings of our study. First, our overall results reveal a high rate of VT recurrence after catheter ablation among patients with ARVD/C. Second, while the increasing use of electroanatomic mapping systems and epicardial ablation strategies are associated with longer freedom from VT, recurrences remain common. Lastly, catheter ablation results in a significant reduction in the burden of VT among ARVD/C patients, regardless of ablation strategy.

**Prior reports**

The novel approach of treating VT in ARVD/C patients with catheter ablation using DC fulguration was first described by Guy Fontaine and colleagues during the late 1980’s\(^{19-21}\). Subsequently, catheter ablation of VT using radiofrequency energy was described in six ARVD/C patients in 1992\(^{22}\). Since then, there have been numerous studies investigating radiofrequency catheter ablation outcomes in VT in patients with ARVD/C. These studies have reported variable rates of short and long term success after catheter ablation of VT\(^{6-9,11,19-21,23-31}\). Our group and others have reported poor long term outcomes following conventional RFA in ARVD/C\(^{7,9}\). Interpretation of these results is complicated by varying mapping and ablation strategies, differing definitions of procedural success, variable follow up, single center studies, and operator experience.

However, over the past several years, the strategy and technology involved in mapping and ablation of VT in ARVD/C patients has evolved\(^{32}\). The limitations of conventional mapping such as noninducibility or hemodynamic instability were overcome by using a substrate based mapping strategy facilitated by the use of electroanatomic mapping systems. Marchlinski et al defined the perivalvular substrate using electroanatomic mapping and reported good outcomes with a substrate based ablative strategy in 19 ARVD/C patients\(^{8}\). Using this technique, Verma et al reported good short term success, but VT recurrences became increasingly common during
long term follow up\textsuperscript{9}.

The pathological substrate in ARVD/C is often diffuse and involves the epicardium\textsuperscript{1}. The variable results achieved with catheter ablation may be related to inadequate characterization of the substrate. The importance of the epicardial approach was first recognized by Guy Fontaine who attempted epicardial ablation in a few cases that failed endocardial ablation\textsuperscript{24}. More recently, Garcia et al showed that the scar in ARVD/C is predominantly epicardial and isolated late potentials were much more frequently encountered in the epicardium in ARVD/C\textsuperscript{11}. In their cohort, a simultaneous endocardial/epicardial substrate based ablation strategy was associated with low recurrence rates of VT during long term follow up. Schmidt and colleagues corroborated these findings by showing that the presence of an epicardial substrate in ARVD/C was high (83\%) and 90\% of the successful procedures, defined as abolishing the clinical VT, required an epicardial approach\textsuperscript{28}. They reported recurrence of sustained VT in 38\% ARVD/C patients during follow up. Additionally, a recent prospective, multicenter study showed that an endocardial/epicardial ablation strategy was associated with higher long term freedom from VT as compared to endocardial ablation in patients with ARVD/C\textsuperscript{10}.

**Impact of RFA on VT Recurrence**

The study results are representative of catheter ablation outcomes achieved in broad clinical practice and reveal that freedom from VT was only 15\% among all procedures at 10 year follow up, with the majority of events occurring within the first year after catheter ablation. The majority of patients in our cohort required several catheter ablation procedures and continued to remain on AAD therapy during long term follow up. Despite the considerable rate of VT recurrence among the overall cohort, the use of electroanatomic mapping and epicardial based ablation strategies are associated with longer survival free of VT recurrence.
The benefits of an epicardial catheter ablation need to be carefully weighed against the risks associated with percutaneous subxiphoid pericardial access, mapping, and ablation. In our cohort, all of the complications associated with catheter ablation occurred in patients undergoing epicardial catheter ablation. Among all epicardial procedures, there was a 7.7% incidence of major complications. This is consistent with the findings reported by Sacher and colleagues in which they report the risk of an acute or delayed complication to be 7%33. Given these findings, epicardial catheter ablation should generally be considered after failing an endocardial ablation procedure. As with other complex procedures, the best results are likely to be achieved at centers with a particular interest in VT ablation.

Interestingly, successful ablation of the clinical VT in patients with ARVD/C does not translate into improved long-term survival free of VT. This finding emphasizes the importance of an ablation strategy targeting not only the critical circuit responsible for the clinical VT but also all regions of slow conduction because of the existence of multiple re-entrant pathways. Additionally, unlike other arrhythmias such as atrial fibrillation, repetition of procedure did not result in improved long-term survival free of VT. This may possibly be related to a progressive disease process or inadequate substrate modification. Lastly, there was no significant discrepancy in outcomes between procedures performed in community and academic hospitals suggesting homogeneity in the level of expertise among centers. However, this data is not reflective of individual centers and it is possible that outcomes may vary among centers that specialize in catheter ablation of VT.

**Impact of RFA on VT Burden**

To date, only one single center study has evaluated the burden of VT after RFA in a very small population of ARVD/C patients26. In our study, among all catheter ablation procedures, the
mean burden of VT was significantly reduced after RFA when comparing appropriate ICD interventions in the year prior to and following catheter ablation. Similarly, among epicardial ablation procedures, there was a significant decrease in the mean VT burden. Therefore, while VT recurrences are common after catheter ablation, the burden of VT is significantly decreased regardless of ablation strategy, which in itself is sufficient justification for treatment of recurrent VT with catheter ablation.

**Clinical Implications**

Recurrence of VT after catheter ablation is not uncommon in ARVD/C and emphasizes the fact that catheter ablation cannot be considered to be “curative” in the long term and should not be viewed as an alternative to placement of an ICD. On the other hand, catheter ablation of VT in ARVD/C patients does reduce VT burden, and because of this, should be viewed as an important treatment option for the subset of patients who are experiencing frequent recurrences of VT despite one or more antiarrhythmic medications. Catheter ablation of VT is also an important treatment option in patients who experience intolerable side effects to antiarrhythmic medications or prefer not to take antiarrhythmic medications. While epicardial catheter ablation is more efficacious than endocardial procedures, it should generally be considered after a prior failed endocardial ablation procedure given the higher complication rates associated with pericardial access, mapping, and ablation. This recommendation is tempered by a particular institutions experience and outcomes. In certain highly experienced centers, an initial combined endocardial/epicardial approach would also be appropriate.

**Limitations**

Our study has several limitations. First, due to the fact that our data is obtained as a part of a large registry, it is likely that there might be significant variability in the level of experience and
expertise in catheter ablation of VT among the centers that performed these ablation procedures. Although this is a limitation of our data, it also represents a strength, as the results of our study are likely to be applicable to the large body of electrophysiologists interested in catheter ablation of VT. In this regard, it is notable that our data showed no difference in outcomes between tertiary referral versus community centers. Second, many patients were referred to our hospital for further evaluation and management ARVD/C which may result in selection bias. This issue can only be resolved by a prospective, randomized study. Third, ICD programming changes following RFA were not systematically tracked when assessing VT recurrences and burden. However, we included both ATP therapy and ICD shock in our analysis. Fourth, correlation of the use of antiarrhythmics and their impact on outcomes was extremely challenging due to multiple changes in antiarrhythmic drugs based on physician preference and arrhythmia occurrence during follow-up. Fifth, staggered entry survival analysis may have been inadequate to discern the differences between subgroups and account for the relatedness of repeat procedures within the same patient. However, we found no difference in survival free of VT between first or repeat procedures. Lastly, the follow-up on patients who underwent epicardial ablation procedures was shorter as the majority of these procedures were performed in the last 5 years. However, the majority of VT recurrences among all the procedures occurred within the first year.

Conclusions

In conclusion, although the use of advanced mapping systems and epicardial substrate based ablation strategies are associated with improved catheter ablation outcomes in ARVD/C, VT recurrence rates remain considerable. However, catheter ablation of VT in ARVD/C patients
results in a significant reduction in the frequency of VT episodes regardless of the ablation strategy. Epicardial ablation procedures were associated with a 7.7% risk of major complications.

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**Conflict of Interest Disclosures:** Dr. Calkins is a consultant for Biosense Webster and Medtronic Inc. The other authors report no conflicts. The Johns Hopkins University Conflict of Interest Committee manages all commercial arrangements.

**References:**


Table 1. Baseline Characteristics of the Patients

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<th>Clinical Variable</th>
<th>Overall Population n=87</th>
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<tr>
<td>Age at time of first procedure (years)</td>
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<tr>
<td>Gender, male</td>
<td>45 (52)</td>
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<td>ICD implantation</td>
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</tr>
<tr>
<td>Before first procedure</td>
<td>38 (44)</td>
</tr>
<tr>
<td>At follow up‡</td>
<td>44 (51)</td>
</tr>
<tr>
<td>No ICD</td>
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<tr>
<td>Drugs, baseline† / follow up‡</td>
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<td>Amiodarone</td>
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<td>Flecainide</td>
<td>2 (2) / 1 (1)</td>
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*Discrete data shown with percentages in parenthesis. ICD = Implantable cardioverter-defibrillator.
† Baseline represents the interval before first catheter ablation procedure.
‡ Follow up represents the interval after last catheter ablation procedure.

Figure Legends:

Figure 1. Survival analysis showing the overall cumulative VT recurrence-free survival in the entire study population. The table below the graph represents the number of procedures at risk at the beginning of that time interval.

Figure 2. Survival analysis showing the comparison in the cumulative VT recurrence-free survival among epicardial and endocardial catheter ablation procedures. The table below the graph represents the number of procedures at risk at the beginning of that time interval.
Figure 3. Survival analysis showing the comparison in the cumulative VT recurrence-free survival among radiofrequency catheter ablation procedures facilitated by 3D electroanatomic mapping and conventional mapping. The table below the graph represents the number of procedures at risk at the beginning of that time interval.

Figure 4. A. Comparison of the rate of appropriate ICD interventions per month in the one year interval before and after catheter ablation (RFA) among all ablation procedures. The horizontal and vertical lines represent the mean and standard deviation, respectively. B. Comparison of the rate of appropriate ICD interventions per month in the one year interval before and after RFA among epicardial ablation procedures. The horizontal and vertical lines represent the mean and standard deviation, respectively.
Cumulative VT Free Survival

Follow up (years)

Number at risk

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p = 0.016
Mean = 0.42 ± 0.4 events/month

p < 0.001

Mean = 0.05 ± 0.1 events/month
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