

Beyond Binary Recurrence: ICD Therapy Burden Reduction as a Marker of Success of Catheter Ablation for Ventricular Tachycardia in Ischemic Heart Disease; and the Association of Scar Metrics with Arrhythmia Recurrence

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Abstract

Background

Catheter ablation (CA) is an established treatment for ventricular tachycardia (VT); however, outcomes are often reported as freedom from recurrence, which may not fully reflect clinical benefit. The significance of the underlying substrate in determining post-ablation outcomes remains uncertain.

Objective

To evaluate effectiveness of ablation strategy and assess predictors of VT recurrence and arrhythmia burden post ablation.

Methods

We conducted a retrospective study of 90 consecutive patients with ischemic cardiomyopathy undergoing VT ablation. Recurrence, defined as sustained VT, or any ICD therapy within the first 12 months. Scar measurements were assessed to determine prediction.

Results

Thirty-seven patients (41.0%) had arrhythmia recurrence. Mean scar area was $76 \pm 36.3 \text{ cm}^2$ in recurrence vs $57 \pm 31 \text{ cm}^2$ ($p=0.021$). Scar proportion $\geq 28.5\%$ emerged as possible independent predictor of VT on multivariate regression analysis. Mean LV ejection fraction (EF) was 28% in recurrence group vs 33% ($p=0.024$).

Median shock burden decreased from 2.0 (IQR 1.0–6.0) to 0.0 (IQR 0.0–1.0) post-ablation ($p<0.001$), and median anti-tachycardia pacing (ATP) burden decreased from 8 (IQR 2.25–21.3) to 0.0 (IQR 0.0–5.0) ($p=0.001$). Reduction in shock burden persisted among recurrent VT subjects (median shocks pre-CA 4 vs 1.0 post-CA, $p=0.001$).

Conclusion

Substrate burden and LV function were associated with recurrence. CA resulted in a significant reduction in ICD therapies, including those with VT recurrence supporting use of arrhythmia burden to measure success. Further studies are needed to evaluate impact of VT ablation on patient-centered outcomes, including quality of life measures.

Summary of the study

1. ICD therapies reduction is a meaningful marker of ablation success compared to binary recurrence.
2. Scar metrics derived from 3-D electro-anatomical mapping, was associated with recurrence. The findings reinforce prior work, emphasizing the role of substrate characteristics as a predictor of arrhythmia recurrence.
3. Scar proportion threshold of $\geq 28.5\%$ was strongly associated with VT recurrence (sensitivity of 74%, and OR of 3.9).

1. INTRODUCTION

Catheter ablation (CA) became an established therapeutic strategy for patients with sustained ventricular tachycardia (VT), particularly in patients experiencing implantable cardioverter defibrillator (ICD) shocks. Current guideline documents provide detailed recommendations regarding indications for ablation, procedural endpoints, and follow-up in patients with structural heart disease. They emphasize the role of CA in recurrent VT in the context of ischemic cardiomyopathy (ICM), particularly after failure of amiodarone therapy.¹⁻³ These recommendations reflect randomized and observational evidence supporting the role of CA as an effective invasive intervention for reducing recurrent arrhythmia more favourably in ICM, than patients with non-ischemic cardiomyopathy (NICM).⁴

Randomized trials like VANISH and VANISH2 trials showed VT ablation in ICM was superior to escalation of antiarrhythmic drugs (AAD) or as a first-line strategy.^{5,6} The BERLIN VT study found no difference in outcomes between preventive CA strategy before ICD implantation and deferred approaches, though VT events were significantly reduced with preventative CA arm over one year.⁷ The PARTITA trial showed early CA within 2 months of the first ICD shock reduced mortality, heart failure (HF) hospitalization (HFH) and reduced recurrent ICD shocks compared with conventional management.⁸ A meta-analysis indicated CA outperforms AAD (except amiodarone) by reducing ICD therapies and cardiovascular death.^{9,10} The lack of efficacy against amiodarone perhaps can be offset by lower risk of complication in CA strategy (6–8%)^{5,6,11}, compared to the long-term side effects of amiodarone with reduced patients' quality of life (QoL).^{12,13} ICD shocks impair QoL and cause psychological distress¹⁴, so reducing ICD therapy burden, including anti-tachycardia pacing (ATP) is a key success metric for VT ablation. VT recurrence as a binary outcome may not reflect procedural benefits, as patients often value fewer shocks and arrhythmia burden, even in asymptomatic recurrences. CA can decrease VT burden without complete elimination, supporting a broader, and patient-centered definition of procedural success.^{15,16} Predicting success before ablation procedure helps to plan procedures, and select suitable patients for CA versus radiation ablation therapy.

In terms of potential substrate predictors of recurrence, scar area remains an integral risk factor for VT in ICM. Cardiac magnetic resonance imaging (CMRI) studies have shown that larger scar burden, such as a pixel signal intensity signifying scar or endocardial scar area ≥ 65 cm², is associated with higher risk of VT recurrence post CA.^{17,18} Similarly, in another study of 59 patients, scar area and VT cycle length (VT-CL) were independent predictors of VT recurrence, with no recurrence seen in those with scar area ≤ 25 cm² and VT-CL > 350 milliseconds (ms).¹⁹

While VT-CL is a clinical parameter easily obtained from ICD electrograms, it has been variably associated with recurrence and has not been consistently integrated into risk models. Moreover, substrate-based variables, such as scar size derived from electroanatomical mapping (EAM) defined as voltage of ≤ 0.5 millivolt (mV), has shown to be a predictor of VT recurrence using a single tip mapping catheter in a small number of studies.^{19,20} With the increasing use of new-generation high-density (HD)

mapping catheters, it remains uncertain how precisely quantifying scar burden with HD mapping affects risk stratification and the prediction of VT recurrence, and whether this newer catheter technology reinforces the results of prior studies.

We conducted a retrospective single-center study of consecutive patients with ICM undergoing CA for VT or VT storm between January 2017 and December 2025. All patients had ICDs or cardiac resynchronization therapy defibrillators (CRT-Ds), with 12 months of device data available before and after ablation. The objectives of this study were: (1) to explore the relationship between the arrhythmogenic substrate, particularly scar burden derived from HD EAM, and subsequent clinical outcomes of VT recurrence and ICD therapy burden; (2) to evaluate the association between presenting VT-CL and arrhythmia recurrence, and (3) to quantify the impact of CA on the burden of ICD therapy following ablation. Recurrence was defined as sustained monomorphic VT lasting ≥ 30 seconds in the monitor zone, appropriate ICD shocks, or ATP.

The hypotheses for predicting VT recurrence following ablation were: (1) a higher scar burden, defined as scar ($< 0.5\text{mV}$) percentage of the total ventricular mapped area, (2) Clinical VT-CL $\leq 350\text{ms}$, and (3) CA would reduce ICD therapy burden, reflecting a meaningful outcome beyond binary recurrence.

2. METHODS

2.1 Study design and population

Our study was a retrospective observational study of consecutive patients undergoing catheter ablation for sustained VT at a single tertiary care center. A total of 99 consecutive patients underwent VT ablation between January 2017 and December 2025, while 4 patients died prior to discharge due to cardiogenic shock. A total of 95 VT ablations were subsequently identified. Follow-up data post-ablation to assess recurrence within the first 12 months were available in 90 patients. The 90 patients represent the analysis cohort.

Baseline clinical features, including age, sex, left ventricular ejection fraction (LVEF), New York Heart Association (NYHA) functional class, and history of VT storm in the preceding 12 months, were collected from the electronic medical chart. VT-CL at the time of referral was recorded, and patients were stratified into two groups: VT-CL > 350 ms versus ≤ 350 ms

2.2 Procedural details:

Procedures were performed under conscious sedation or general anesthesia at the operator's and anesthetist's discretion. A multipolar high-density mapping catheter (Pentaray or Octaray) was used in all cases, introduced either via a retrograde aortic approach or transseptal access into the LV. Systemic anticoagulation was maintained with heparin administration, targeting an activated clotting time > 350 seconds.

Ablations were performed using 3.5mm irrigated-tip catheters. Ablation strategies varied based on the operator's preference, hemodynamic tolerance, and targeting late potentials (LPs) on substrate mapping, with treatment of inducible clinical VT if hemodynamically tolerated. Intraprocedural details, including the number of VTs induced either by systematic programmed stimulation or by catheter ectopy, scar site, and inducibility post-ablation, were recorded.

2.3 Electrophysiology study and scar quantification

All patients underwent EAM and CA using a three-dimensional mapping system (CARTO - Biosense Webster, Diamond Bar, CA, USA). Endocardial substrate mapping was performed, and Bipolar voltage maps were used to identify endocardial scar, defined as low voltage of ≤ 0.5 mV. The scar area was quantified by manual demarcation of the low-voltage region and recorded in square centimetres (cm²). The scar burden was defined as the percentage of the defined scar area to total mapped myocardial area above the scar threshold. Scar measurements were available for 74 of 90 patients; 16 did not have retrievable EAMs.

2.4 Outcome definitions

The primary endpoint was VT recurrence, defined as documented appropriate ICD therapy (shock or ATP) or sustained VT episode in the monitor zone on device interrogation lasting longer than 30 seconds, within the first 12 months following ablation. Time to recurrence was calculated from the procedure date to the first documented VT episode.

The secondary endpoint was the change in ICD device therapy burden, including shocks and ATP, 12 months prior to the ablation and compared to ICD therapy within the first 12 months following ablation. ICD shocks and ATP episodes were analyzed separately.

2.5 Follow up

Clinical follow-up was obtained through device interrogation and clinic visits within 12 months following ablation. ICD programming before and after ablation was physician-dependent. Programming was modified if inappropriate therapy occurred, and a slow VT zone was created when monitor-zone VT was documented.

2.6 Statistical analysis

Continuous variables were reported as mean $\pm$ standard deviation (SD), and categorical variables were reported as counts and percentages. Comparisons between patients with and without VT-recurrence were performed using the Mann–Whitney U test for continuous variables and Fisher's exact test for categorical variables.

Univariable logistic regression was used to evaluate variables associated with VT recurrence, including age, NYHA, LVEF, presence of VT storm within the year preceding ablation, VT-CL (> 350 ms vs ≤ 350 ms), AAD use, scar area, scar burden, and number of intraprocedural VTs. Variables with a threshold p-value of < 0.1 were entered into multivariate analysis. Due to collinearity between scar area and scar

proportion, only scar proportion was included in the multivariate model. Results were reported as hazard ratio (HR) with 95% confidence intervals (CI). Cox regression analysis was used for time-to-event analysis. Paired comparisons of ICD therapies before and after ablation were analyzed using the Wilcoxon signed-rank test. Analysis was done for all available variables against recurrence in the logistic regression model. Descriptive analysis was carried out using an independent sample t-test to compare the means of continuous variables between two separate groups split by recurrence.

ROC analysis was used to establish thresholds for scar area and scar proportion. Kaplan–Meier survival curves were generated to illustrate freedom from VT recurrence during the first 12 months after ablation as influenced by scar area and scar proportion.

A two-sided p-value < 0.05 was considered statistically significant. Statistical analyses were performed using SPSS version 25.0 (IBM Corp., Armonk, NY).

3. RESULTS

A total of 90 patients with ICM underwent CA for VT from January 2017 to December 2025; 37 patients (41.0%) experienced recurrent VT, while 53 patients (59.0%) remained VT recurrence-free.

The cohort was predominantly men (88/90, 98%). The mean age was 67 ± 9.7 years, the mean LVEF was $30.7 \pm 10\%$, the mean LV scar area was 65 ± 34.5 cm², and mean scar proportion to total LV area $30 \pm 12\%$. VT storm in the preceding 12 months was present in 40/90 patients (44.4%). The NYHA functional class was available in 77 patients. Twenty-six (33.8%) were in class I, 33 (42.8%) in class II, and 18 (23.3%) in class III. (Table 1).

Among patients with available ICD therapy data, shock data of pre and post-ablation showed a median shock burden decreased from 2.0 (IQR 1.0–6.0) to 0.0 (IQR 0.0–1.0), $p < 0.001$. A reduction of 76% in total shock burden from 400 episodes to 97 episodes (Figs. 2). Similarly, among patients with paired ATP data, median ATP burden decreased from 8 (IQR 2.25–21.3) pre-ablation to 0.0 (IQR 0.0–5) post-ablation ($p = 0.001$).

In 34 out of 37 (3/37 have recurrence documented but no ICD data) patients with recurrent VT following ablation, median shocks decreased from 4 (IQR 2.0–8.0) before ablation to 1.0 (IQR 0.0–3.75) after ablation ($p = 0.001$), with 46.4% reduction in total shock burden as shown in Fig. 3. By contrast, ATP burden in the VT-recurrence group did not significantly reduce with median ATP episodes of 12.0 (IQR 3.0–23.0) before ablation and 7.0 (IQR 1.0–40.0) after ablation ($p = 0.69$).

VT-CL was not associated with VT-recurrence prediction. VT recurred in 37.7% of patients with VT-CL > 350 ms and in 43.2% with VT-CL $\leq$ 350 ms (OR = 1.4, 95% CI = 0.6–3.3, $p = 0.44$).

Mean scar area was significantly higher in patients with VT-recurrence compared to those without (76.1 ± 36.3 cm² vs 57.1 ± 31 cm², $p = 0.012$). Scar burden relative to total mapped LV myocardium was also higher in patients with VT recurrence ($35 \pm 12\%$ vs $27 \pm 12\%$; $p = 0.008$). ROC analysis identified a cutoff

of $\geq 42.5\text{cm}^2$ for absolute scar area and $\geq 28.5\%$ for scar burden. Scar Proportion of 28.5%, as a potential recurrence predictor, has a sensitivity of 74%, specificity of 58%, positive predictive value of 56%, negative predictive value of 76% and OR of 3.99, $p = 0.009$. (Fig. 1) On univariable regression, scar area, scar proportion, and LVEF were associated with ventricular arrhythmia recurrence (Table 2). In multivariate analysis, only a scar proportion of $\geq 28.5\%$ remained independently associated with ventricular arrhythmia recurrence (HR = 2.8, 95% CI = 1.0–7.8, $p = 0.045$), as shown in table 2.

LVEF was lower in patients with VT-recurrence than in those without VT-recurrence (mean LVEF $27.8 \pm 7.6\%$ vs $32.6 \pm 11\%$; $p = 0.024$). On univariable regression analysis, higher LVEF was associated with reduced recurrence risk (OR 0.946, 95% CI 0.90–0.99, $p = 0.029$).

The presence of VT storm in the preceding 12 months prior to the procedure showed a non-significant trend toward higher recurrence. Recurrent VT occurred in 20/40 patients (50%) with prior VT storm, compared to 17/50 (34.0%) without (OR 1.94, 95% CI 0.83–4.56, $p = 0.127$).

Post-ablation AAD use was more frequent among patients with recurrence compared to those without (58.7 vs 21%, $p = 0.003$). Patients treated with AAD post-ablation were older (69 ± 7.6 vs. 65 ± 11 years), larger scar area on EAM ($76 \pm 49\text{ cm}^2$ vs. $56 \pm 31\text{ cm}^2$, $p = 0.026$), and had lower LVEF ($28 \pm 9\%$ vs. $33 \pm 10\%$, $p = 0.017$) compared to those without AAD. (Fig. 4)

NYHA functional class was not different between the two groups ($p = 0.9$) and was not associated with VT recurrence.

In this cohort, median time to recurrence was 33.0 days (IQR 12.0–110.0 days). Recurrence happened within 30 days in 18/37 patients (48.6%), between 31 and 180 days in 17/37 (45.9%), and between 181 and 365 days in 2/37 (5.4%).

4. DISCUSSION

Our single-center study of patients who underwent CA for VT in ICM shows two key findings. First, although VT-recurrence following ablation was common, occurring in 41% of patients within the first year, CA significantly reduced ICD therapy burden, particularly shocks. Secondly, scar burden was the main variable associated with VT recurrence, whereas clinical parameters such as VT-CL, VT storm, and NYHA were not. These findings advocate for comprehensive preprocedural scar assessment to predict VT recurrence and aim to reduce ICD shock burden, rather than focusing solely on binary recurrence.

The reduction in ICD therapies may reflect the practical benefit of ablation in the scar-related VT population and aligns well with prior literature. The results extend the focus on patients' specific characteristics, such as endocardial scar burden, as a potential predictor to CA success. For those with identified lower success, other modalities such as the emerging field of radiation therapy might be a more suitable option.

Previous randomized trials, including VANISH and VANISH2, demonstrated that CA was superior to escalation of AAD therapy or as a first-line strategy by reducing ICD shocks.^{5,6} CA in ICM can be effective in reducing VT burden and ICD shocks, despite substantial recurrence.¹⁵ In a sub-study of the VANISH trial, VT burden and shock burden in the amiodarone refractory arm were significantly reduced following CA.²¹ Similar results were seen in a study of mixed cardiomyopathies, which demonstrated a reduction in overall VT and ICD-treated events at 6-month follow-up and used VT burden reduction as a marker of procedural success.¹⁶ ICD shocks, both appropriate and inappropriate, have an increased mortality and significant impairment in QoL.^{12,14} The impact of ICD shocks may extend to increasing HFH as demonstrated by a relatively recent study showing that a single appropriate ICD shock is associated with worse outcomes.²² A sub-study of the RAFT trial evaluated that clustering of VT events requiring ATP or shocks (≥ 2 events within 3 months) is associated with higher mortality when compared to no clustering.²³

The reduction in ICD therapy burden persisted even among patients who experienced VT, supporting that recurrence does not necessarily negate the procedural benefit. Patients with VT post-ablation may still experience QoL improvement through fewer ICD shocks, possibly due to less malignant ventricular arrhythmias that are more susceptible to painless ATP. Prior studies show substrate-based ablation can reduce VT and ICD therapy burden.^{15,24,25} We report a 74% reduction in ICD therapies post-ablation in patients with VT recurrence. These findings suggest relying on binary recurrence outcomes may underestimate the true clinical benefit of CA.

The second finding of our study is the association between substrate burden and VT recurrence. Both absolute scar area and scar burden were significantly higher in patients with recurrence. Scar-related VT in ICM is a re-entrant arrhythmia influenced by the extent, heterogeneity, and channel architecture of the myocardium, supporting the increasing use of advanced imaging in VT ablation strategies.^{1,17}

Our ROC analysis identified thresholds of $\geq 42.5\text{cm}^2$ for absolute endocardial scar area and $\geq 28.5\%$ for scar proportion as potential predictors of recurrence, though these need validation in larger cohorts. Prior studies reported a similar association between scar burden and VT recurrence in ICM patients. However, they used point-by-point mapping with single-tip catheters, creating lower mapping density and potentially less accurate scar delineation when compared to the high-density mapping catheters used in our cohort.^{19,20} Beyond recurrence prediction, endocardial scar size and ablation technologies like as radiofrequency and pulsed field ablation, may aid risk stratification and procedural planning such as determining LP elimination extent or the role of inducibility at the end of the procedure.

Data on the link between LVEF and VT recurrence are inconsistent.^{15,24,26,27} In our study, although LV systolic function was associated with recurrence on univariable analysis, this association did not hold in multivariate analysis, after adjusting for scar burden, suggesting that LVEF might be a surrogate for scar substrate rather than a standalone factor. This supports the concept that direct burden are more informative than global function parameters.

The timing of VT recurrence after ablation provides key insights. In our cohort, most VT recurrences occurred early, with a median of 33 days, likely due to incomplete substrate modification rather than disease progression. Muser et al. showed that recurrence within the first month predicts higher mortality risk, with risk reducing between 1 to 6 months. Therefore, early follow-up is crucial, especially in the first 6 months.²⁸ However, common predictors like VT-CL, VT storm, intraprocedural VT count, and NYHA class were not associated with recurrence, suggesting substrate features may be more useful than clinical metrics for predicting outcomes in ischemic VT. Studies vary on VT-CL's predictive value highlighting the need for larger studies for recurrence stratification.¹⁹

Patients on AAD therapy post-ablation had higher recurrence, likely as higher-risk patients are more frequently prescribed AADs, not because AADs cause recurrence. These findings need validation, and future research should include patient-centred outcomes, QoL, and standardized risk assessment combining substrate and clinical features to tailor management.

LIMITATIONS:

Our study has several limitations. This retrospective, single-center study with a modest sample size limits statistical power and generalizability. Some variables, notably scar measurements and paired device therapy data, were missing for some patients. While recurrence was carefully monitored via follow-up and device interrogation, varying follow-up durations remain an inherent limitation of retrospective studies. Finally, referral VT-CL was dichotomized for pragmatic clinical interpretation, but a more sophisticated physiologic analysis of VT phenotype in larger cohorts may offer different insights.

5. CONCLUSION

In this cohort of ICM patients undergoing CA for VT, a substrate burden $\geq 28.5\%$ is predictive of VT recurrence. CA was associated with a marked reduction in ICD therapy burden, supporting a framework that integrates reduction in arrhythmia burden and ICD therapy burden rather than a binary outcome, and risk-stratifying VT patients based on scar burden. The results require validation with a multicenter study of a larger sample size.

Abbreviations

CA
catheter ablation
VT
ventricular tachycardia
LV
left ventricle
EF
ejection fraction

3D
three dimensional
EAM
electro anatomic map
HD
high density
CMRI
cardiac MRI
ICM
ischemic cardiomyopathy
NICM
non ischemic cardiomyopathy
ICD
implantable cardiac defibrillator
AAD
antiarrhythmic drugs
HF
heart failure
HFH
heart failure hospitalization
CL
cycle length
QoL
quality of life
ATP
anti-tachycardia pacing
CRTD
cardiac resynchronization therapy defibrillators
NYHA
New York Heart Association
LP
late potentials

Declarations

Ethics Approval and Consent to Participate:

This study was retrospective in design. It was approved by the Institutional Research Ethics Board. The Western University Ethics Board ID number is 128981. Consent was waived as this retrospective study. All steps of retrospective data collection and methodology were carried out in compliance with the ethical standards and according to the relevant regulations and guidelines.

Consent for Publication:

Not applicable. No images, or information that may break anonymity.

Availability of Data and Materials:

Data is available if available if requested. No patients' identification.

Competing Interests:

Nothing to disclose.

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Authors' Contributions:

Ahmed Almarzuqi: lead author, study validation, study conceptualization, data analysis, and the writing of the manuscript

Mina Garas: supportive role in writing, co-lead data collection.

Eileen Ju: supportive role in data collection.

Ahmed T. Moustafa: supportive role in writing manuscript, and review.

Allan Skanes: Supportive role in reviewing. Co lead in validation.

Lorne Gula: Supportive role in review. Co lead in data analysis and methodology.

Peter Leong-Sit: Supportive role in writing and review.

Danielle Prestia: supportive role in maps analysis and scar assessment.

Anthony SL Tang: supportive role in methodology, and review.

Habib Khan: Senior author. Co lead in writing, validation, and data analysis.

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References

1. Cronin EM, Bogun FM, Maury P, Peichl P, Chen M, Namboodiri N, et al. 2019
HRS/EHRA/APHRS/LAHRS expert consensus statement on catheter ablation of ventricular

- arrhythmias. *Heart Rhythm*. 2020;17:e2–154. 10.1016/j.hrthm.2019.03.002.
2. Deyell MW, AbdelWahab A, Angaran P, Essebag V, Glover B, Gula LJ, et al. 2020 Canadian Cardiovascular Society/Canadian Heart Rhythm Society Position Statement on the Management of Ventricular Tachycardia and Fibrillation in Patients With Structural Heart Disease. *Can J Cardiol*. 2020;36:822–36. 10.1016/j.cjca.2020.04.004.
3. Zeppenfeld K, Tfelt-Hansen J, de Riva M, Winkel BG, Behr ER, Blom NA, et al. 2022 ESC Guidelines for the management of patients with ventricular arrhythmias and the prevention of sudden cardiac death. *Eur Heart J*. 2022;43:3997–4126. 10.1093/eurheartj/ehac262.
4. Kanagaratnam A, Virk SA, Pham T, Anderson RD, Turnbull S, Campbell T, et al. Catheter Ablation for Ventricular Tachycardia in Ischaemic Versus Non-Ischaemic Cardiomyopathy: A Systematic Review and Meta-Analysis. *Heart Lung Circ*. 2022;31:1064–74. 10.1016/j.hlc.2022.02.014.
5. Sapp JL, Tang ASL, Parkash R, Stevenson WG, Healey JS, Wells G. A randomized clinical trial of catheter ablation and antiarrhythmic drug therapy for suppression of ventricular tachycardia in ischemic cardiomyopathy: The VANISH2 trial. *Am Heart J*. 2024;274:1–10. 10.1016/j.ahj.2024.04.009.
6. Sapp JL, Wells GA, Parkash R, Stevenson WG, Blier L, Sarrazin JF, et al. Ventricular Tachycardia Ablation versus Escalation of Antiarrhythmic Drugs. *N Engl J Med*. 2016;375:111–21. 10.1056/NEJMoa1513614.
7. Willems S, Tilz RR, Steven D, Kaab S, Wegscheider K, Geller L, et al. Preventive or Deferred Ablation of Ventricular Tachycardia in Patients With Ischemic Cardiomyopathy and Implantable Defibrillator (BERLIN VT): A Multicenter Randomized Trial. *Circulation*. 2020;141:1057–67. 10.1161/CIRCULATIONAHA.119.043400.
8. Della Bella P, Baratto F, Vergara P, Bertocchi P, Santamaria M, Notarstefano P, et al. Does Timing of Ventricular Tachycardia Ablation Affect Prognosis in Patients With an Implantable Cardioverter Defibrillator? Results From the Multicenter Randomized PARTITA Trial. *Circulation*. 2022;145:1829–38. 10.1161/CIRCULATIONAHA.122.059598.
9. Santoro F, Mugnai G, Perrotta L, Kovacs B, Dinshaw L, Del Castillo AM, et al. Catheter ablation vs. anti-arrhythmic drug therapy for ventricular tachycardia in ischaemic heart disease: a meta-analysis of randomized controlled trials. *Europace*. 2025;27. 10.1093/europace/euaf302.
10. Khan U, Khlidj Y, Ibrahim AA, Amin AM, Rakab MS, AlBarakat MM, et al. Catheter ablation versus medical therapy for ventricular tachycardia in patients with ischemic heart disease: A systematic review and meta-analysis of randomized controlled trials. *Indian Pacing Electrophysiol J*. 2025;25:91–103. 10.1016/j.ipej.2025.03.004.
11. Arenal A, Avila P, Jimenez-Candil J, Tercedor L, Calvo D, Arribas F, et al. Substrate Ablation vs Antiarrhythmic Drug Therapy for Symptomatic Ventricular Tachycardia. *J Am Coll Cardiol*. 2022;79:1441–53. 10.1016/j.jacc.2022.01.050.
12. Poole JE, Johnson GW, Hellkamp AS, Anderson J, Callans DJ, Raitt MH, et al. Prognostic importance of defibrillator shocks in patients with heart failure. *N Engl J Med*. 2008;359:1009–17.

- 10.1056/NEJMoa071098.
13. Raeder EA, Podrid PJ, Lown B. Side effects and complications of amiodarone therapy. *Am Heart J.* 1985;109:975–83. 10.1016/0002-8703(85)90238-8.
 14. Mark DB, Anstrom KJ, Sun JL, Clapp-Channing NE, Tsiatis AA, et al. Sudden Cardiac Death in Heart Failure Trial I. Quality of life with defibrillator therapy or amiodarone in heart failure. *N Engl J Med.* 2008;359:999–1008. 10.1056/NEJMoa0706719.
 15. Quinto L, Sanchez-Somonte P, Alarcon F, Garre P, Castillo A, San Antonio R, et al. Ventricular tachycardia burden reduction after substrate ablation: Predictors of recurrence. *Heart Rhythm.* 2021;18:896–904. 10.1016/j.hrthm.2021.02.016.
 16. Bennett R, Turnbull S, Kotake Y, Campbell T, Kumar S. Ventricular Arrhythmia Burden as a Marker of Success Following Catheter Ablation of Ventricular Arrhythmias in Patients with Structural Heart Disease. *Korean Circ J.* 2021;51:455–68. 10.4070/kcj.2020.0415.
 17. Avila P, Perez-David E, Izquierdo M, Rojas-Gonzalez A, Sanchez-Gomez JM, Ledesma-Carbayo MJ, et al. Scar Extension Measured by Magnetic Resonance-Based Signal Intensity Mapping Predicts Ventricular Tachycardia Recurrence After Substrate Ablation in Patients With Previous Myocardial Infarction. *JACC Clin Electrophysiol.* 2015;1:353–65. 10.1016/j.jacep.2015.07.006.
 18. Bhagirath P, Campos FO, Costa CM, Wilde AAM, Prassl AJ, Neic A, et al. Predicting arrhythmia recurrence following catheter ablation for ventricular tachycardia using late gadolinium enhancement magnetic resonance imaging: Implications of varying scar ranges. *Heart Rhythm.* 2022;19:1604–10. 10.1016/j.hrthm.2022.05.021.
 19. Arenal A, Hernandez J, Calvo D, Ceballos C, Atea L, Datino T, et al. Safety, long-term results, and predictors of recurrence after complete endocardial ventricular tachycardia substrate ablation in patients with previous myocardial infarction. *Am J Cardiol.* 2013;111:499–505. 10.1016/j.amjcard.2012.10.031.
 20. Yokokawa M, Desjardins B, Crawford T, Good E, Morady F, Bogun F. Reasons for recurrent ventricular tachycardia after catheter ablation of post-infarction ventricular tachycardia. *J Am Coll Cardiol.* 2013;61:66–73. 10.1016/j.jacc.2012.07.059.
 21. Samuel M, Healey JS, Nault I, Sterns LD, Essebag V, Gray C, et al. Ventricular Tachycardia and ICD Therapy Burden With Catheter Ablation Versus Escalated Antiarrhythmic Drug Therapy. *JACC Clin Electrophysiol.* 2023;9:808–21. 10.1016/j.jacep.2023.01.030.
 22. MacIntyre CJ, Sapp JL, Abdelwahab A, Al-Harbi M, Doucette S, Gray C, et al. The Effect of Shock Burden on Heart Failure and Mortality. *CJC Open.* 2019;1:161–7. 10.1016/j.cjco.2019.04.003.
 23. Elsokkari I, Parkash R, Tang A, Wells G, Doucette S, Yetisir E, et al. Mortality Risk Increases With Clustered Ventricular Arrhythmias in Patients With Implantable Cardioverter-Defibrillators. *JACC Clin Electrophysiol.* 2020;6:327–37. 10.1016/j.jacep.2019.11.012.
 24. Nakasone K, Fukuzawa K, Kiuchi K, Takami M, Sakai J, Nakamura T, et al. Predictors of recurrence in patients without non-inducibility of ventricular tachycardia at the end of ablation. *J Arrhythm.* 2023;39:52–60. 10.1002/joa3.12796.

25. Garcia Garcia J, Arya A, Dinov B, Bollmann A, Ter Bekke RMA, Vernooy K, et al. Impact of repeat ablation of ventricular tachycardia in patients with structural heart disease. *Europace*. 2023;26. 10.1093/europace/euad367.
26. Dinov B, Fiedler L, Schonbauer R, Bollmann A, Rolf S, Piorkowski C, et al. Outcomes in catheter ablation of ventricular tachycardia in dilated nonischemic cardiomyopathy compared with ischemic cardiomyopathy: results from the Prospective Heart Centre of Leipzig VT (HELP-VT) Study. *Circulation*. 2014;129:728–36. 10.1161/CIRCULATIONAHA.113.003063.
27. Heybati K, Pradeep A, Futela P, Woelber T, Deng J, Arunachalam Karikalan S, et al. Outcomes following catheter ablation for structural ventricular tachycardia stratified by left ventricular ejection fraction: A retrospective cohort study. *Heart Rhythm O2*. 2025;6:995–1004. 10.1016/j.hroo.2025.03.010.
28. Muser D, Mendelson T, Fahed J, Liang JJ, Castro SA, Zado E, et al. Impact of timing of recurrence following catheter ablation of scar-related ventricular tachycardia on subsequent mortality. *Pacing Clin Electrophysiol*. 2017;40:1010–6. 10.1111/pace.13149.

Tables

Tables 1 and 2 are available in the Supplementary Files section.

Figures

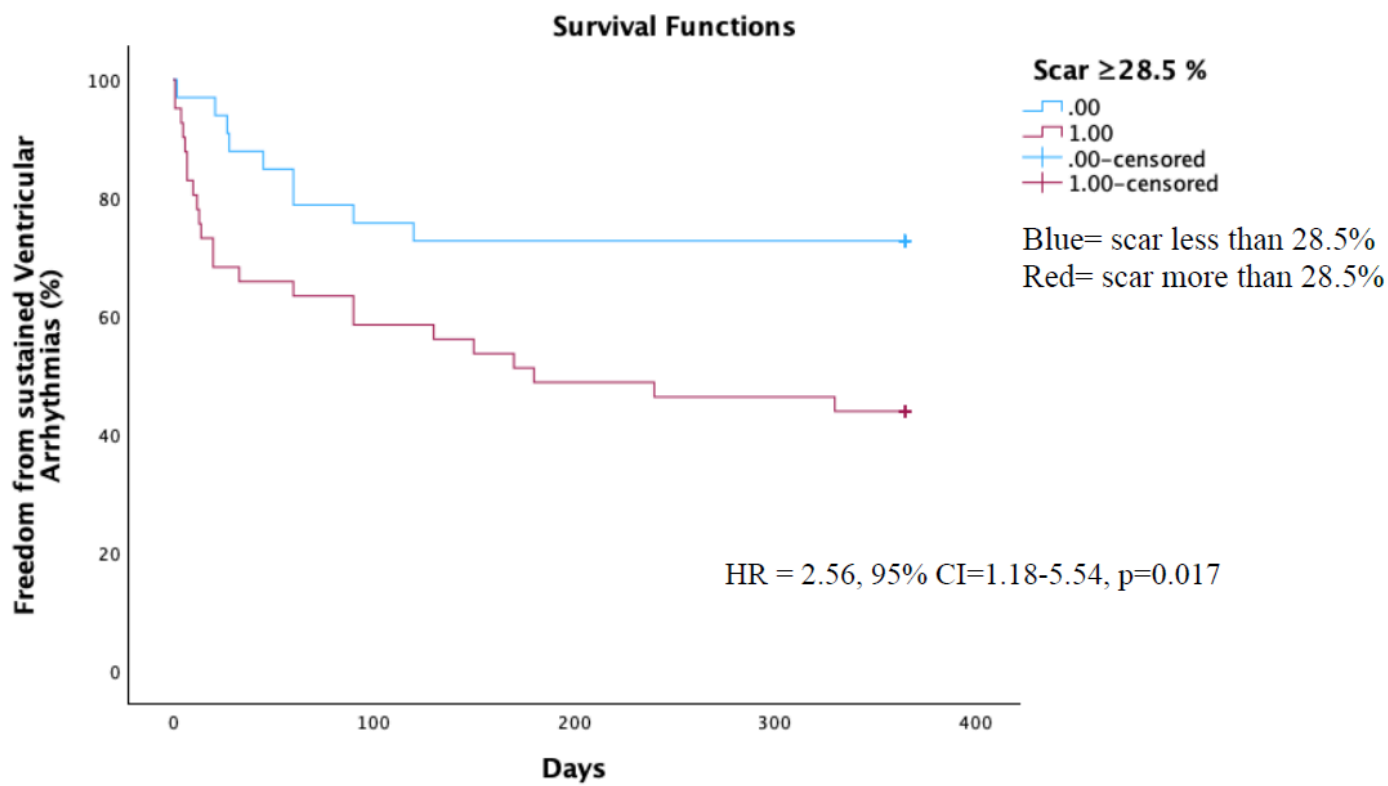


Figure 1

KM curve based on Scar proportion of 28.5%

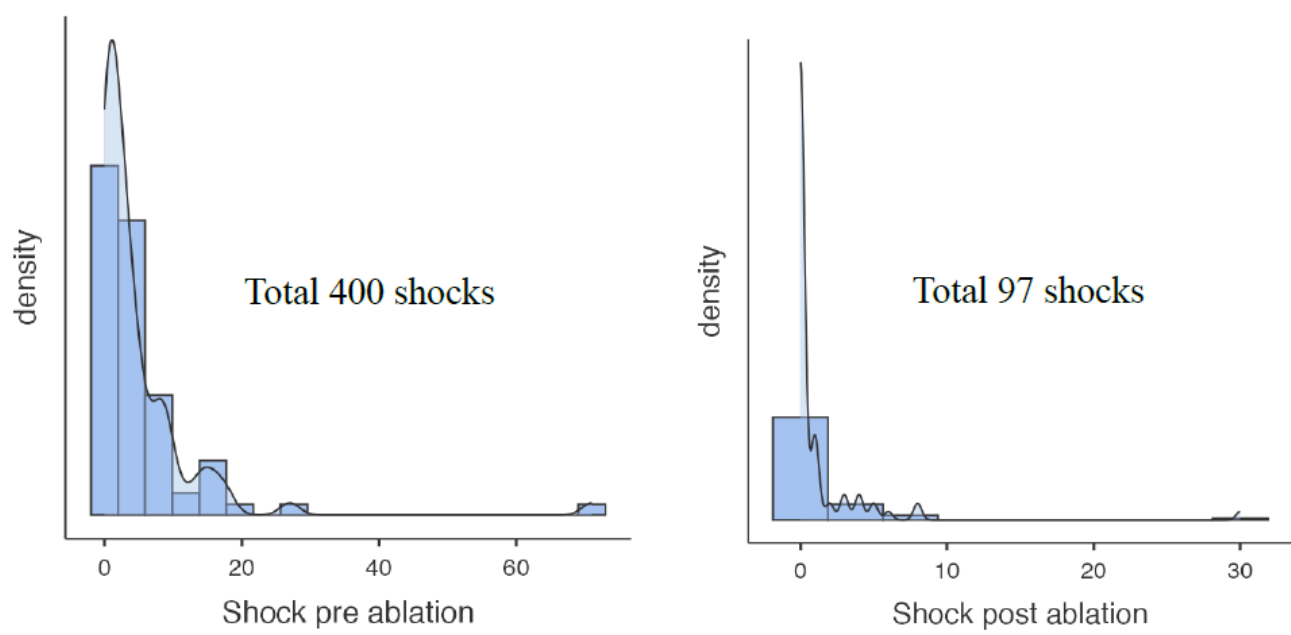


Figure 2

Density histogram of ICD shock burden in the year preceding ablation compared with the first year following ablation among patients with paired device interrogation data (n = 78). VT ablation was associated with a significant reduction in shock burden.

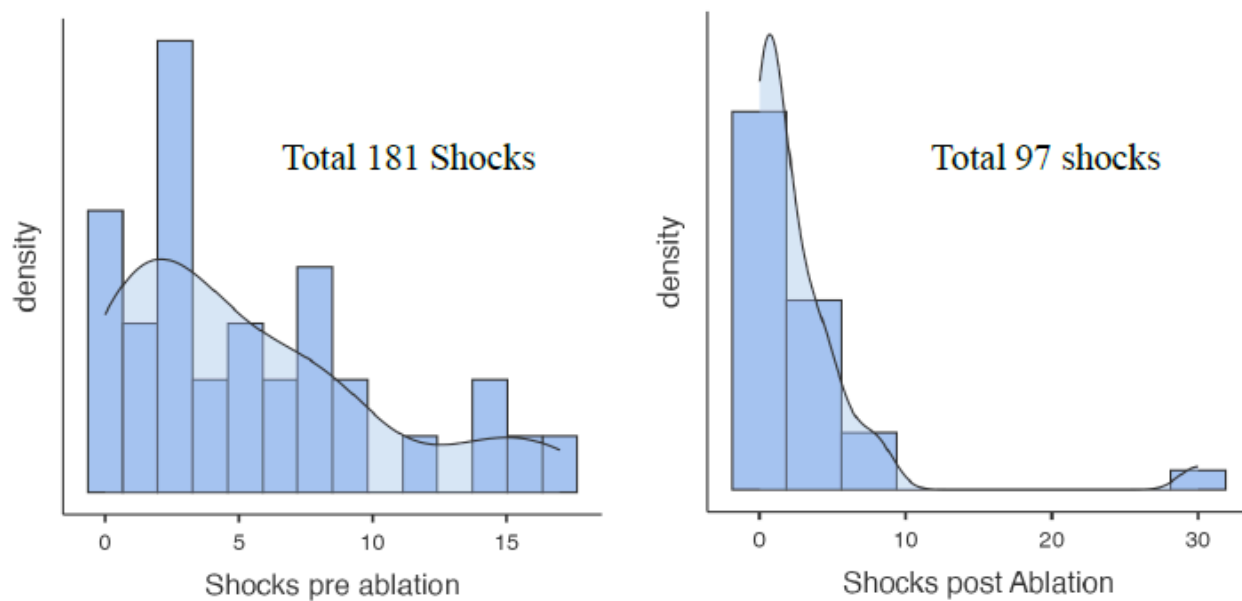
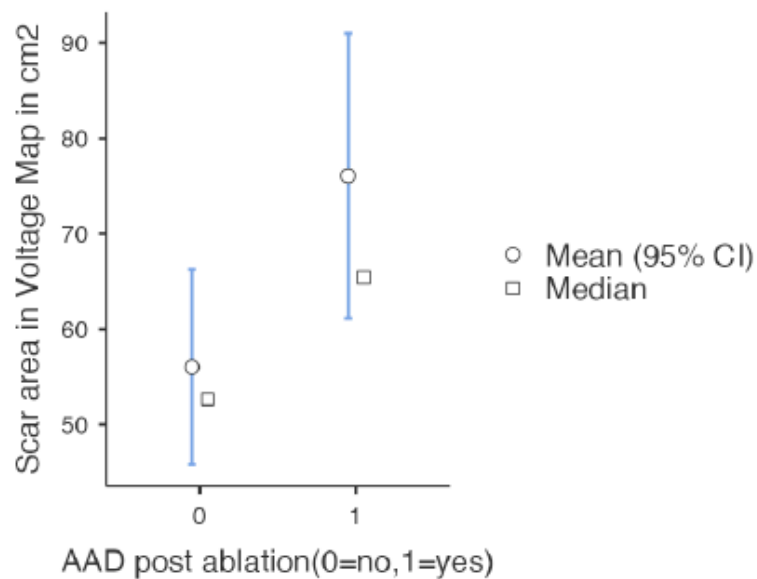


Figure 3

Density histogram of ICD shock burden before and after ventricular tachycardia ablation among patients with recurrent VT. Despite recurrence, most patients experienced a reduction in ICD shock burden following ablation

Scar area in Voltage Map in cm2



LVEF %

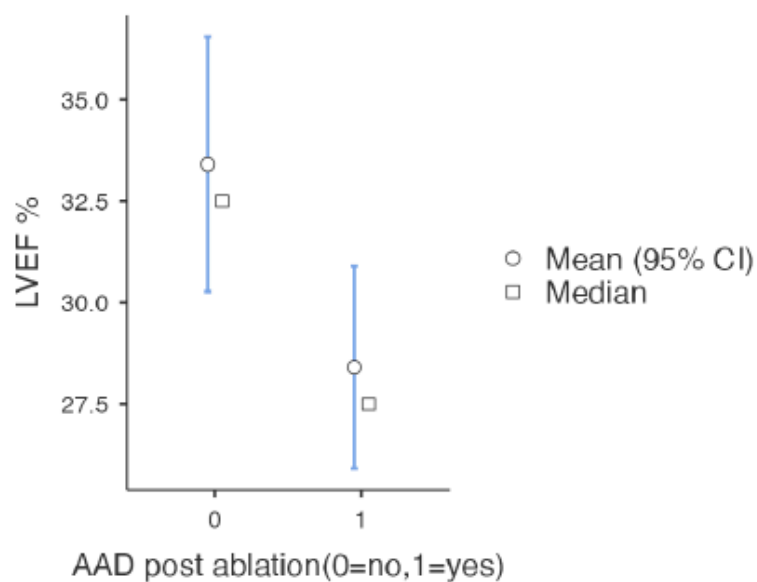


Figure 4

Descriptive plot comparing LVEF and Scar area between those treated with AAD, and those not on AAD post ablation. They show larger scar area in cm2 and lower LVEF% in the AAD treated patients.

AAD=Antiarrhythmic drug

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [CENTRALILLUSTRATION.docx](#)
- [TABLES.pdf](#)