A Stepwise Approach to the Management of Post-Infarct Ventricular Tachycardia Using Catheter Ablation as the First Line Treatment: A Single Center Experience

Running title: Pauriah et al.; Post-Infarct VT ablation as a first line treatment

Maheshwar Pauriah, MD1; Gabriel Cismaru, MD1; Isabelle Magnin-Poull, MD1; Marius Andronache, MD, PhD1; Jean-Marc Sellal, MD1; Jérôme Schwartz, MD1; Béatrice Brembilla-Perrot, MD1; Nicolas Sadoul, MD1; Etienne Aliot, MD1; Christian de Chillou, MD, PhD1,2

1CHU de Nancy, Department of Cardiology, University Hospital Nancy; 2IADI - INSERM, U947, Nancy, France

Address for Correspondence
Christian de Chillou, MD, PhD
Département de Cardiologie
Hôpitaux de Brabois,
1, rue du Morvan
54511 Vandoeuvre lès Nancy
France
Tel: (33) 3 83 15 74 43
Fax: (33) 3 83 15 49 17
E-mail: c.dechillou@chu-nancy.fr

Abstract:

Background - The occurrence of ventricular tachycardia (VT) following myocardial infarction (MI) is associated with poorer prognosis. In such patients, implantable cardioverter-defibrillators (ICD) are recommended. Catheter ablation of VT is currently recommended only as an adjunctive therapy. Whether a successful VT ablation alone might be a viable strategy in some of these patients, however, remains unknown. The aim of the present study was to evaluate this strategy.

Methods and Results - Between January 2002 and December 2011, 189 patients with cardiomyopathy underwent 259 VT ablations in our centre. 45 patients (mean age 65.2±9.6 years, 91% males) with a history of MI and mean left ventricular ejection fraction of 39.7±9.7% matched the study criteria and were included in this analysis. Acute success was obtained in 40/45 (88.9%). During a follow-up, based on our stepwise algorithm [utilising acute success, repeat electrophysiological study (EPS) and recurrence of VT], 19/45 (42.2%) underwent ICD implantation. During a median follow-up of 4.5 (IQR: 2.1-7.0) years, all-cause mortality occurred in 14/45 (31.1%) of patients. Using multivariate Cox regression analysis, age [hazard ratio (HR)=1.13, 95% confidence interval (CI): 1.03-1.22, p=0.007] was the only independent predictor of mortality while ICD implantation was not [HR=0.54, 95% CI: 0.18-1.64, p=0.28]

Conclusions - Our results suggest that a stepwise approach to the management of VT with ablation as a first line treatment in post-infarct patients presenting with VT might be a reasonable option. Further studies are required to confirm these results.

Keywords: ventricular tachycardia, catheter ablation, ischaemic cardiomyopathy, programmed electrical stimulation, implantable cardioverter-defibrillator
Introduction

In patients with ischemic cardiomyopathy (ICM), ventricular tachycardia (VT) is associated with poor long-term outcomes. Three secondary prevention studies have shown the unequivocal benefit of implantable cardioverter-defibrillators (ICD) in patients with previous myocardial infarction (MI) and impaired left ventricular ejection fraction (LVEF). These studies, however, excluded patients with stable VT or with LVEF>40%. Analysis from the Anti-arrhythmics versus Implantable Defibrillators (AVID) registry, however, suggests that clinically well-tolerated VT carries a poor prognosis as well. ICDs are therefore recommended in patients with previous MI and sustained VT. While ICDs improve overall survival, they do not eliminate the substrate responsible for sustained arrhythmia. ICD without ablation carries a higher risk of shocks and shocks are associated with decreased quality of life and increased in mortality. VT ablation, on the other hand, reduces or even abolishes VT episodes in some patients. Currently, guidelines suggest that VT ablation to be used as an adjunct to ICD. It is not known whether some patients presenting with VT can be treated by ablation alone.

In our centre, we have been routinely performing VT ablation as a first line treatment in patients with ICM presenting with VT. Patients with a successful ablation, defined as the non-inducibility of all VTs at the end of the index procedure followed by a negative electrophysiological study (EPS) within 3 months, do not have an ICD implanted. The aim of this study was, therefore, to evaluate this stepwise approach to VT management by comparing the long-term outcomes of those who received an ICD with those who did not.

Methods

2.1 Study Population

Between January 2002 and April 2011, a total of 189 patients with structural heart disease
underwent 259 VT ablations in our centre: [145 with ischaemic cardiomyopathy (ICM), 17 with dilated cardiomyopathy (DCM), and 18 with arrhythmogenic right ventricular dysplasia (ARVD)]. In this study, we included patients with the following criteria: 1) previous history of myocardial infarct, 2) documented monomorphic VT, 3) no prior ICD, 4) repeat or planned EPS after first procedure and 5) follow-up of at least 1 year after ablation or until censoring at the time of death. Patients were excluded if 1) initial presentation was cardiac arrest and/or 2) patients with severe co-morbidities where a clinical decision was made not to implant an ICD. Of the 145 patients with ICM, 74 did not have an ICD prior to VT ablation and 45 fulfilled the criteria for the study. All patients provided informed consent and all procedures were conformed to the CHU-Nancy guidelines.

2.2 Electrophysiological Study, Mapping, and Ablation

Electrophysiological study (EPS), mapping, and catheter ablation were performed as previously described11. Briefly, a bipolar catheter was inserted via the femoral vein and positioned at the right ventricular apex and used primarily for VT induction with the application of up to 3 extrastimuli during spontaneous rhythm then during paced rhythm (600-ms and then 400-ms basic cycle length). This programmed electrical stimulation (PES) protocol was delivered through an external stimulator (Biotronik UHS 20, Biotronik Inc) with a 2-ms pulse width at twice the diastolic threshold. Failure to induce a sustained VT promoted the same protocol in the right ventricular outflow tract.

An 8F or 7F, 8mm-tip or 3.5mm-irrigated tip catheter (NAVI-STAR® or THERMOCOOL®, Biosense-Webster, Johnson & Johnson) was used for mapping and ablation of VT circuits. Access to the left ventricle was achieved retrogradely across the aortic valve or through trans-atrial septal puncture.
The electrical reference was chosen as a morphologically stable and regular ventricular electrogram that was obtained from either an endocardial or surface lead, with the choice determined by a QRS complex with a sharp apex and a strong positive (or negative) deflection during VT. The width of the window of interest varied from one VT map to another, inasmuch as it was correlated with the VT cycle length with the following formula: window of interest width=VT cycle length−20 ms. The middle of the window of interest was selected to coincide with the electrical reference. The local activation time for each endocardial position under the mapping catheter was calculated as the interval between the electrical reference and the peak deflection of the mapping bipolar electrogram. In case of double potentials, the earliest peak deflection of the doublet was used. Long-duration fractionated electrograms were marked to the highest peaklet.

The left ventricle was plotted during the induced clinical VT by dragging the catheter over the endocardium. In case of a VT with a right ventricular septal exit, the right ventricle was mapped as well to check whether the VT isthmus, or a part of it, was located in the right ventricle. Infarct regions were sought first, and more data points (target filling threshold set to 10) were acquired in and around these areas. Refining the area under investigation relied on the usual clinical indicators, such as sinus rhythm analysis, echocardiography, and VT morphology on the 12-lead ECG. More data points were acquired in the zones defined as scarified, with low-amplitude potentials, with diastolic electrograms, or with double potentials. These areas were probed because they are important for the identification of the re-entrant circuit. The mapping procedure was terminated when a density of points was achieved that was sufficient enough to allow an understanding of the VT circuit. The resulting reentrant circuit was considered to be the spatially shortest route of unidirectional activation encompassing a full range of mapped
activation times (>90% of the tachycardia cycle length) and returning to the site of earliest activation. Conventional mapping, including pace mapping during sinus rhythm, entrainment manoeuvres and post-pacing interval analysis\(^1\) during VT, were not performed routinely since VT isthmus definition was based upon VT activation time mapping. Once defined, linear RF lesions were placed so as to transect the VT isthmus in case of mappable VTs. For unmappable VTs, ablation sites were required to have abnormal low-amplitude electrograms, electrograms with double potentials, wide fractionated potentials, or isolated late potentials during sinus or paced rhythm. Pacemapping during sinus rhythm and measurement of the stimulus-to-QRS interval were then used to unmask VT isthmuses and determine ablation sites\(^2\) of unmappable VTs.

Systemic anticoagulation was achieved with heparin (initial bolus of 50 U/kg IV followed by 1000 to 2000 U per hour) throughout the procedure. Sedation was obtained with 10 mg IV nalbuphine, with incremental doses at 5 mg as necessary.

2.3 RF Ablation and End-point

Identification of the ablation site was based on analysis of the 3D map. The anode was a 575-cm\(^2\) back plate placed under the patient’s left shoulder. RF ablation was performed with a 550-kHz RF Stockert-Cordis generator. The RF energy was delivered in a temperature-controlled mode for 60 to 120 seconds at each ablation site with a maximal temperature/power target of 45°C/40W for 3.5-mm tips (55°C/75W for 8-mm tips). Acute success was defined as a negative EPS at the end of the procedure. Successful VT ablation was defined as acute success and a negative repeat EPS at 2-3 months. Negative EPS was defined as absence of inducibility of any sustained monomorphic VT with a rate <270/min. Induction of monomorphic very fast VT (rate≥270/min) as well as polymorphic VT or VF, were not defined as positive EPS.
2.4 Management after Ablation

After ablation, patients were monitored for 72 hours by telemetry. Transthoracic echocardiography was performed within 2 days after ablation. Patients were then discharged and followed on an outpatient basis with clinical evaluation and 24-hour Holter recordings performed regularly.

All patients were evaluated routinely at 6-8 weeks post procedure and the 3 to 6 months intervals. Patients with ICD underwent interrogation every 6 months and all recorded arrhythmic episodes were collected and analysed. Follow-up data, including mortality was available on all patients.

2.5 Stepwise approach algorithm

All patients underwent VT ablation with the primary aim of complete abolition of all VTs. After a successful procedure, an EPS was performed at 3 months and further ablation carried if VT was induced. Before this repeat EPS, antiarrhythmic drugs were withdrawn for at least 5 half-lives in all patients, except amiodarone which was stopped at least one month before. Repeat EPS was continued after a successful ablation until the study was negative or an ICD was implanted. The stepwise algorithm is shown in Figure 1. ICD was implanted if any of both following criteria were present:

1) Ejection Fraction ≤35% in patients who underwent VT ablation after the publication of the European Society of Cardiology Guidelines for ICD implantation (i.e.: patients with EF<35% who underwent VT ablation prior to this publication did not receive an ICD if they had successful ablation).

2) A fast VT (VT with a shorter cycle length than the clinical VT) was inducible at the end of the procedure.
2.6 Statistical Analysis

All variables were tested for normal distribution based on the visual inspection of the frequency histogram and Shapiro-Wilk test. Normal data are presented as mean ± SD and categorical variables are expressed as percentages. Non Gaussian data are presented as median [interquartile range (IQR)]. For qualitative data, absolute and relative frequencies are shown. Comparisons between groups were made by $\chi^2$ test or Fisher exact test for categorical variables and unpaired $t$ test for normally distributed variables. Survival analysis was carried out using the non-parametric Kaplan-Meier curve and differences between survival curves was analysed using the Log rank test. Multivariate Cox regression analysis was carried out to provide adjusted hazard ratio (HR). All probability values are presented as 2 tailed, with statistical significance inferred at p<0.05. Analyses were performed using SPSS for windows version 17.0 (SPSS Inc., Chicago, ILL).

Results

3.1 Patient Characteristics

The study population consists of forty-five patients (mean age 65.2±9.6 years, 91% males) with a previous history myocardial infarct (Table 1). Thirty-two (71.1%) patients had a previous inferior MI and the left ventricular ejection fraction was 40% (IQR= 30-50%). Twenty-seven (60%) presented with a combination of shortness of breath or palpitations, 6 (13.3%) with chest pain, 5 (11.1%) patients with syncope, 1 (2.2%) with cardiogenic shock and the rest with a combination of these. The median VT cycle length was 370 ms at presentation and varied from 240 to 664ms. Table 2 shows the characteristics of the different VTs during ablation.
3.2 Ablation Results

success was obtained in 40 (88.9%) after first ablation. Of the remaining 5 patients, 3 patients had fast VT at the end of the procedure and had an ICD implanted and the other 2 patients had repeat EPS (Figure 1).

At follow-up and before repeat EPS, 1 patient died of heart failure and there was VT recurrence in 3 (7.5%). Repeat EPS was performed in 36 patients and VT was inducible in 13 (36.1%). For patients with a negative EPS, 1 (4.5%) had recurrent VT. Based on our algorithm, ICD was implanted in 19 (42.2%) patients.

Complications occurred in 4 patients including two cerebrovascular accidents (CVA), one femoral haematoma and one complete heart block.

3.3 ICD Therapies and Mortality

During a median follow-up of 4.5 years (IQR= 2.1-7.0), there were 5 deaths in the group without an ICD and 9 in the ICD group. Patients with an ICD had a lower median survival as compared to patients without an ICD, although the results were not statistically significant (log rank test, p = 0.11) (Figure 2). The mean age in the ICD vs. no ICD group were 63.4±10.4 years vs. 67.2±8.6 years, p=0.18, and median left ventricular ejection fraction (%) was 40 (30-44) vs. 45 (30-50), p=0.21. ICD implantation was not associated with improved survival [unadjusted HR=0.42 (0.14-1.25), p=0.11]. Using Cox regression analysis with age and ICD implantation as covariates, only age was an independent predictor of mortality [HR=1.13, 95% confidence interval (CI): 1.03-1.22, p=0.007] while ICD implantation was not [HR=0.54, 95% CI: 0.18-1.64, p=0.28]. A similar trend was obtained when cardiovascular (CV) mortality (4 CV deaths in the group without an ICD and 6 in the ICD group) was compared (Figure 3) between patients with and those without an ICD. The causes of CV deaths were : 1) heart failure [3 in the no ICD
 group and 3 in the ICD group], 2) intractable VT/VF [2 in the ICD group], 3) sudden death [1 in the no ICD group] and 4) cardiac tamponade following ICD implantation in one patient.

**VT with syncope or cardiovascular compromise:** A subgroup of patients (10/45) presented with VT with syncope or significant cardiovascular compromise (pre-syncope, pulmonary edema or cardiogenic shock). They all underwent the same protocol of VT ablation and ablation guided ICD implantation. The results of these patients are shown in Table 3.

**Arrhythmic Death:** 2 patients in the ICD group died due to intractable VT/VF and 1 patient in the group without ICD had a sudden death. This was a 76 year-old man, with a LVEF of 50%, who initially presented with a VT cycle length of 353 ms and had an acutely successful ablation.

**ICD Therapies**

In patients with an ICD, therapy for VT was delivered in 8/19 (42.1%) patients, with 7 patients having had 2 or more therapies.

**Discussion**

The aim of this study was to look at the results of a stepwise approach for the management of patients with ICM presenting with VT with ablation as an initial treatment strategy. ICD was implanted based on a predefined decision tree taking into consideration acute success, inducibility at repeat EPS and recurrence. To our knowledge, this is the first study to look at such an approach. This study has a number of interesting findings. Firstly, it suggests that a strategy of successful VT ablation, defined as non-inducibility of all VTs followed by a negative EPS, in patients with post-infarct VT is safe, feasible and can be used as a means to risk stratify patients as to the implantation of ICD. Secondly, the mortality rate in the successful ablation group was not higher than the ICD group. Although the numbers are limited, this strategy does not seem harmful even in patients presenting with haemodynamically unstable VT.
In patients with ischemic cardiomyopathy, ventricular tachycardia (VT) carries a poor prognosis. Various studies have shown the superiority of ICD therapy compared to medical therapy on long term outcomes in such patients. Devices, however, do not take away the arrhythmic substrate capable of sustaining a VT circuit. They merely provide therapy for fast heart rates which the ICD recognises as VT or VF based on predefined algorithms. VT ablation, on the other hand targets the substrate responsible for the arrhythmia mechanism. Two randomised control trials have shown that catheter ablation reduces ICD therapies, including shocks in patients with ICM and VT. The question that arises therefore is whether a successful ablation is enough, at least in a subgroup of patients. One problem with “successful” VT ablation is the high rate of recurrence varying between 20 and 44%. In a group of patients with ischemic heart disease and haemodynamically well-tolerated VT, Della Bella et al. showed that VT ablation resulted in the abolition of the targeted VT in 73% of patients. Although the recurrence rate was substantial (27%), only three patients (2.5%) died suddenly. Our study is similar to the study by Della Bella et al. in that we looked at a similar cohort of patients. However, in the above study, repeat VT stimulation study was not carried out. Moreover, ICD was implanted in 11% in the study population and they were prior to the VT ablation. The same group showed that a negative EPS after VT ablation for VT storm was a predictor of absence of VT recurrence over a long period of time. It is possible that incomplete ablation and/or oedema might limit the predictive value of EPS immediately post ablation and therefore it is possible that an EPS remote from the ablation time provide a better answer. In patients with a structural heart disease, Frankel et al. showed that a negative EPS performed 3.1±2.1 days after ablation predicted >80% VT-free survival over 1 year follow up. We arbitrarily chose a 3 month period to allow the scar to “mature”. Our study therefore adds further to the current understanding.
However, given the high recurrence rates, additional substrate based ablation might provide even better results.

There was a trend towards a survival benefit in the successful VT ablation group compared to the group with ICD, although the results were not statistically significant. Several trials have shown that ICD therapies are associated with mortality and morbidity, and therefore it is conceivable that successful ablation and abolition of substrate for sustained VT might lower mortality.

In addition, there is also an economic argument in favour of the stepwise approach to VT ablation. ICDs are costly and therefore this strategy might allow us to use limited resources in a more cost effective way.

Limitations
This study is not a randomised controlled trial and therefore the inherent limitations of observational studies apply. Patient groups are not homogeneous. Decision on whether patients had an ICD was not random but based on a decision tree. It is therefore conceivable that the patient group without an ICD represented a less healthy cohort. However, the mortality difference demonstrated would argue against this. It can be argued that physicians may have felt more comfortable not implanting an ICD in certain patients and this would have created an inherent bias. However, this is unlikely, in our opinion, given that this decision was made on a predefined algorithm.

Secondly, it is a small study, and analysis of subgroups inherently, makes the groups smaller.

Thirdly, the exact timing of a repeat VT stimulation study to confirm non-inducibility is unknown. We used a 3-month window based on experience.
Fourth, the only endpoint of the study was prevention of VT inducibility. Whether modification of the arrhythmia substrate was achieved cannot be proven.

Finally, the results of this observational study need to be verified in a randomised controlled trial (RCT). We appreciate that it may take a long time for such a RCT to be carried out, mainly because of the current guidelines.

Conclusions

The results of this observational study suggest that a strategy of VT ablation and ablation guided ICD implantation might be a reasonable option in selected patients with previous MI.

Conflict of Interest Disclosures: Dr de Chillou, Andronache and Aliot have received lectures fees from Biosense Webster for less than 10,000 annual USD.

References:


from the antiarrhythmics versus implantable defibrillators (AVID) registry. Circulation. 2001;103:244-252.


### Table 1: Clinical Characteristics

<table>
<thead>
<tr>
<th></th>
<th>ICD Group n= 19</th>
<th>No ICD group n= 26</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>63.4 ± 10.4</td>
<td>67.2 ± 8.6</td>
<td>0.18</td>
</tr>
<tr>
<td>Sex (% male)</td>
<td>16 (84.2)</td>
<td>25 (96.2)</td>
<td>0.20</td>
</tr>
<tr>
<td>Ejection Fraction (%)</td>
<td>40 (30-44)</td>
<td>45 (30-50)</td>
<td>0.24</td>
</tr>
<tr>
<td>History of AF (%)</td>
<td>4 (21.0)</td>
<td>3 (11.5)</td>
<td>0.43</td>
</tr>
<tr>
<td>History of CABG (%)</td>
<td>6 (31.5)</td>
<td>8 (30.8)</td>
<td>0.95</td>
</tr>
<tr>
<td>History of PTCA / stenting (%)</td>
<td>4 (21.0)</td>
<td>9 (34.6)</td>
<td>0.51</td>
</tr>
<tr>
<td>Chronic renal failure (%)</td>
<td>2 (10.5)</td>
<td>3 (11.5)</td>
<td>0.92</td>
</tr>
<tr>
<td>NYHA (%)</td>
<td></td>
<td></td>
<td>0.32</td>
</tr>
<tr>
<td>I</td>
<td>1 (5.3)</td>
<td>4 (15.4)</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>17 (89.4)</td>
<td>18 (69.2)</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>1 (5.3)</td>
<td>4 (15.4)</td>
<td></td>
</tr>
<tr>
<td>Location of Infarct (%)</td>
<td></td>
<td></td>
<td>0.19</td>
</tr>
<tr>
<td>Anterior</td>
<td>3 (15.8)</td>
<td>9 (34.6)</td>
<td></td>
</tr>
<tr>
<td>Inferior/Posterior</td>
<td>16 (84.2)</td>
<td>17 (65.4)</td>
<td></td>
</tr>
<tr>
<td>VT tolerance (%)</td>
<td></td>
<td></td>
<td>0.31</td>
</tr>
<tr>
<td>Fair</td>
<td>14 (73.7)</td>
<td>21 (80.8)</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>4 (21.1)</td>
<td>1 (3.8)</td>
<td></td>
</tr>
<tr>
<td>Syncope</td>
<td>1 (5.3)</td>
<td>4 (15.4)</td>
<td></td>
</tr>
<tr>
<td>Amiodarone prior to ablation (%)</td>
<td>11 (57.9)</td>
<td>12 (46.2)</td>
<td>0.55</td>
</tr>
<tr>
<td>Amiodarone post ablation* (%)</td>
<td>10 (52.6)</td>
<td>7 (26.9)</td>
<td>0.07</td>
</tr>
</tbody>
</table>

AF: Atrial Fibrillation, CABG: coronary artery bypass grafting, ICD: Intra-cardiac defibrillator, NYHA: New York Heart Association, PTCA: Percutaneous Transluminal Coronary Angioplasty, *: Treatment at hospital discharge after the first procedure

VT: ventricular tachycardia

**VT Tolerance:**
- Fair: VT without cardiovascular compromise
- Poor: VT and cardiovascular compromise (i.e.: pre-syncope, pulmonary edema or cardiogenic shock)
**Table 2: Ablation & Ventricular Tachycardia Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>ICD Group n= 19</th>
<th>No ICD group n= 26</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of ablation procedures</td>
<td>1 (IQR 1-2)</td>
<td>1 (IQR 1-2)</td>
<td>0.22</td>
</tr>
<tr>
<td>Number of different VTs at first ablation</td>
<td>1 (IQR 1-2)</td>
<td>1 (IQR 1-3)</td>
<td>0.57</td>
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<tr>
<td>Epicardial ablation</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>NA</td>
</tr>
<tr>
<td>Entrainment(^{12}) (%) YES(^*)</td>
<td>0(0)</td>
<td>3 (11.5)</td>
<td>0.25</td>
</tr>
<tr>
<td>Pacemapping (%YES(^*))</td>
<td>10(52.6)</td>
<td>20(76.9)</td>
<td>0.16</td>
</tr>
<tr>
<td>VT termination during RF application (%)</td>
<td>5(26.3)</td>
<td>8 (30.8)</td>
<td>0.51</td>
</tr>
<tr>
<td>Abolition of post systolic potentials (% YES**)</td>
<td>3(15.8)</td>
<td>8 (30.8)</td>
<td>0.32</td>
</tr>
<tr>
<td>Procedure Duration (minutes)</td>
<td>221±76</td>
<td>242±61</td>
<td>0.73</td>
</tr>
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</table>

ICD: Intra-cardiac defibrillator, NA: non-applicable, NS: non-significant, RF: radiofrequency, VT: ventricular tachycardia, \(^*\): percentage of patients in whom VT entrainment and/or pacemapping during sinus rhythm were used to help unmask the VT isthmus, **: percentage of patients in whom abolition of post systolic potentials (recorded on sinus rhythm EGM) was performed in addition to VT isthmus trans-section.

**Table 3: Clinical characteristics and outcomes in patients presenting with VT and cardiovascular compromise prior to ablation**

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age</th>
<th>LVEF</th>
<th>VT tolerance</th>
<th>NYHA</th>
<th>ICD Implanted</th>
<th>Death</th>
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<tr>
<td>M</td>
<td>63</td>
<td>42</td>
<td>POOR</td>
<td>2</td>
<td>YES</td>
<td>YES</td>
<td>Bladder Cancer</td>
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<tr>
<td>M</td>
<td>64</td>
<td>46</td>
<td>POOR</td>
<td>2</td>
<td>YES</td>
<td>YES</td>
<td>Unknown</td>
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<tr>
<td>M</td>
<td>80</td>
<td>40</td>
<td>POOR</td>
<td>2</td>
<td>YES</td>
<td>YES</td>
<td>Heart Failure</td>
</tr>
<tr>
<td>M</td>
<td>75</td>
<td>30</td>
<td>POOR</td>
<td>3</td>
<td>NO</td>
<td>YES</td>
<td>Heart Failure</td>
</tr>
<tr>
<td>M</td>
<td>71</td>
<td>30</td>
<td>POOR</td>
<td>2</td>
<td>YES</td>
<td>YES</td>
<td>Untractable VT/VF</td>
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<tr>
<td>M</td>
<td>78</td>
<td>20</td>
<td>SYNCOPE</td>
<td>3</td>
<td>YES</td>
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<td>Heart Failure</td>
</tr>
<tr>
<td>M</td>
<td>51</td>
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<td>SYNCOPE</td>
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<tr>
<td>M</td>
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<td>M</td>
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<td>F</td>
<td>74</td>
<td>30</td>
<td>SYNCOPE</td>
<td>2</td>
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</tbody>
</table>

ICD: Implantable Cardioverter Defibrillator, CVA: Cerebrovascular Accident, NYHA: New York Heart Association, VT Ventricular Tachycardia, LVEF: Left Ventricular Ejection Fraction, NA: non-applicable (patient alive)

*POOR: patients presenting with VT and cardiovascular compromise (i.e.: pre-syncope, pulmonary edema or cardiogenic shock)
Figure Legends:

**Figure 1:** Stepwise Approach to the management of patients with Ischaemic Cardiomyopathy and Ventricular Tachycardia.

CRT: Cardiac Resynchronisation Therapy, EP: Electrophysiology, ICD: Implantable Cardioverter Defibrillator, VT: Ventricular Tachycardia. Well tolerated ventricular tachycardia was defined as VT without cardiovascular compromise (i.e.: pre-syncope, pulmonary edema or cardiogenic shock) and with no requirement of an immediate DC cardioversion.

**Figure 2:** Kaplan-Meier Survival Curves for Patients with and without ICD

**Figure 3:** Kaplan-Meier Survival free from cardiovascular death in patients with and without ICD.

ICD: Implantable Cardioverter Defibrillator
45 patients with monomorphic VT and no ICD

Acute Success, n=40

Repeat EPS within 3 months, n=36

No VT Inducible, n=23

VT inducible, n=13

No VT Recurrence, n=22

Are all the VTs well tolerated?

Yes, n=6

No, n=7

Repeat Ablation, n=6

ICD implanted, n=3

Repeat Ablation, n=1*

Repeat EPS, n=1

No VT inducible, n=1

ICD implanted, n=5

No ICD, n=1

I CD implanted, n=1

ICD implanted, n=3

ICD implanted, n=1

ICD implanted, n=5

ICD implanted, n=1

ICD implanted, n=1

ICD implanted, n=1

VT inducible, n=2

ICD implanted, n=2

Repeat Ablation, n=2

Acute Success, n=2

Unsuccessful, n=5

Are all the remaining VTs well Tolerated?

Yes, n=2

No, n=3

Repeat EPS, n=2

No VT inducible, n=1

Positive EPS, n=1

Negative EPS, n=1

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If  

1 patient died of heart failure, prior to repeat EPS

Recurrence of VT prior to EPS, n=3

Repeat Ablation

Acute Success and Negative repeat EPS, n=0

Recurrence of VT @follow-up, n=1

No ICD, n=22

Are all the VTs well tolerated?

Yes, n=6

No, n=7

Repeat Ablation, n=6

ICD implanted, n=3

Repeat Ablation, n=2

Acute Success, n=2

Repeat EPS, n=2

No ICD, n=1

Positive EPS, n=1

Negative EPS, n=1

ICD implanted, n=1

No ICD, n=1

ICD implanted, n=1

ICD implanted, n=1

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Maheshwar Pauriah, Gabriel Cismaru, Isabelle Magnin-Poull, Marius Andronache, Jean-Marc Sellal, Jérôme Schwartz, Béatrice Brembilla-Perrot, Nicolas Sadoul, Etienne Aliot and Christian de Chillou

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