Endo-Epicardial versus Only-Endocardial Ablation as a First Line Strategy for the Treatment of Ventricular Tachycardia in Patients with Ischemic Heart Disease

Running Title: Izquierdo et al.; Epicardial ablation of Ischemic VT

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Abstract:

Background - Epicardial ablation has shown improvement in clinical outcomes of patients with ischemic heart disease (IHD) after ventricular tachycardia (VT) ablation. However, usually epicardial access is only performed when endocardial ablation has failed. Our aim was to compare the efficacy of endocardial+epicardial ablation versus only endocardial ablation in the first procedure in patients with IHD.

Methods and Results - Fifty three patients with IHD, referred for a first VT ablation to our institution, from 2012 to 2014, were included. They were divided in 2 groups according to enrolment time: from May 2013, we started to systematically perform endo-epicardial access (Epi-Group) as first-line approach in consecutive patients with IHD (n=15). Patients who underwent only an endocardial VT ablation in their first procedure (Endo-Group) included: patients with previous cardiac surgery and the historical (before May 2013) (n=35). All late-potentials in the scar zone were eliminated and if VT was tolerated critical isthmuses were also approached. The endpoint was the non-inducibility of any VT. During a median follow-up of 15±10 months, the combined endpoint (hospital or emergency admission because of a ventricular tachycardia or re-ablation) occurred in 14 patients of the Endo-group and in one patient in the Epi-group (event-free survival curves by Grey-test, p= 0.03). Ventricular arrhythmia recurrences occurred in 16 and in 3 patients in the Endo and Epi Group respectively (Grey test, p=0.2).

Conclusions - A combined endocardial-epicardial ablation approach for initial VT ablation was associated with fewer readmissions for VT and repeat ablations. Further studies are warranted.

Key words: ablation, ventricular tachycardia, epicardial
Introduction

Epicardial substrate ablation of ventricular tachycardia (VT) as a first-line option has shown to improve outcome, in terms of VT recurrences, in many cardiac diseases as nonischemic dilated cardiomyopathy\textsuperscript{1} and arrhythmogenic right ventricular dysplasia\textsuperscript{2-4}. However, the role of this approach in patients with ischemic heart disease (IHD) has not been clearly defined. Several studies including patients with IHD that undergo epicardial ablation for VT have shown improvement in clinical outcomes, but in these patients the epicardial access is usually performed in a second or third procedure, after an endocardial ablation has failed\textsuperscript{5-8}.

The purpose of this study was to compare the efficacy of only-endocardial VT ablation to combined endocardial and epicardial ablation in the same procedure in unselected patients with IHD that undergo their first VT ablation in our institution.

Methods

Patient Population

The present analysis includes all patients with IHD referred to our institution from 2012 to 2014 for a first ablation procedure of sustained monomorphic VT.

Since May 2013, we decided to prospectively perform both, endo and epicardial access as a first-line approach, in all consecutive patients with IHD referred for their first VT ablation procedure, except for contraindications. Baseline characteristics, safety and outcome of this Epi-Group were compared to patients who underwent only an endocardial VT ablation in their first procedure (Endo-Group).

The Endo-Group finally included:

- Patients with previous cardiac surgery in whom epicardial access was contraindicated.
- The historical cohort of consecutive patients with IHD referred to our institution for a first VT ablation from 2012 to May 2013.
- A small number of patients from May 2013 to 2014 who underwent only endocardial ablation despite not having contraindications to epicardial ablation, because of physician preference (usually related to the lack of experience in epicardial access during the learning curve of the technique).

This study was approved by the Institutional Review Board and all patients signed an informed written consent.

**VT ablation**

The procedure was performed under local anaesthesia and conscious sedation. A quadripolar diagnostic catheter was introduced via the right femoral vein to the right ventricular apex. The left ventricle was accessed retrogradely through the aortic valve and/or via a transseptal approach. Electroanatomical left ventricle maps were obtained using CARTO 3 (Biosense Webster, Diamond Bar, CA, USA) or EnSite NavX (St Jude Medical, St Paul, MN, USA). For ablation 3.5-4 mm saline-irrigated tip ablation catheters (Navistar Thermocool, Celsius Thermocool -Biosense Webster- or CoolFlex -ST Jude) were used. Simultaneous recordings of ventricular bipolar electrograms (bandpass filtered 30-500 Hz) and 12-lead surface electrocardiogram (ECG) were stored digitally (Prucka Cardiolab, GE Medical Systems, Milwaukee, WI, USA). The procedures were performed under intravenous anticoagulation with sodium heparin (initial bolus of 50-100 IU/kg followed by a 1000 IU/hour perfusion adjusted to maintain the partial time of tromboplastine activated above 250 s).

If the VT was not incessant, VT was induced with programmed stimulation (high rate pacing and extrastimulus test using two pacing cycles, up to three extrastimuli, from the right and,
if necessary, left ventricle) and number of morphologies was recorded.

Isovoltage maps of the left ventricle’s endocardium and also epicardium in the Epi-Group were constructed. The voltage thresholds used to consider dense scar and border zone were 0.5 and 1.5mV, respectively. Regions with late potentials inside or in the borders of a scar were annotated using colour tags. A first attempt of VT induction was always performed. Points with QRS morphology during pace-mapping identical to that during documented VT were also annotated. When VT was present or induced and it was hemodinamically well tolerated, activation maps and entrainment-mapping techniques were performed trying to characterize the arrhythmia circuit. Radiofrequency energy was delivered in the power control mode through the irrigated tip catheters using a Stockert or Irvine generator with power set to 30-50 w and irrigation set to 17-30 ml/min. Radiofrequency lesions were created either during VT or sinus rhythm in the regions identified or supposed to be critical for the sustenance of clinical or inducible VTs. The end-point was the elimination of all late potentials in the endocardial scar and also in the epicardial scar in the Epi-Group. Lack of inducibility of any VT after ablation was considered acute procedural success; partial success was defined as inducibility of faster, nonclinical VT. In patients with induced, not tolerated VT before ablation that needed more than two DC shocks to be cardioverted, postprocedure inducibility was not sistematically tested.

Pericardial access

The pericardium was accessed percutaneously using the technique described by Sosa et al.9 once the venous and arterial accesses were gained, and prior to start intravenous anticoagulation. As stated before, pericardial access wasn’t performed in patients with previous cardiac surgery. Before epicardial ablation, coronary angiography was performed to avoid coronary artery damage. Epicardial phrenic nerve capture was tested with bipolar pacing from the ablation
catheter. When epicardial position of the ablation catheter was too close to a coronary artery or when phrenic capture was obtained from it, the catheter was slightly moved trying to avoid damage of such structures. If imminent damage was suspected radiofrequency wasn’t delivered.

**Clinical outcome and Follow-up**

All patients without previous ICD implant were implanted before discharge except for one patient in the Epi-group with important pulmonary comorbidity. All patients were followed in the outpatient clinic at three months and then every six months after ablation.

**Endpoints**

Primary endpoints were:

1) VT recurrence, that included an ICD appropriate therapy (antitachycardia pacing or shock) or a documented, slow, symptomatic VT not detected by the ICD.

2) A combined end-point that included: hospital or emergency admission because of a new episode of VT or the need of a second ablation procedure.

3) Mortality for any cause.

**Statistical analysis**

Continuous variables were expressed as median and interquartile range (IQR). Discrete variables were summarized as percentages. Baseline characteristics were compared between Epi-Group and Endo-Group using non-parametric tests (Fisher’s exact test and Mann-Whitney Test for categorical and continuous variables respectively). An adapted version of Cox regression, that takes into account the effect of all-cause mortality as competing event \(^{10}\), was used to examine the univariated association between baseline variables and both endpoints (VT recurrence and the combined end-point).

The univariate effect of the combined epi/endo ablating strategy (Epi-Group) on the
incidence of the end-points (VT recurrence and combined end-point) was analyzed by the Fine and Gray\textsuperscript{10} event-free survival curves.

The interaction in the Epi-Group prognosis of those variables that significantly differed in baseline characteristics between groups (in particular previous cardiac surgery) was also studied and for that purpose a second sensitivity analysis excluding patients with previous cardiac surgery was performed. A multivariate test was not considered as none of the candidate co-variables had p<0.15 in the univariate analysis and because of the small sample size. Estimated survival curves in both groups (Endo- and Epi- groups) were assessed by Kaplan-Meier analysis and differences between strata were assessed by Log-rank test. Univariate Cox-regression model was performed to find if there were any baseline characteristics that predicted mortality for any cause. After that, a second sensitivity analysis excluding patients with previous cardiac surgery was performed.

A 2-sided p-value of <0.05 was considered to be statistically significant for all analyses. Statistical analyses were performed using STATA 13.1 (StataCorp. 2013. Stata Statistical Software: Release 13.1. College Station, TX: StataCorp LP).

Results

From January 2012 to December 2014, 53 patients with IHD were referred for their first VT ablation procedure. Thirty-five patients underwent only endocardial ablation:

- 12 patients because they had had previous cardiac surgery,
- 12 patients included from January 2012 to May 2013 when a combined procedure, endo and epicardial access, was not being performed as a first attempt yet
- 8 patients from May 2013 that underwent only endocardial ablation, 7 because of physician
decision as it is explained in methods and 1 patient because of skin lesions in the subxifoid area that contraindicated subxifoid access.

-3 patients in whom epicardial access failed (two of them because of the existence of pericardial adhesions)

Figure 1 shows a flow-chart where the incorporation of patients is depicted.

Table 1 shows a comparison of the baseline characteristics between both groups. There were no significant differences except for previous cardiac surgery, given that all operated patients were in the Endo-Group.

**Clinical Follow-up**

Complete clinical follow-up was available for all but 1 patient that was lost after moving to another country. The median follow-up was 397 (IQR 233-637) days in the Endo-Group and 324 (IQR 174-454) days in the Epi-Group (p=0.38).

**Ablation procedure**

Among the 15 patients in the Epi-Group, epi and endocardial ablation targets with subsequent radiofrequency delivery were found in 11 patients (figure 2). In 2 patients only endocardial targets were found although there were epicardial dense scars, and in 2 patients only epicardial targets were encountered. Phrenic nerve capture and the proximity of coronary arteries did not prevent any radiofrequency delivery.

There were no significant differences in acute complete success of ablation, 20 (57%) vs 6 (40%) patients in Endo and Epi-Group respectively (p=0.69). Induction of a non clinical tachycardia occurred in 7 (20%) vs 5 (33%) in Endo and Epi-Group. Ablation failure, that is induction of the clinical tachycardia, occurred in 2 patients (6%) in the Endo-Group and in 1 patient (7%) in the Epi-Group. Induction was not tried in 6 (17%) and in 3 patients (20%) of the
Endo and Epi-Group respectively.

The rest of the variables related to the procedure are displayed in table 2. There were no significant differences between groups. The mean radiofrequency delivery time in the endocardium was significantly shorter in the Epi-Group. However, total delivery time didn’t differ between the two groups.

**Complications**

There were 4 local groin complications; two pericardial effusions in the Epi-group, one during the endocardial mapping, before ablation, that needed drainage and finally required cardiac surgery (this effusion was suspected to be produced by endocardial mapping), and another that occurred during epicardial mapping and that needed drainage (this second patient underwent a second only-endocardial procedure because of pericardial adhesions).

**VT recurrence**

During follow-up, 16 (46%) patients of the Endo-Group had VT recurrence. Remarkably, 5 of these patients had slow symptomatic VT that were undetected by the ICD, 4 needed a hospital admission because of this symptomatic slow VT and one had a slow VT episode before discharge after ablation.

In the Epi-Group 3 (20%) patients had VT recurrences: 1 patient with a few episodes reverted with antitachycardia pacing and 2 patients with an isolated VT episode requiring an ICD shock. No slow, undetected VTs were registered.

Although a trend towards more VT recurrences in the Endo-Group was observed (figure 3A), no independent predictors of VT recurrence were found (table 3).

As it is displayed in figure 3A, the majority of recurrences occurred in the first 3 months in both groups (2 of 3 in the Epi-Group and 10 of 16 in the Endo-Group).
Combined end-point (hospital or emergency admission or re-ablation)

The need of admission because of VT recurrence occurred in 13 (34%) patients of the Endo-Group (12 had a hospital admission and one patient attended the emergency department). One patient of the Epi-Group attended the emergency department during follow-up. A second VT ablation procedure was indicated in 10 (29%) patients of the Endo-Group and in none of the Epi-Group.

The occurrence of the combined endpoint (hospital or emergency admission because of VT or re-ablation) was significantly lower in the Epi-Group (figure 3B). Baseline characteristics between groups were comparable except for previous cardiac surgery, so the interaction was studied and a second analysis excluding those patients was performed. Survival curves analysis showed a trend towards better outcomes excluding these patients (P=0.06) (figure 4).

No other predictors of the combined endpoint were found in the univariate analysis (table 3).

Mortality

Eleven patients (31%) of the Endo-Group died during follow-up. Causes of death were heart failure (6 patients) and lung cancer, intestine occlusion, pneumonia, sepsis and endocarditis over a resynchronization therapy device with rapid heart failure after removal of the system (1 patient each).

In the Epi-Group, only one patient died during follow-up because of tracheomalacia secondary to a previous prolonged intubation. There were no significant differences in the estimated cumulative risk of mortality between groups (Log Rank, p=0.17).

In the univariate analysis mortality was associated to previous cardiac surgery. Excluding this subgroup, there were no significant differences in the estimated cumulative risk of mortality.
between groups (log Rank=0.49)

Discussion

The main findings of this single-center experience are that a systematic combined access, endocardial and epicardial, in consecutive, unselected patients with IHD that undergo their first VT ablation procedure improve clinical outcome in terms of readmission because of VT and reduce the need of re-ablation when compared to only endocardial ablation.

To our knowledge, all the published studies that assess the acute success and clinical outcomes of epicardial ablation of sustained monomorphic VT in IHD include patients that have a previous failed only-endocardial ablation procedure, so the epicardial access remains consigned to a second step5-8. In these studies, a bias toward enriched epicardial substrates may be present, given that prior endocardial ablation had failed.

This study systematically includes unselected, consecutive patients that underwent epicardial access in their first procedure. The only reason to accede or not to the epicardium, except for contraindications, was the date of the procedure. Only a previous study by Di Biase et al11 compared a systematic endo-epicardial strategy in IHD patients with electrical storm to an historical endo-ablation cohort. This study showed that an endo-epicardial approach reduced the number of VT recurrences. However, the main limitation of the study of Di Biase et al was that the ablation technique differed between groups: scar homogenization in the epi-group versus limited substrate ablation in the historical cohort. Our series includes not only electrical storms but all patients with sustained monomorphic VTs, and the same ablation technique was used in both groups.

This systematic endo-epicardial approach in IHD patients could be justified by some arguments: a) Different data point to increased electrophysiologists confidence with the
technique, that probably reflects the improvement in terms of security and the awareness of the extent of epicardial involvement. b) Epicardial and intra-mural re-entry circuit locations are well recognized in the literature and are an important cause of failure of endocardial ablation. c) Improvements in outcome have been demonstrated when patients undergo an endo-epicardial ablation in a second procedure after a first only endocardial ablation has failed. d) Clinical and EKG characteristics have failed to reliably identify endocardial or epicardial components of VT circuit in IHD.

So we speculated that an appropriate choice of a combined endo-epicardial approach as a first line mapping and ablation strategy may avoid a substantial number of repeated procedures and improve ablation outcome, as it has been demonstrated. Although we also observed a trend towards a reduction in ICD therapies with the endo-epicardial approach we failed to demonstrate a significant difference. However, all hospital admissions because of VT and all re-ablation procedures during follow-up occurred in the Endo-Group.

It must be emphasized that epicardial targets were found in 13 of 15 patients in the Epi-Group, and two of them had only epicardial targets. Although it’s true, on the one hand, that the presence of abnormal electrograms that may not participate in reentry could overestimate epicardial isthmuses, and only the number of terminated VT in the epicardium may be more real; it’s also true, on the other hand, that most tachycardias are not hemodynamically tolerated and cannot be mapped. Moreover, as Jaïs et al demonstrated, elimination of all late potentials is associated with a superior clinical outcome.

Surprisingly, acute success did not differ between groups in our series. Tung et al when compared only-endo versus endo-epicardial ablation mainly in ischemic patients with previous failed procedures reported a similar finding. Procedural endpoints may therefore be unreliable as
well. Lack of inducibility of VT after ablation does not unequivocally predict a better outcome after ablation\textsuperscript{17,18}. Although non-inducibility has been related to reduced mortality and VT recurrences\textsuperscript{19}, it is known that VT ablation doesn’t improve survival, so we can speculate that non-inducibility can be seen as a well prognosis marker that may not be achieved in all patients.

In other series, VT ablation has failed to demonstrate a survival improvement\textsuperscript{20,21}. In our study, a reduction in terms of hospital admission because of a VT or need of re-ablation or even a trend towards less VT recurrences in the Epi-Group didn’t associate with a mortality reduction. The only predictor of mortality was previous cardiac surgery. As it is shown in table 3, previous cardiac surgery was not a predictor of VT recurrence or the combined end-point. However, as this subgroup of patients were all allocated in the Endo-Group, further statistical analysis was performed removing this subgroup. Even then endo-epicardial ablation as a first step still showed a trend towards a better outcome in terms of hospital admissions and re-ablations.

A curious finding was that 5 patients in the Endo-Group and none in the Epi-Group had a recurrence in the form of slow VT undetected by the ICD. There are few studies including patients with slow VT that show that these patients have a worse prognosis in terms of VT recurrence and even mortality\textsuperscript{22,23}.

Finally but not less important is that two patients had significant pericardial bleeding in the Epi-group, a percentage already described in the literature\textsuperscript{6,24}, so it must be emphasized that the procedure should be performed by experienced operators with surgical back-up.

**Limitations**

The major limitations of our study are:

1. It is not a randomized study, however the patients that underwent epi+endo ablation were unselected and the assigned access depended in most of them only on the time period.
Moreover, there were no significant differences in baseline characteristics, but for previous surgery, between both groups.

2. No surgical epicardial ablation was performed, so patients with previous surgery were included in the Endo-Group. However the interaction of previous surgery for the combined end-point was not significant.

3. It reflects only the practice in a single center but, just because of this, the ablation technique is homogeneous in all the patients

4. The sample is small and the follow up period in the Epi-Group is short, especially when compared to the Endo-Group. Thus our series must be taken as an hypothesis generating study or as a feasibility study.

5. The composite end-point (hospital or emergency admission because of VT or re-ablation) is not a hard end-point and could be somehow subjective.

Conclusions

A combined endocardial and epicardial approach in the first ablation procedure for monomorphic sustained VT is feasible. It is not associated, in our limited series, to a significant reduction in VT recurrence. However it is associated with a significant reduction in hospital and emergency admissions because of VT recurrence and with the need of reablation in IHD patients. Further studies are warranted.

Conflict of Interest Disclosures: None

References:


Table 1: Baseline patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Endo-Group</th>
<th>Epi-Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>35</td>
<td>15</td>
<td>0.82</td>
</tr>
<tr>
<td>Age (y)</td>
<td>66 (61-78)</td>
<td>67 (64-78)</td>
<td>1.00</td>
</tr>
<tr>
<td>Sex: Male</td>
<td>33 (94%)</td>
<td>14 (94%)</td>
<td>0.38</td>
</tr>
<tr>
<td>Ejection Fraction</td>
<td>32 (28-41)</td>
<td>30 (22-41)</td>
<td>0.46</td>
</tr>
<tr>
<td>QRS duration</td>
<td>144 (107-156)</td>
<td>119 (100-153)</td>
<td>0.30</td>
</tr>
<tr>
<td>Hypertension</td>
<td>25 (71%)</td>
<td>13 (86%)</td>
<td>0.45</td>
</tr>
<tr>
<td>Creatinin</td>
<td>1.08 (0.88-1.44)</td>
<td>1.19 (0.94-1.54)</td>
<td>0.74</td>
</tr>
<tr>
<td>Dyslipemia</td>
<td>23 (65%)</td>
<td>11 (73%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Smoker</td>
<td>6 (17%)</td>
<td>3 (20%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Ex smoker</td>
<td>16 (46%)</td>
<td>7 (47%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Diabetes</td>
<td>11 (31%)</td>
<td>5 (33%)</td>
<td>0.22</td>
</tr>
<tr>
<td>Previous atrial fibrillation</td>
<td>11 (31%)</td>
<td>4 (27%)</td>
<td>0.72</td>
</tr>
<tr>
<td>History of Heart failure Admission</td>
<td>11 (31%)</td>
<td>3 (23%)</td>
<td>0.96</td>
</tr>
<tr>
<td>Previous ICD</td>
<td>22 (63%)</td>
<td>10 (67%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Secondary prevention</td>
<td>13 (56%)</td>
<td>5 (50%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Resynchronization Therapy</td>
<td>6 (18%)</td>
<td>2 (14%)</td>
<td>0.82</td>
</tr>
<tr>
<td>Previous Cardiac Surgery</td>
<td>11 (31%)</td>
<td>0</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>1 (3%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Antiarrhythmics post-ablation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amiodarone</td>
<td>16 (46%)</td>
<td>7 (47%)</td>
<td>0.83</td>
</tr>
<tr>
<td>Sotalol</td>
<td>7(20%)</td>
<td>2(13%)</td>
<td>0.83</td>
</tr>
<tr>
<td>Betablockers</td>
<td>31 (88%)</td>
<td>12 (85%)</td>
<td>0.56</td>
</tr>
<tr>
<td>Furosemide</td>
<td>20 (57%)</td>
<td>11 (73%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Oral antiarrhythmics pre-ablation</td>
<td>5 (35%)</td>
<td>17 (48%)</td>
<td>0.5</td>
</tr>
<tr>
<td>Furosemide</td>
<td>20 (57%)</td>
<td>11 (73%)</td>
<td>0.35</td>
</tr>
<tr>
<td>Qualifying episode:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First VT episode</td>
<td>18 (51%)</td>
<td>6 (40%)</td>
<td>0.54</td>
</tr>
<tr>
<td>Presentation as a VT storm</td>
<td>12 (33%)</td>
<td>5 (33%)</td>
<td>0.79</td>
</tr>
<tr>
<td>Presentation as a cardiac arrest</td>
<td>5 (14%)</td>
<td>2 (13%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Lone VT episode</td>
<td>9 (26%)</td>
<td>3 (20%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Syncope</td>
<td>11 (31%)</td>
<td>5 (33%)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

VT: ventricular tachycardia; ICD: implantable cardiac defibrillator.
Values are expressed as a median (interquartilic range) or n (percentage)
### Table 2: Procedure characteristics

<table>
<thead>
<tr>
<th></th>
<th>Endo-Group</th>
<th>Epi-Group</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N</strong></td>
<td>35</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Carto System</td>
<td>19 (54%)</td>
<td>12 (80%)</td>
<td>0.11</td>
</tr>
<tr>
<td>NavX System</td>
<td>16 (45%)</td>
<td>3 (20%)</td>
<td>0.11</td>
</tr>
<tr>
<td>Procedure Time (h)</td>
<td>5.5 (5-6)</td>
<td>6 (5.5-6.5)</td>
<td>0.15</td>
</tr>
<tr>
<td>xRay time (min)</td>
<td>8 (6-11)</td>
<td>9 (8-14)</td>
<td>0.26</td>
</tr>
<tr>
<td>RF time (min)</td>
<td>19 (13-28)</td>
<td>16 (13-23)</td>
<td>0.34</td>
</tr>
<tr>
<td>Epicardial</td>
<td>-</td>
<td>6 (0-10)</td>
<td></td>
</tr>
<tr>
<td>Endocardial</td>
<td>19 (13-28)</td>
<td>10 (3-17)</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Scar location</strong></td>
<td></td>
<td></td>
<td>0.67</td>
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<tr>
<td>Inferior/ lateral/ infero septal</td>
<td>22 (64%)</td>
<td>7 (53%)</td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>8 (23%)</td>
<td>4 (27%)</td>
<td></td>
</tr>
<tr>
<td>Apical</td>
<td>5 (14%)</td>
<td>4 (26%)</td>
<td></td>
</tr>
<tr>
<td><strong>Number of VT induced</strong></td>
<td>2 (1-3)</td>
<td>3 (1-3)</td>
<td>0.44</td>
</tr>
<tr>
<td><strong>Ablation during VT episode</strong></td>
<td>10 (29%)</td>
<td>4 (27%)</td>
<td>1.00</td>
</tr>
</tbody>
</table>

VT: ventricular tachycardia  
Values are expressed as a median (interquartilic range) or n (percentage)
**Table 3:** Predictors of VT recurrence and the combined end-point (hospital or emergency department admissions because of VT and need of reablation)

<table>
<thead>
<tr>
<th>Cox regression</th>
<th>Unadjusted Hazard Ratio for VT recurrence</th>
<th>Unadjusted HR for the combined end-point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HR (95% CI)</td>
<td>P-value</td>
</tr>
<tr>
<td>Ejection Fraction*</td>
<td>0.82 (0.50, 1.36)</td>
<td>0.45</td>
</tr>
<tr>
<td>Cardiac Surgery</td>
<td>1.37 (0.84, 2.14)</td>
<td>0.23</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.67 (0.25, 1.76)</td>
<td>0.42</td>
</tr>
<tr>
<td>Smoker</td>
<td>1.08 (0.66, 1.76)</td>
<td>0.76</td>
</tr>
<tr>
<td>Diabetes</td>
<td>0.82 (0.35, 2.15)</td>
<td>0.69</td>
</tr>
<tr>
<td>Age</td>
<td>0.97 (0.92, 1.01)</td>
<td>0.16</td>
</tr>
<tr>
<td>Creatinine†</td>
<td>1.05 (0.94, 1.18)</td>
<td>0.37</td>
</tr>
<tr>
<td>First VT episode</td>
<td>1.70 (0.68, 4.14)</td>
<td>0.25</td>
</tr>
<tr>
<td>QRS duration‡</td>
<td>1.08 (0.92, 1.28)</td>
<td>0.33</td>
</tr>
<tr>
<td>Anti-arrhythmic drug</td>
<td>2.07 (0.75, 5.73)</td>
<td>0.15</td>
</tr>
</tbody>
</table>

VT: ventricular tachycardia; HR: Hazard Ratio; CI: confidence interval.
* For each 10% increase; † for each 0.1 mg/dl increase; ‡ for each 10 ms increase.
Figure Legends:

Figure 1: Patients flow-chart. *One patient had a pericardial efusion during epicardial mapping and underwent a second procedure in which pericardial Access failed because of pericardial adhesions. †Neither endocardial nor epicardial scar (the diagnosis of ischemic disease was questioned)

Figure 2: Epicardial (left) and endocardial (right) bipolar maps using Carto (panel A) and NavX (panel B). The pink (panel A) and red marks (panel B) inside the scar identify late potential zones.

Figure 3: Event-free survival curves for VT recurrences (left) and the composite end-point (right).

Figure 4: Event-free survival curves for VT recurrences (left) and the composite end-point (right), excluding patients with previous surgery
53 Patients undergoing a first VT ablation

35 Endo-Group
- 12 patient previous cardiac surgery
- 1 patient lost

35 endo-Group

18 Epi-Group
- 2 Not ablation
- 1 Pericardial effusion during endocardial mapping
- 1 no electrical scar

15 epi-Group
Cum. Probability of VT recurrence

Gray Test: 0.267

Cum. Probability of hospital or emergency admission or re-ablation

Gray Test: 0.036

<table>
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<th>Endo-group</th>
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<tr>
<td>Follow-up (days)</td>
<td>0</td>
<td>100</td>
<td>200</td>
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<tr>
<td>Cumulative risk of VT</td>
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<td>0.2</td>
<td>0.4</td>
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<td>10 (1)</td>
<td>7 (0)</td>
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<tr>
<td>Endo-group</td>
<td>35 (10)</td>
<td>21 (1)</td>
<td>17 (1)</td>
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<table>
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<th>Epi-group</th>
<th></th>
<th>Endo-group</th>
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</thead>
<tbody>
<tr>
<td>Follow-up (days)</td>
<td>0</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Cum Risk of admission because of VT or Re-ablation</td>
<td></td>
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<tr>
<td>Epi-group</td>
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<td>12 (0)</td>
<td>10 (0)</td>
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<tr>
<td>Endo-group</td>
<td>35 (5)</td>
<td>27 (1)</td>
<td>22 (1)</td>
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</table>
Endo-Epicardial versus Only-Endocardial Ablation as a First Line Strategy for the Treatment of Ventricular Tachycardia in Patients with Ischemic Heart Disease

Maite Izquierdo, Juan Miguel Sanchez-Gomez, Angel Ferrero de Loma-Osorio, Angel Martínez, Alejandro Bellver, Antonio Pelaez, Julio Núñez, Carlos Nuñez, F. Javier Chorro and Ricardo Ruiz-Granell

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