Extracorporeal membrane oxygenation for hemodynamic support of ventricular tachycardia ablation: a 2-center experience

Oxigenador extracorpóreo de membrana como asistencia hemodinámica para la ablación de la taquicardia ventricular: experiencia de dos centros

To the Editor,

Ablation is an effective procedure for the treatment of ventricular tachycardia (VT) and has been demonstrated to improve both survival and time free from arrhythmia recurrence.[1]

Patients with ventricular dysfunction and heart failure are at risk of acute hemodynamic decompensation and multiorgan failure during the procedure. This risk is particularly high in patients with poorly-tolerated recurrent VT requiring cardioversion or defibrillation, or in cases of electrical storm.[2]

Ablation of the arrhythmic substrate, performed in sinus rhythm, is an effective technique for the treatment of VT. If VT occurs with hemodynamic compromise during the procedure, substrate modification can be challenging, as it can be difficult to identify potential pathological substrates, impossible to thoroughly map the substrate, and difficult to fully test efficacy. In addition, after a theoretically effective substrate modification, it may still be possible to induce VT.[3]

The use of various hemodynamic support devices has been described in the literature.[4] The only such device that can provide complete circulatory and respiratory support is extracorporeal membrane oxygenation (ECMO). ECMO use as both rescue and prophylactic circulatory assistance has been described, but there is no consensus on the best strategy to follow.[5] In the subgroup of patients with electrical storm, the circulatory support provided by ECMO during ablation so far appears to give good results.[6]

In this article, we present a prospective series of all consecutive patients who underwent VT ablation with hemodynamic assistance using ECMO in 2 Spanish centers between January 2016 and December 2018. The series included 13 VT ablation procedures in 11 patients (Table 1). The mean age was 60 ± 7 years, 64% had ischemic cardiomyopathy, and 73% had severe ventricular dysfunction. A total of 55% of the patients had an implantable cardioverter-defibrillator and 36% had previously undergone at least one VT ablation.

Ninety-one percent of the patients met the criteria for arrhythmic storm; in 3 of them this was secondary to a recent acute myocardial infarction, and in the others it was secondary to an underlying cardiomyopathy.

ECMO was implanted as support for ablation in 64% of patients; in the others, it was implanted due to cardiogenic shock in the context of electrical storm. ECMO was implanted predominantly (64%) in the operating room, at a median of 1 [interquartile range, 1-3] days before ablation, and was continued for a median of 4 [1-6] days after ablation.

A combined endocardial and epicardial approach was used in 38% of cases. Activation mapping of clinical VT was performed in 85% of the procedures, and 62% were completed with substrate ablation. An induction protocol was used in 77% of cases, and the procedure was considered successful in 77%. There were no complications directly related to ablation. In 1 patient, the ECMO had to be removed due to acute lower limb ischemia.

After a mean follow-up of 12 months, 6 patients remained free from arrhythmic events, 1 patient received a heart transplant, and 2 had recurrence of VT, which was treated effectively with antitachycardia pacing and optimization of antiarrhythmic drugs. During follow-up, 3 patients received treatment with amiodarone, 1 with mexiletine, and 1 with sotalol + mexiletine. Two patients died while still inpatients: both were patients undergoing a further ablation after a first failed procedure and who developed multiorgan failure in the context of refractory heart failure, and it was not possible to attempt more advanced therapies.

In this prospective series from 2 Spanish centers, hemodynamic assistance with ECMO proved be an essential tool to increase the likelihood of successful ablation in 13 particularly high-risk procedures in the context of electrical storm and hemodynamic instability.

In patients with VT and structural heart disease, ablation is a complex procedure and presents a unique challenge, due to the concomitant presence of severe congestive heart failure, episodes of recurrent VT, frequent shocks from the implantable cardioverter-defibrillator, arrhythmic storm, and the presence of significant comorbidity such as diabetes and chronic kidney disease. Therefore, careful patient selection and detailed planning of the procedure are required to optimize efficacy and safety.

The results of our series and of previously-published studies indicate that ECMO can be useful as hemodynamic assistance for

Table 1
Patient and procedure characteristics

Patients, No.	11
Age, years	60 ± 7
Male	11 (100)
Ischemic heart disease	7 (64)
NYHA ≥ III before ablation	2 (18)
EF before ablation	30 ± 9
Previous cardiac surgery	3 (27)
Diabetes mellitus	6 (54)
COPD Gold III-IV	1 (9)
Lactate > 2 before ECMO	6 (54)
Renal failure before ablation	8 (73)
ICD/ICD-CRT	6 (54)
Previous ablation	4 (36)
> 1 AAD before ablation	8 (73)
Procedures, n	13
Duration of ablation, min	296 ± 82
Retroaortic access	11 (85)
Transseptal access	9 (69)
Epicardial access	5 (38)
N°. of induced VTs	3.6 ± 2.5
CL of induced VTs	280 ± 29
ECV during procedure	5 (38)
Clinical VT mapping	11 (85)
Nonclinical VT mapping	9 (69)
Substrate ablation	8 (62)
Induction protocol after ablation	10 (77)
Acute success of ablation	10 (77)
Days of ECMO after ablation	4 [1-6]
Follow-up (12 mo)	
In-hospital VT recurrence (n = 11)	2 (18)
In-hospital mortality (n = 11)	2 (18)
VT recurrence after hospital discharge (n = 8)	2 (25)
Mortality after hospital discharge	

AAD, antiarrhythmic drug; CL, cycle length; COPD, chronic obstructive pulmonary disease; CRT, cardiac resynchronization therapy; ECMO, extracorporeal membrane oxygenator; ECV, electrical cardioversion; EF, ejection fraction; ICD, implantable cardioverter-defibrillator; NYHA, New York Heart Association functional class; VT, ventricular tachycardia.
Unless otherwise indicated, values are reported as No. (%), mean ± standard deviation or median [interquartile range].

VT ablation in patients with hemodynamic instability prior to the procedure or with high risk of hemodynamic compromise during the procedure, as is the case for patients with a diagnosis of electrical storm.

ECMO helps maintain blood pressure and oxygenation even if the patient has sustained VT, ensuring adequate organ perfusion. This allows more detailed, reliable activation maps to be created, which could result in improved procedure outcomes and lower long-term morbidity and mortality. Compared with other devices such as Impella or Tandem Heart, the advantages of ECMO are that it provides greater circulatory assistance as well as pulmonary assistance and does not impede catheter movement during the procedure, as it is an extracardiac device.

Despite the observational design of our series and the lack of a control group, we describe a cohort from 2 centers with experience in VT ablation. In the absence of clinical trials evaluating the real benefit of ECMO as hemodynamic assistance in VT ablation, we believe that this device represents a tool to consider for selected patients.

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Long-term follow-up of patients with repaired coarctation of the aorta who develop hemoptysis

Evolución a largo plazo de pacientes con coartación de aorta reparada que presentan hemoptisis

To the Editor,

In patients who have undergone repair of coarctation of the aorta, hemoptysis is a worrying symptom that should lead to suspicion of an underlying thoracic aortic aneurysm complicated with an aortobronchial fistula.[1] Given the ominous prognosis associated with this complication, we wanted to study its causes and outcomes in this context.

We present the first case series, to our knowledge, of patients with a history of coarctation of the aorta who developed hemoptysis years after repair, with an analysis of the causes, complications, treatment, and outcomes.

Of a cohort of 481 adult patients with coarctation of the aorta diagnosed in *Hospital Universitario La Paz* between 1999 and 2018, 357 underwent surgical repair (146 with patch aortoplasty). At long-term follow-up, 49 patients (10% of the series) developed aneurysms or pseudoaneurysms at the site of surgical aortoplasty of the descending aorta (descending aortic aneurysm was defined as dilatation greater than 150% of the diameter of the diaphragmatic aorta) and 3 patients developed aneurysms of the intercostal arteries. Of the entire cohort, 7 patients (1.5%) developed hemoptysis at follow-up; of these, 3 died. The characteristics and clinical outcomes of these patients are described in table 1. Of the 7 patients with hemoptysis, 2 had similar outcomes: 1 patient, after repeated, self-limiting episodes of hemoptysis due to an aortobronchial fistula, underwent successful surgery for the pseudoaneurysm (at that time endovascular treatment was not available) and died in the immediate postoperative period due to a further episode of massive hemoptysis following severe pulmonary hemorrhage; the other patient, with no previous history of hemoptysis, underwent an elective endovascular procedure to exclude the aneurysm with percutaneous implantation of 2 polytetrafluoroethylene stents. At 7 days postprocedure, after exclusion of the pseudoaneurysm at the aortoplasty site, the patient was readmitted with an episode of massive hemoptysis, in which severe bleeding was observed in the left lung adjacent to the pseudoaneurysm (figure 1A-D). An aortic endoprosthesis was placed, but the patient died due to multiorgan failure in the days following the pulmonary hemorrhage. Finally, the third patient, after an episode of massive hemoptysis secondary to an aortobronchial fistula, and despite successful emergency surgery to implant 2 vascular endoprostheses, died days later due to multiorgan failure. The other 4 patients in the series had repeated episodes of hemoptysis: 3 were treated with endovascular exclusion of the pseudoaneurysm, and the fourth, after percutaneous exclusion of an intercostal artery aneurysm, developed episodes of hemoptysis secondary to the presence of an aberrant bronchial artery, which was successfully embolized (figure 1E-H).

Aortobronchial fistulas were first described in 1934 by Keefer and Malory.[2] In 1962, Davey described the first successful surgical repair.[3] These fistulas are caused by the thoracic aneurysm eroding the adjacent pulmonary tissue or bronchial tree. They are an uncommon condition, usually presenting with hemoptysis, which is generally recurrent and self-limiting, but which gradually increases in severity until massive hemoptysis occurs. Diagnosis is