Alternative Approaches for Ablation of Resistant Ventricular Tachycardia

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KEYWORDS

• Ventricular tachycardia • Alcohol ablation • Coil embolization • Simultaneous unipolar RF ablation • Bipolar RF ablation • Surgical ablation • Stereotactic ablative radiosurgery

KEY POINTS

- Unipolar radiofrequency (RF) ablation can be ineffective for ventricular tachycardias (VTs) with a deep intramural origin or cases in which epicardial access is not attainable due to prior cardiac surgery.
- Alternative approaches include alcohol ablation or coil embolization, simultaneous unipolar or bipolar RF ablation, surgical ablation, or noninvasive ablation with stereotactic radiosurgery.
- Alcohol ablation is commonly used to treat resistant VT with good acute and long-term results, although it is limited to the territories vascularized by the target vessel.

INTRODUCTION

Ventricular tachycardia (VT) ablation is usually performed with an ablation catheter that delivers unipolar radiofrequency (RF) energy to eliminate the re-entry circuit responsible for VT. However, there are some instances when unipolar RF ablation fails, notably in VTs with a deep intramural origin or cases in which epicardial access is not attainable due to prior cardiac surgery. To overcome these limitations, several alternative approaches have been used in clinical practice, including alcohol ablation, coil embolization, simultaneous unipolar or bipolar RF ablation, surgical ablation, or noninvasive ablation with stereotactic radiosurgery. This review article describes some of these alternative techniques.

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ALCOHOL ABLATION

Transcoronary ethanol ablation (TCEA) is performed by intracoronary injection of ethanol. Via direct chemical injury and ischemic injury secondary to vascular damage, ethanol causes coagulative necrosis of the myocardium, which is later replaced by a permanent scar, thereby affecting the circuit that sustains VT.[1]

TCEA can be performed either anterogradely via a coronary artery or retrogradely via the coronary venous system. In anterograde TCEA, selective coronary angiography allows identification of the arterial branches that supply the tachycardia-related region. The target artery is engaged with an angioplasty wire and occluded with an over-the-wire balloon. It is important to exclude vessels with a pronounced collateral circulation to avoid unnecessary damage to distant areas. The angioplasty wire can also be used to record a unipolar electrogram from within the myocardium and select the vessels in close proximity to the area of VT origin with more precision.[2] To do so, only the distal end of the guidewire should be exposed, using either an uninflated angioplasty balloon or a subselector catheter. Once the target vessel is identified, confirmation of the potentially successful site is achieved by inducing the VT and observing its termination after injecting iced saline (2–3 mL). To follow, slow ethanol injection (95%–100%, 1 mL at 1 mL/min up to 5 mL per vessel) is then performed and the balloon remains inflated for approximately 10 minutes after the infusion to prevent backflow of ethanol and ensure good tissue penetration. An alternative approach to TCAE is retrograde intracoronary venous infusion of ethanol.[3] A selective coronary venogram can show the target venous branches that drains the area of VT origin, as determined with activation mapping. As with anterograde TCAE, the target vessel can be cannulated with an angioplasty wire and occluded with an over-the-wire balloon to infuse ethanol (95%–100%, 1 mL at 0.5 mL/min with the balloon inflated for 2 minutes).

Compared with unipolar RF ablation, TCEA allows creation of deeper myocardial lesions; however, it is limited to the territories vascularized by the target vessel. Moreover, the target vessel itself might be inadequate (too small, stenotic, occluded, or with prominent collaterals) and complications are not negligible. In addition to the complications inherent to coronary artery instrumentation (eg, coronary arterial dissection and thrombosis), the reflux of ethanol to nontargeted areas can cause complete heart block (septal alcohol ablation) and myocardial infarction of distant unwanted regions. Additionally, a case of fatal free wall rupture secondary to intramyocardial dissection has been described.[4]

Several case reports and a few case series (**Table 1**) have demonstrated the feasibility of TCAE for VT ablation; however, both the acute and long-term success rates, as well as the complication rates, remain suboptimal.[2–16] Most of these studies were performed in the setting of ischemic cardiomyopathy, although cases of successful TCAE have been reported for valvular,[4] Chagas',[13] hypertrophic,[17] and dilated idiopathic cardiomyopathies.[2,9–11,15,16]

CORONARY COIL EMBOLIZATION

A recently described approach is transcoronary coil embolization. After selecting the target vessel, coils can be deployed, resulting in coronary occlusion and subsequent myocardial infarction.[18] This might be an alternative in cases with severely reduced systolic dysfunction, given the unpredictable amount of injury when performing TCAE.

SIMULTANEOUS UNIPOLAR OR BIPOLAR RADIOFREQUENCY ABLATION

In conventional unipolar RF, current is delivered from the ablation catheter tip to a grounding patch positioned on the patient's skin: this results in larger current density at the catheter tip (given the smaller surface area) with resistive tissue heating at the catheter-myocardium interface, as well as conductive heating of deeper tissues. To increase efficacy, it is possible to deliver RF current between 2 electrodes positioned on opposing sides of the target deep myocardial tissue. This can be done simultaneously both in a unipolar or bipolar RF fashion. In simultaneous unipolar RF ablation, 2 ablation catheters are connected to 2 RF generators each with their own return electrode, whereas in true bipolar RF ablation, RF current flows between the 2 ablation catheters using 1 as the active electrode and the other as the return electrode. Bipolar RF has been shown to improve lesion transmurality in animal studies compared with both sequential and simultaneous unipolar RF ablation, probably because it depends less on catheter contact and alignment.[19] However, to deliver bipolar RF energy, noncommercially available custom-engineered cable and switch box are necessary to attach the return catheter record and display the temperature from the tip of both catheters, as well as their location on the electroanatomic system. In contrast, simultaneous unipolar RF ablation can be more easily applied, provided 2 RF generators are available.