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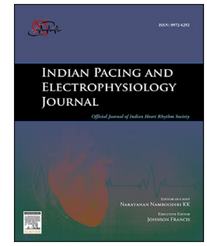

Successful cryoablation of an incessant atrial tachycardia arising from the right atrial appendage

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ABSTRACT

The right atrial appendage can be the origin of focal atrial tachycardias. Their ablation can be challenging owing to the complexity of the appendage anatomy. To our knowledge, we describe the first successful solid tip cryoablation of a focal tachycardia within the right atrial appendage in a patient presenting with tachycardia-induced cardiomyopathy.

Case report

A 31-year old female presented with palpitations during the first trimester of her pregnancy and was found to have an incessant long RP supraventricular tachycardia (SVT). Her echo initially showed mild LV systolic dysfunction, normal biatrial/biventricular size and no valvular abnormalities. She was commenced on beta blockers, but her SVT persisted with poorly controlled rates. Amiodarone was then started and she was electrically cardioverted after a 2 week load, but her tachycardia recurred within a few hours. The option of catheter ablation was discussed and she preferred to defer the procedure until after her delivery. One month later, her LV ejection fraction had declined to 20% and Holter showed incessant SVT at 110–140 bpm with variable AV conduction despite amiodarone, high dose beta-blockade and digoxin. A second attempt at electrical cardioversion only transiently restored sinus rhythm. She remained on amiodarone for the next 5 months of her pregnancy with close monitoring of her fetus and ventricular function. She was induced at 35 weeks and her delivery was uncomplicated without hemodynamic compromise or clinical heart failure. Her newborn did not suffer any adverse effects from amiodarone. Her tachycardia persisted postpartum and she was scheduled for catheter ablation.

During her electrophysiology study, the SVT initiated and terminated spontaneously with AV nodal Wenchebach. P wave morphology during SVT was biphasic (positive/negative) in lead V1 with an inferior axis suggesting a high right atrial (RA) origin (Fig. 1). Lead V2 had a negative bifid P wave quite distinct from the positive P wave during sinus rhythm. Electroanatomic mapping (CARTO 3, Biosense Webster) during SVT demonstrated a focal origin in the RA appendage with centrifugal activation to the rest of the RA. While mapping within the RA appendage, the tachycardia terminated at a site where the local atrial electrogram was 30 ms ahead of the P wave. A single irrigated radiofrequency [RF] application [power 20 W, 90 s, 8 cc/min saline] was delivered to this site. No further SVT was observed even after programmed atrial stimulation and isoproterenol. Her amiodarone was then discontinued and her beta blocker dose was reduced.

Two months after ablation, she was again in incessant atrial tachycardia with the same P wave morphology and variable AV conduction. With her LV ejection fraction remaining 20%, she was scheduled for redo catheter ablation.

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A RA appendage angiogram was performed with a multipurpose catheter which revealed a single lobed structure (Fig. 2). Using electroanatomic mapping, the site of earliest atrial activation was again localized to the lateral aspect of the distal tip of the RA appendage where local atrial electrogram was 20 ms ahead of P wave (Fig. 2). Despite several irrigated RF applications to this site (20–25 W, 8 cc/min saline) and surrounding region, the tachycardia did not terminate or slow down. Poor catheter contact due to the dynamic movement of the RA appendage was felt to be a limitation to further RF application. Cryoablation was then attempted in a bid to attain better catheter contact throughout the cardiac cycle. A Freezor Max 8 mm cryocatheter (Medtronic Inc.) was maneuvered to the tip of the RA appendage under fluoroscopic guidance and positioned at a site with local EGM 20 ms ahead of surface P wave (Fig. 2). Within 4 s of initiating cryoablation, the tachycardia terminated leaving sinus rhythm (Fig. 3). Two cryoablation lesions (−80 °C, 4 min each) were then delivered at the same site. Postablation, programmed and burst atrial pacing with isoproterenol failed to reinduce the tachycardia.

After a 6 month followup period, there was no tachycardia recurrence based on surveillance ECGs and Holter recordings. A cardiac MRI done 6 months postablation showed normalization of ventricular function and no late gadolinium enhancement.

Discussion

We present, to our knowledge, the first case of incessant focal atrial tachycardia arising from the apex of the RA appendage which was successfully cryoablated with a solid tip catheter after failing conventional RF ablation. Focal atrial tachycardias from the RA appendage are uncommon with a prevalence of 3.8% and the commonest location within the RA appendage is the inferolateral base [1]. The ECG is usually characterized by a positive P wave in the inferior leads, negative in V1, isoelectric/positive in lead I and isoelectric/negative in aVR. However, this P wave vector may also be seen with focal atrial tachycardias arising from the tricuspid annulus and the crista terminalis. In our patient, the P wave was biphasic in lead V1 (positive/negative) and lead I (negative/positive).

The anatomy of the RA appendage is complex and presented technical challenges in our patient. Tachycardia foci

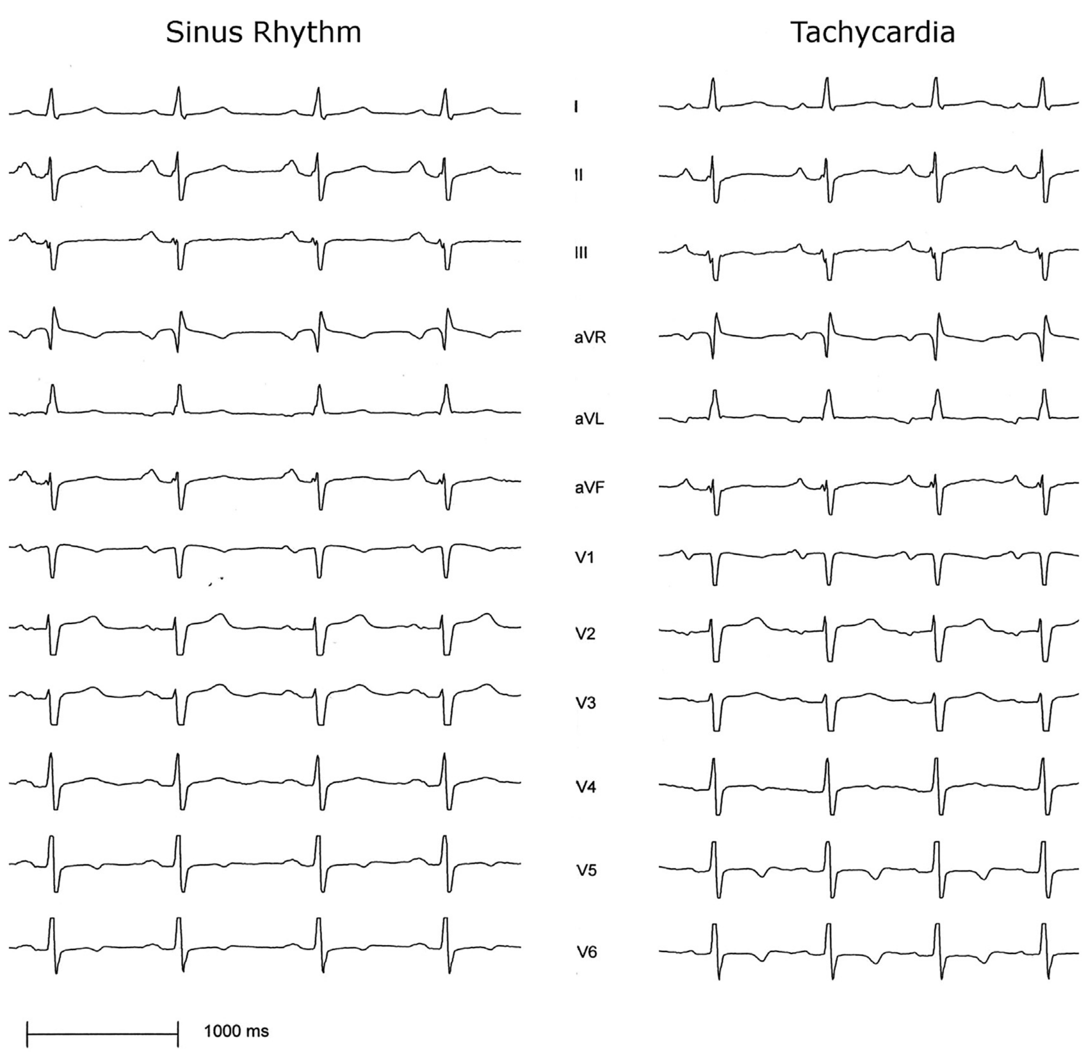

Fig. 1 – Comparison of P wave morphology during sinus rhythm and atrial tachycardia. Abbreviations include ECG leads I, II, III, aVR, aVL, aVF, V1–V6.

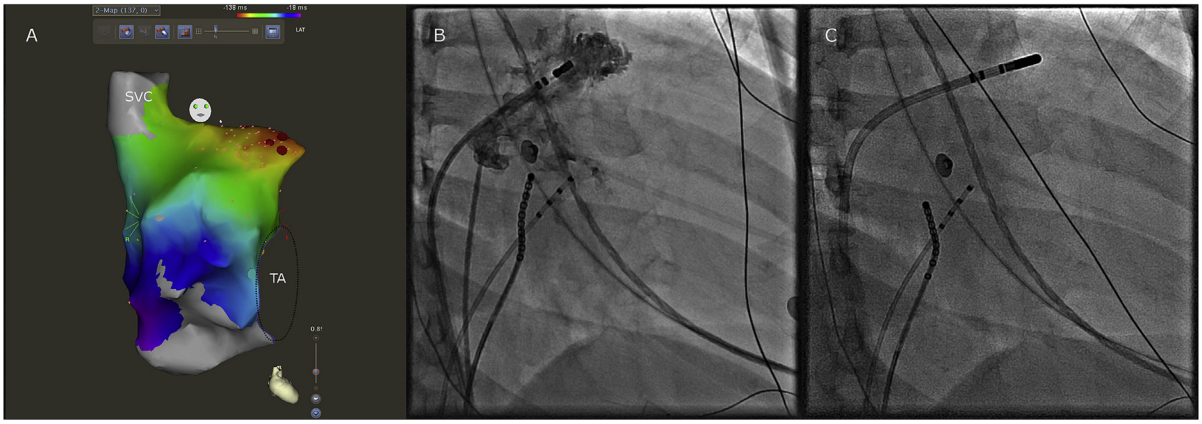

Fig. 2 – A. Electroanatomic map of RA showing site of earliest atrial activation at the apex of the RA appendage. B. Fluoroscopic image (right anterior oblique view) showing the complex trabeculated anatomy of the RA appendage during nonselective contrast injection. C. Fluoroscopic image (same right anterior oblique view) showing cryocatheter and ice-ball silhouette at the apex of RA appendage where the atrial tachycardia was successfully ablated. Abbreviations include: TA-tricuspid annulus, SVC-superior vena cava.

near the apex are rare and not easily reached. The medial wall is thick and limited in extent. The lateral wall consists of ridges of pectinate muscles separated by thin membrane like walls with sparse myocardium [2]. The trabeculations of the pectinate muscles often restrict catheter mobility and maneuverability within the RA appendage. Performing a RA appendage angiogram to clarify its anatomy and depth may be helpful in guiding mapping and avoiding perforation. Our patient's tachycardia focus was located on the thin lateral wall near the apex which may explain why a large portion of the

Fig. 3 – Successful cryoablation of atrial tachycardia in RA appendage indicated by asterisk. Local atrial electrogram was 20 ms ahead of P wave. The artifact resulting from cryoablation is evident in the distal bipolar ablation channel (ABL d). Abbreviations include ECG leads I, II, V1, V2 and bipolar electrograms from His, CS prox-proximal coronary sinus; CS dist-distal coronary sinus, ABL p-proximal ablation.

proximal RA appendage showed equally early local atrial EGMs. In such situations, it is essential to carefully map more distally within the RA appendage.

RA appendage tachycardias tend to be incessant often resulting in tachycardia-induced cardiomyopathy [1]. Hence an aggressive therapeutic approach including ablation is warranted. Our patient's ablation was postponed until after her delivery as she was concerned about the potential risk of fetal radiation exposure despite our intention to use a low radiation dose protocol. The delay in ablation therapy and the ineffectiveness of amiodarone/electrical cardioversion led to a significant deterioration in ventricular function, thereby increasing the risk of fetal and maternal complications late in pregnancy and during delivery. Contemporary electroanatomic 3D mapping systems and intracardiac echocardiography can help to minimize radiation exposure and in some cases may obviate the need for fluoroscopy altogether. Ferguson et al. reported successful radiofrequency ablation of a focal left atrial tachycardia using this approach with no fluoroscopy [3].

Catheter ablation of focal tachycardias in the RA appendage using RF energy is often associated with recurrences as was evident in our patient [4]. The small size and low cavitary blood of the RA appendage may reduce RF energy delivery despite saline irrigation. In addition, the RA appendage is a highly mobile structure that limits consistent catheter contact during ablation, even with a steerable sheath. Our patient failed two attempts at RF ablation using irrigated catheters, which was felt to be due to poor catheter stability within the appendage. As an alternative, surgical excision of the RA appendage to eliminate the focus [4,5] and cryoablation may have a role. Chun et al. described the use of a cryoballoon to isolate the RA appendage when conventional RF within the RA appendage proved unsuccessful [6]. In their case, the tachycardia focus was not eliminated, but rather dissociated from the rest of the RA. The efficacy of cryoballoon therapy is highly dependent on suitable RA appendage anatomy and may not be possible in all patients with broad RA appendage bases or multiple lobes. Poor balloon contact in these cases may not produce enduring lines of conduction block. The isolated RA appendage may also increase the risk of thrombus formation due to loss of contractile drive from the sinus node.

As an alternative, we chose the large 8 mm tipped cryocatheter with the intention of improving contact and increasing the probability of approximating the focal origin of the tachycardia. This was evident from termination of the tachycardia within a few seconds of cryoablation. In contrast to RF ablation where the catheter remains mobile during ablation, cryoablation is associated with freeze-mediated catheter adhesion to the target tissue. This catheter–tissue attachment provides several advantages [7]. Firstly, freeze-mediated catheter stability facilitates ablation of sites where contact is difficult to maintain, like the RA appendage. Second, cryoadhesion eliminates the brushing effect seen with RF ablation, whereby RF energy is applied to the target and surrounding non-target tissue because of cardiac and respiratory motion. It can be expected that increased catheter stability will result in less collateral damage to nearby critical structures such as the right coronary artery at the base of the RA appendage [2]. Another advantage of cryoablation is the preservation of ultrastructural integrity, an observation that is attributed to the marked resilience of fibroblasts and collagen fibers to hypothermia. Preservation of tissue ultrastructural integrity should reduce the risk of perforation even in the RA appendage and our patient had no procedural complications following cryoablation [7]. The large surface area of the cryocatheter probably also makes it less likely to perforate.

In summary, RA appendage focal tachycardia, though rare, tends to be incessant and needs to be aggressively managed in order to avoid tachycardia-cardiomyopathy. Cryoablation with a solid tip catheter may be more effective and safer than RF energy for ablation deep in the RA appendage owing to greater catheter stability and a lower likelihood of perforation.

Conflicts of interest

None.

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