ELECTROPHYSIOLOGY
Case Report

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Right atrial appendage accessory pathway causing pseudo-refractory atrioventricular reentrant tachycardia

Lucas Hollanda Oliveira[1,2*]; Christian Moreno Luize[1]; Ricardo Sobral de Carvalho[1]; Felipe Kalil[1]; Cristiano de Oliveira Dietrich[3]; Alleh Nogueira[2]

ORCID ID

Oliveira LH https://orcid.org/0000-0002-6770-4462
Luize CM https://orcid.org/0000-0002-4024-1963
Carvalho RS https://orcid.org/0000-0002-5349-4265
Kalil F https://orcid.org/0009-0000-5644-9112
Dietrich CO https://orcid.org/0000-0002-7373-9119
Nogueira A https://orcid.org/0000-0001-5995-6179

ABSTRACT

Catheter ablation is the first-line therapy for symptomatic atrioventricular reentrant tachycardia (AVRT). Pseudo-refractory AVRT may stem from misdiagnosis, the use of inadequate ablation methods, or the presence of additional concealed or unusually located pathways that initiate or sustain the tachycardia. This is a case of right atrial appendage accessory pathway— a rare and often overlooked cause of AVRT—to illustrate the importance of considering suspicion for this condition when standard mapping and ablation around the tricuspid valve annulus fail to eliminate pathway conduction. Furthermore, we present a straightforward, effective approach for localizing the pathway site and safely performing irrigated ablation at the base of the right atrial appendage.

KEYWORDS: Accessory atrioventricular pathway; Supraventricular tachycardia; Tachycardia, Catheter ablation; Atrial appendage.

INTRODUCTION

Catheter ablation is the first-line therapy for symptomatic atrioventricular reentrant tachycardia (AVRT). Arrhythmia recurrence is commonly observed (5–12% of cases) in AVRT, particularly in challenging ablations that involve multiple, septal, or right free wall-located accessory pathways[1,2]. Nevertheless, electrophysiologists must maintain a high level of suspicion for cases labeled as "refractory" to ablation. Pseudo-refractory AVRT may result from misdiagnosis, the use of inadequate ablation methods, or the presence of additional concealed or unusual located pathways that initiate or sustain the tachycardia. We present a case of right atrial appendage accessory pathway—a rare and overlooked cause of AVRT—to illustrate the importance of raising suspicion for this condition when standard mapping and ablation around the tricuspid valve annulus fail to eliminate pathway conduction. Furthermore, we present a straightforward, effective approach for localizing the pathway site and safely performing irrigated ablation at the base of the right atrial appendage. Understanding accessory pathways and effective treatment strategies is essential for minimizing patient risks linked to multiple procedures.

1. Hospital São Rafael – Cardiac Arrhythmia Service – Salvador - BA, Brazil.
2. Escola Bahiana de Medicina e Saúde Pública – Clinica Medica Department – Salvador - BA, Brazil.
3. Hospital Dois de Julho – Cardiac Arrhythmia Service – São Paulo - SP, Brazil.
***Correspondence author:** lucas.hollanda78@gmail.com
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CASE REPORT

A 24-year-old male without established structural heart disease was referred to our arrhythmia clinic after undergoing three unsuccessful ablations for AVRT due to recurrent symptoms persisting for four years. His medical history and physical examination were otherwise unremarkable. A surface 12-lead electrocardiogram performed at rest revealed sinus rhythm with pre-excitation suggestive of right lateral and anterior accessory pathway (Fig. 1).

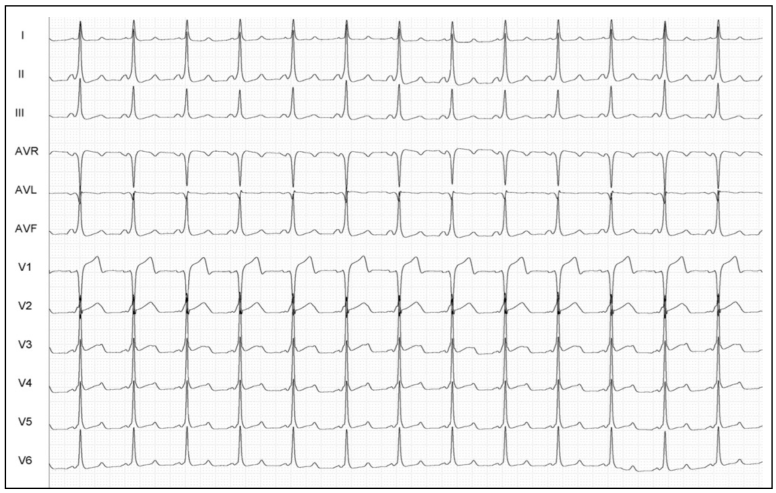

Figure 1. Resting ECG. Subtle pre-excitation compatible with a right anterior accessory pathway

The initial electrophysiology study demonstrated an accessory pathway anterograde effective refractory period of 340 ms with a basic cycle length of 450 ms. The AVRT was readily and consistently induced during programmed atrial stimulations. The shortest atrioventricular intervals (observed during atrial pacing) and ventriculoatrial intervals (observed during AVRT) were identified at the anterior and lateral aspects of the tricuspid annulus. During the first two of his prior ablation attempts, electroanatomical mapping was employed to identify the earliest ventricular (relative to surface QRS complex) and atrial (relative to intracardiac coronary sinus) intracardiac electrograms during atrial pacing and AVRT, respectively. In the initial attempt, radiofrequency ablation was performed at 50 Watts using a 4-mm unidirectional Therapy™ Ablation Catheter (Abbott, IL, US). In the second attempt, radiofrequency ablation was done at 30–40 Watts using an open tip Therapy™ Irrigated Ablation Catheter (Abbott, IL, US) with an irrigation rate of 17 mL/minute.

His third prior attempt employed a 3.5-mm open-tip irrigated catheter (TactiCath™ Contact Force Ablation Catheter, Sensor Enabled™; Abbott, IL, US), a multielectrode mapping catheter (Advisor™ HD Grid Mapping Catheter, Sensor Enabled™, Abbott, IL, US) and an electroanatomical mapping system (EnSite Precision™ Cardiac Mapping System, Abbott, IL, US). In order to identify a breach in the extended "early meets late" feature, which is indicative of conduction from the right atrium to the right ventricle, an "open window mapping" strategy was employed to locate the accessory pathway. A series of radiofrequency applications (30–40 Watts; irrigation rate, 17 ml/minute) were delivered in the "early meets late" region of the electroanatomical activation map (anterior and lateral aspect of the tricuspid annulus). However, these applications only resulted in a temporary interruption of conduction through the accessory pathway.

In our approach, following confirmation of normal anatomy with right atrial computed tomography angiography (Fig. 2), we proceeded with activation "open window" mapping during sinus rhythm using the following devices: a 7.5-Fr, 3.5-mm open-tip irrigated catheter (ThermoCool® SmartTouch®, Biosense Webster, CA, US); a multi-electrode mapping catheter (PentaRay® Nav Eco, Biosense Webster, CA, US); and an electroanatomical mapping system (CARTO® 3, Biosense Webster, CA, US). The open window mapping procedure confirmed the presence of a conduction gap between the right atrium and the right ventricle, which was consistent with the hypothesis of an accessory pathway. Nonetheless, no electrical signals indicative of successful ablation of the accessory pathway were observed after radiofrequency application (40 Watts; irrigation rate, 17 ml/minute) to the anterior and lateral aspects of the tricuspid annulus.

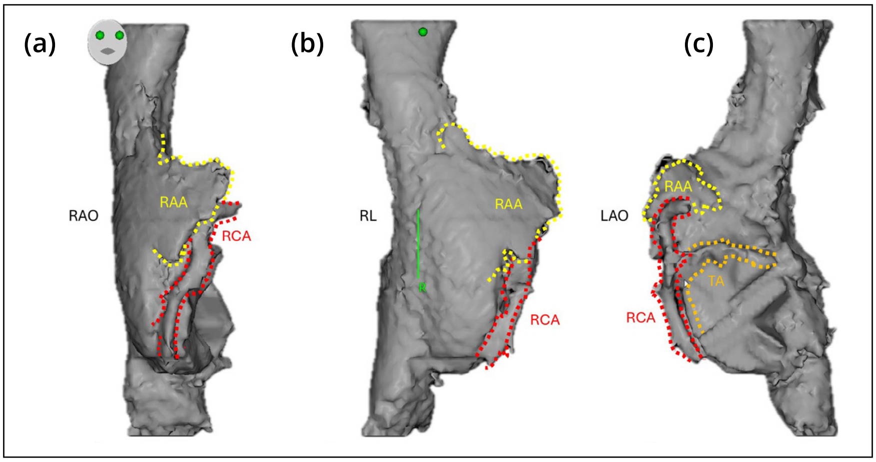

Figure 2. Computed tomography (CT) of the right atrium; a) Right anterior oblique view; b) Right lateral view and c) Anterior posterior view of the right atrium showing no evidence of anatomical abnormalities, the anatomical relation of right coronary artery (RCA- yellow dotted line) just behind the tip of the right atrial appendage (RAA- red dotted line) and the distance from the RAA to the tricuspid annulus (TA- orange dotted line).

Upon closer analysis of the open window mapping during sinus rhythm, a potential conduction pathway towards the base of the right atrial appendage was identified, suggesting its involvement in aberrant atrioventricular conduction (Supplementary Video 1 and Fig. 3). Considering that different mapping techniques were unsuccessful in eliminating the accessory pathway and suspected of a right atrial appendage accessory pathway, we elected to pursue a purely anatomical approach by electrically disconnecting the atrial appendage from the atrium.

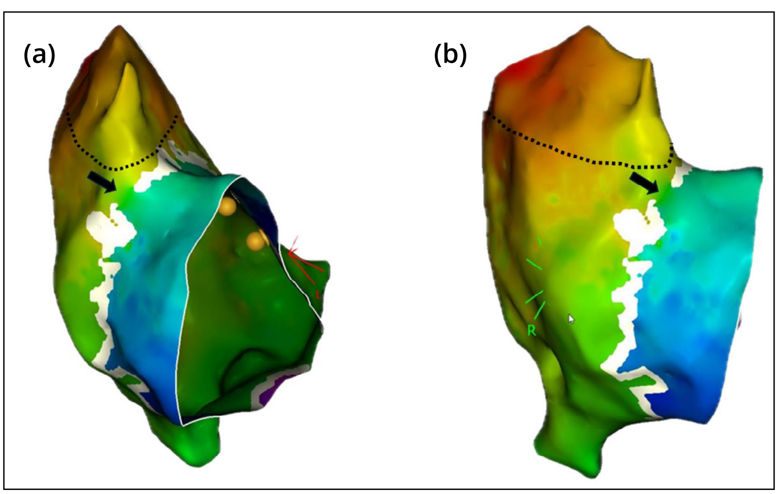

Figure 3. "Open window" mapping technique; a) Activation mapping in sinus rhythm of the right atrium in anterior posterior view showing earlier ventricular activation in a region close to the base of the right atrial appendage. Reddish yellow and greenish yellow color representing earlier atrial activation and reddish blue and purple tones representing latest ventricular activation. Black dashed line and the white line delimits right atrial appendage (RAA) and conduction block zone. Black arrow highlights a region of atrioventricular conduction. Yellow dots indicate the location of his bundle electrograms; b) Same activation mapping in a right lateral projection with black dashed line demarcating RAA, white line and black arrow indicating block conduction zone, respectively.

We eradicated pre-excitation by performing ostial ablation of the inferior base of the right atrial appendage (Figs. 4 and 5). When the pre-excitation was interrupted, the intracardiac electrogram at the catheter tip showed an atrial signal occurring no earlier than the surface P wave, with no ventricular component present.

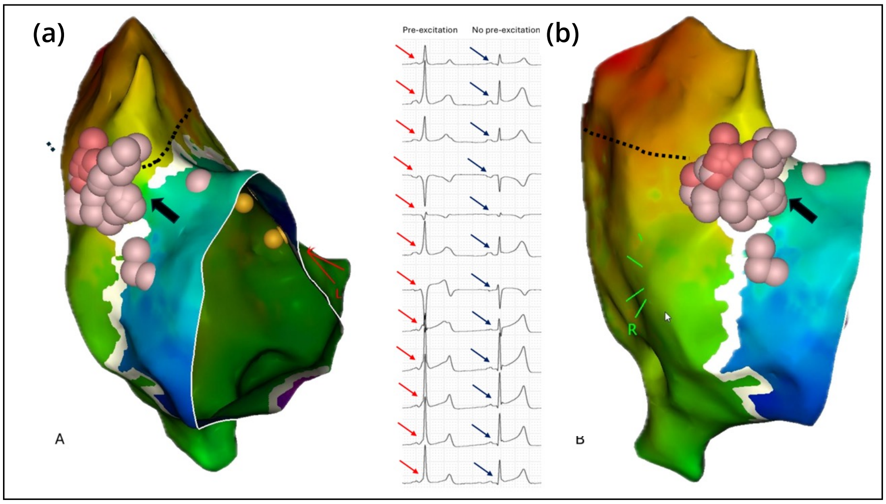

Figure 4. Radiofrequency catheter ablation (RCA) and electroanatomical mapping; a) Anterior posterior projection of RCA lesions in pink and light pink at the base of the right appendage (circumscribed by the black dotted line) in the region pre-excitation was abolished (black arrow- middle ECG tracing). White line delimitates a conduction block zone; b) A right lateral projection of RCA lesions in pink and light pink at the base of the right appendage (circumscribed by the black dotted line) in the region pre-excitation was abolished (black arrow- middle ECG tracing). White line delimitates a conduction block zone.

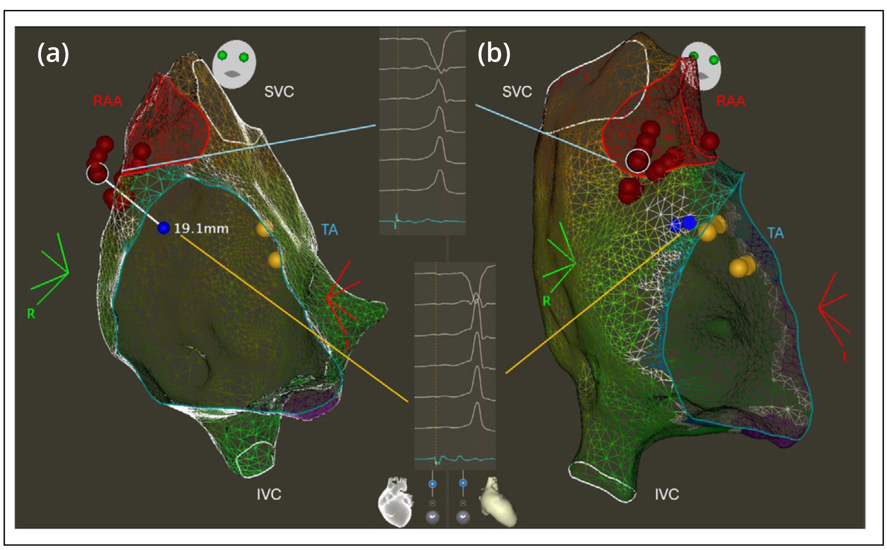

Figure 5. Radiofrequency ablation at the base of the right atrial appendage (RAA) and the relation to the tricuspid annulus (TA); a) A left anterior oblique view of the right atrium showing a 19.1mm distance between the local of the elimination of pre-excitation (encircled red dot) and the tricuspid annulus (blue dot). The atrial and ventricular components of the electrogram corresponding to the blue dot reveals its location ant the tricuspid annulus. The single atrial component of the electrogram correspondent to the location at which the accessory pathway was ablated (red dot) reassures that ablation was performed distant from the TA; b) A right anterior oblique view showing a more posterior location of success ablation relative to the TA. Yellow dots represent the bundle of His. (RAA- right atrial appendage, SVC- superior vena cava, IVC- inferior vena cava).

Nevertheless, the heartbeat following the interruption of pre-excitation exhibited a low-amplitude ventricular far-field signal at the tip of the ablation catheter (Fig. 6). Following a 30-minute interval, the electrophysiological study was repeated with and without isoproterenol. Neither AVRT was induced, nor was evidence of any accessory pathway observed (Fig. 7). At nearly two years post-ablation, the patient remains free of symptoms. The follow-up electrocardiogram showed no evidence of ventricular pre-excitation, and transthoracic echocardiogram findings were normal.

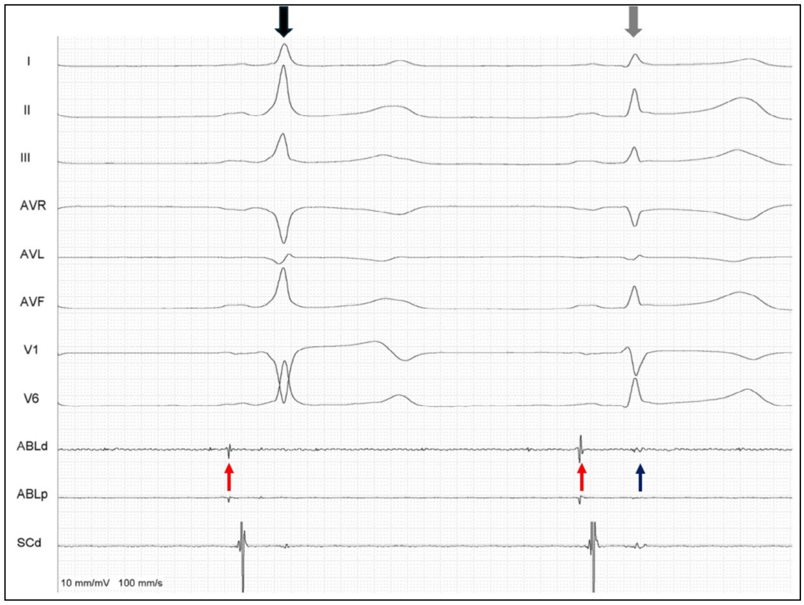

Figure 6. Intracardiac electrograms at the tip of the ablation catheter positioned at the posterior and ostial base of the right atrial appendage and radiofrequency ablation. The first red arrow shows the atrial low amplitude intracardiac electrogram with no ventricular component at the tip of the ablation catheter with a pre-excited QRS (black arrow). The second red arrow shows the same atrial electrogram with a greater amplitude and a low amplitude ventricular far field -blue arrow just after abolishment of pre-excitation- gray arrow. (ABLd- distal ablation catheter dipole; ABLp- proximal ablation catheter dipole; SCd- distal coronary sinus dipole).

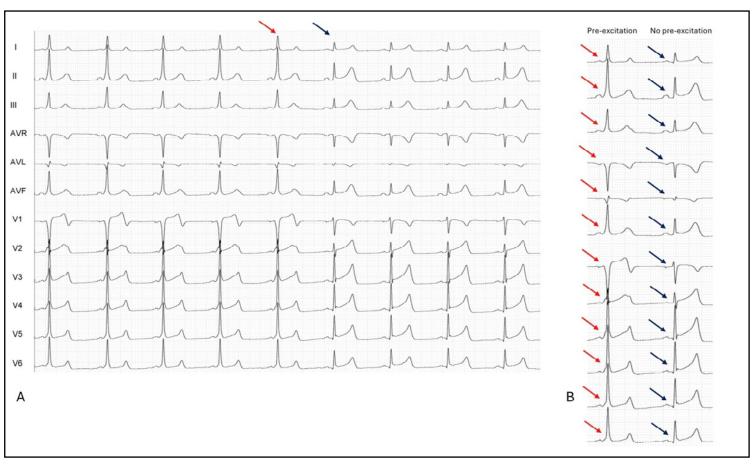

Figure 7. Surface ECG and radiofrequency ablation; a) Change in QRS morphology during ablation with loss of subtle pre-excitation (- red and blue arrows, respectively); b) Surface QRS in detail evidencing subtle pre-excitation (red arrow) and QRS normalization- blue arrow- during ablation.

DISCUSSION

Atrial appendage pathways are rarely identified as sites for successful ablation of accessory atrioventricular connections. The published literature on this topic is primarily limited to individual case reports and small case series[3-5]. Right atrial appendage pathways are observed more frequently, likely due to the larger surface area of the right atrial appendage in comparison to the left. Although appendage pathways are anatomically located on the epicardial ventricular surface, they can be successfully localized and treated during endocardial mapping and ablation[6]. This was demonstrated in our case, where disrupting the appendage-ventricle connections resulted in the elimination of pre-excitation and inducible orthodromic AVRT.

Although some authors have demonstrated that an epicardial mapping and ablation approach is safe and feasible, the risks involved in the epicardial access such as cardiac perforation, internal mammary artery lesion and liver perforation must be considered[7]. An anecdotal ablation approach in which the accessory pathway was incidentally localized by bump mapping while the ablation catheter was roving inside the right appendage have been described[8]. Ablation in this point inside the right appendage resulted in elimination of the accessory pathway.

Since prior studies suggest that right accessory pathways communicating the atrium to the ventricle crosses the appendage floor and considering that there is no intracardiac electrogram to pursuit to locate them, we suggest an anatomical approach by performing an ablation line at the base of the appendage whenever this accessory pathway is suspected.

While catheter ablation in or near the right atrial appendage may be safe procedure, certain potential complications and contraindications must be considered. First, the right atrial appendage is a triangular-shaped structure located anteriorly to the aortic arch. It is composed of pectinate muscle that originates from the *crista terminalis* and a thin web-like myocardium in between them. These histological characteristics increase the risk of perforation during catheter ablation attempts[9,10]. Secondly, the vestibule of the right atrial appendage overlies the right coronary artery (Fig. 1), and caution must be taken when considering catheter ablation in this area due to the risks of occlusion, thrombosis and, thermal injury[10,11] Thirdly, the ostium of the right atrial appendage is basically the crista terminalis, a relatively easy to find thicker and stable landmark, over which the ablation catheter may be stabilized, improving lesions and avoiding complications[9]. These anatomical considerations reinforce the theoretical framework of endocardial ablation of right atrial appendage pathways.

CONCLUSION

The mapping and ablation of the right atrial appendage accessory pathway represents a challenging procedure. However, an empirical approach targeting and ablation line at the right atrial appendage base has been demonstrated to be both feasible and safe.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Oliveira LH.; **Draft:** Nogueira A.; Kalil F.; **Review and editing:** Luize CM.; Oliveira LH.; **Supervision:** Carvalho RS.; Dietrich CO.

DATA AVAILABILITY STATEMENT

All data sets were generated or analyzed in the current study. Supplementary Video available at: https://doi.org/10.5281/zenodo.14159682

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Not applicable.

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Not applicable.

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