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Clinical case

What is the origin of this arrhythmia?

Quelle est l'origine de cette arythmie ?

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Abstract

Purpose. – The existence of inter-atrial epicardial connections bridging the two atria at different levels has well been described and their implication in some forms of supraventricular arrhythmias is a known fact. However, up to date, little data exists in the literature showing their role in the mechanisms of focal atrial tachycardias, providing at the same time clear electroanatomical and activation maps using a three-dimensional, non-fluoroscopic mapping system.

Patients and methods. – We present the case of a 29-year-old woman with a focal atrial tachycardia with the origin in a pulmonary vein, manifested as a right atrial origin due to the conduction of the electrical impulse form the right inferior pulmonary vein (RIPV) to the postero-inferior right atrium (RA) via inter-atrial epicardial connections. Using a three-dimensional, non-fluoroscopic mapping system (CARTO, Biosense Webster), an RA activation map was created during tachycardia.

Results. – Radiofrequency (RF) application at the earliest endocardial breakthrough site situated in the postero-inferior RA changed the right atrial depolarization sequence without terminating the arrhythmia. Subsequently, a left atrium activation map was created showing the earliest endocardial breakthrough site at the level of the RIPV ostium and RF application at this level abolished the atrial tachycardia.

Conclusion. – Inter-atrial epicardial connections can be part of the substrate of some forms of supraventricular arrhythmias. Awareness of their existence is important to the electrophysiologist, since a better understanding of transseptal activation can avoid, in some cases, unnecessary RF applications at the level of the postero-septal right atrium, with a subsequent increase in procedural risk.

Keywords: Focal; Atrial; Tachycardia; Inter-atrial; Epicardial; Connections

Résumé

But de l'étude. – La présence de connections interatriales épicardiques aux différents niveaux a été déjà décrite et leur implication dans les différentes formes de tachyarythmies supraventriculaires est bien connue. Néanmoins, jusqu'à présent, il y a peu de données dans la littérature décrivant leur rôle dans le mécanisme des tachycardies atriales focales, en même temps présentant des cartes électroanatomiques utilisant un système de cartographie à trois dimensions (CARTO, Biosense Webster).

Patients et méthode. – Nous présentons le cas d'une femme de 29 ans ayant une tachycardie atriale focale avec une origine dans une veine pulmonaire, manifestée comme une origine dans l'oreillette droite en raison de la propagation de l'activité électrique de l'oreillette gauche à l'oreillette droite par des connections interatriales épicardiques. Dans un premier temps, une carte d'activation de l'oreillette droite a été créée pendant la tachycardie.

Résultats. – L'application de radiofréquence dans la zone de primodépolarisation apparente située au niveau de la partie postéro-inférieure de l'oreillette droite a changé la séquence d'activation, sans terminer l'arythmie. En suite, une carte d'activation de l'oreillette gauche a montré une zone d'activation précoce au niveau de la veine pulmonaire inférieure droite. L'application de radiofréquence à ce niveau a terminé la tachycardie.

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Conclusion. – Les connections interatriales épicardiques peuvent être impliquées dans certaines formes de tachycardies supraventriculaires. La connaissance de leur existence est importante pour le médecin, car une meilleure compréhension de l'activation du septum interatrial peut éviter des applications de radiofréquence inutiles au niveau de la partie postérieure de l'oreillette droite, avec une élévation du risque procédural.

Mots clés : Focale ; Atriale ; Tachycardie ; Interatriale ; Épicardique ; Connections

A 29-year-old woman with almost incessant, drug refractory atrial tachycardia was referred for radiofrequency catheter ablation. She had a history of paroxysmal palpitations from the age of ten. Several anti-arrhythmic treatments had been tried, including amiodarone, propafenone and sotalol. She was currently treated with a combination of propafenone 600 mg/day and sotalol 160 mg/day, which was no longer effective. The electrocardiogram (ECG) showed episodes of narrow QRS tachycardia with a positive P wave morphology in lead I, aVL, DII, VF, V2 to V6 and biphasic in lead III, a morphology slightly different than the sinus P wave morphology, which had a higher P wave amplitude in lead III, aVF and a lower P wave amplitude in V2, V3 (Fig. 1). The transthoracic echocardiography showed no structural heart disease.

A left atrium 64-multislice CT-scan was done 24 hours prior to the ablation procedure. A deflectable 5F quadripolar electrode catheter was placed inside the coronary sinus and a deflectable 7F, externally irrigated catheter with a 3.5 mm tip electrode was used as mapping and ablation catheter. A three-dimensional, non-fluoroscopic mapping system (CARTO, Biosense Webster) was used to guide the procedure. An electroanatomic activation map of the right atrium was created during atrial tachycardia, which demonstrated an endocardial breakthrough site (78 ms ahead of the atrial electrogram on the coronary sinus catheter) at the level of the inferior third of the crista terminalis, with a centrifugal propagation sequence and QS aspect on the unipolar electrogram, suggesting a focal origin of the tachycardia (Fig. 2A and B). The left atrium CT-scan image was integrated into the active screen and this showed a close anatomical relationship between the right atrial endocardial breakthrough site during tachycardia and the left inferior pulmonary vein (Fig. 2A).

Radiofrequency energy was applied in a temperature control mode at the site of the earliest activation and a slight change in the P wave morphology was noticed, but the tachycardia continued, with no significant change in cycle length.

A new activation map of the right atrium was done, this time demonstrating a different activation sequence, with an endocardial breakthrough site at the level of the inter-atrial septum (Fig. 2C).

At this point of the procedure, considering this shift in the right atrial activation pattern, a relationship between a possible left atrium (LA) origin of the AT and the existence of inter-atrial epicardial connections (supposedly interrupted by the RF energy application) which had activated the posterior right atrium at the level of the inferior third of the crista terminalis was suggested, and a decision to perform mapping of the LA was taken. The access was gained via a patent foramen ovale. Left atrial activation mapping was performed, which showed a centrifugal depolarization pattern with the earliest endocardial activation site at the level of the right inferior pulmonary vein (RIPV), preceding the atrial electrogram in the coronary sinus by 91 ms, with a QS aspect of the unipolar electrogram (Fig. 3A and B).

The ablation catheter now demonstrated a double potential in the right atrium at the previously ablated site. This finding can be explained by a change in the right atrial activation sequence post RF application, with a collision of two activation wavefronts at the ablation site, and is compatible with the interruption of the inter-atrial epicardial connections bridging the two atria at that level.

RF energy was applied at the ostium of the RIPV and the tachycardia was terminated. Ablation was continued until the RIPV was isolated. The electrical isolation was proved using a Lasso catheter (Biosense Webster, Johnson and Johnson Inc), which showed the absence of pulmonary vein potentials after the RF delivery was discontinued. After a waiting period of one hour, the tachycardia did not recur and the procedure was stopped.

During a follow up period of seven months, the patient was still free of arrhythmia.

This case describes a focal atrial tachycardia with the origin in a pulmonary vein, manifested as a RA origin due to the conduction of the electrical impulse form the RIPV to the postero-inferior RA via inter-atrial epicardial connections.

The existing studies on the inter-atrial connections performed either on animal models [1] or on human hearts using three-dimensional electroanatomic mapping systems [2] have demonstrated the existence of several key fascicles in the electric impulse propagation between the two atria. It is now known that the atria are electrically connected at several levels: the Bachmann's bundle, the coronary sinus (CS) musculature and the inter-atrial septum. These connections play an important role in the inter-atrial conduction and perpetuation of various types of atrial tachyarrhythmias.

As demonstrated by Platonov et al. [3], who conducted a histological study on human hearts, there is, among the different types of inter-atrial connections, a 'bridge-type' connection between two sites on the posterior atrial walls, one on the right side with the other one on the left side of the inter-atrial groove. The existence of this type of connection (schematically illustrated in Fig. 3C) can explain, in the present case, the change in the activation pattern of the RA after the application of RF energy in its postero-lateral area, with the perpetuation of the tachycardia.

With the present case we point out the possible implications of the inter-atrial epicardial connections in the mechanisms of atrial tachycardias with an apparent right atrial focal origin. Awareness of their existence is important to the electrophysiologist, since a better understanding of transseptal activation can avoid, in