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CASE REPORT

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Navigating the fine line between focal atrial tachycardia and atrial flutter?

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Key Clinical Message

Focal atrial tachycardia (FAT) is an organized atrial rhythm >100 beats per minute initiated from a discrete origin and spreading over both atria in a centrifugal pattern. The arrhythmia may be sustained or incessant. Dynamic forms with recurrent interruptions and reinitiating may be frequent. In this report, we present a 36-year-old man who came to the emergency room complaining of palpitation and shortness of breath. All laboratory evaluations were normal. With an initial electrocardiogram (ECG) the patient was admitted with the initial diagnosis of atrial flutter. Finally, after the electrophysiologist's examination, with the diagnosis of FAT, ablation was successfully performed. Atrial tachycardia (AT), excluding atrial fibrillation (AF) and cavotricuspid isthmus-dependent atrial flutter (AFL), account for 10% of supraventricular tachycardia referred for ablation procedures. More than 70% of these cases are focal and occur in patients with no records of cardiac surgery or ablation of AF. FAT originating from the right pulmonary veins (PV) can be challenging to differentiate from atrial flutter due to their proximity and overlapping symptoms. The right PV is close to the right atrium, and the abnormal electrical activity in FAT may mimic the organized circuit found in atrial flutter. Distinguishing between FAT and atrial flutter is crucial for choosing the best therapeutic option. This can be done most of the time by focusing on the differences in the pattern of their P and QRS waves, R-R wave intervals, and also their baseline changes on ECG, as well as their cycle duration, response to adenosine and risk factors of the patient.

KEYWORDS

3D mapping, ablation, arrhythmia, atrial flutter, focal atrial tachycardia, HD catheter

1 | INTRODUCTION

There are several types of arrhythmias with various etiologies, risk factors, treatments, and prognoses.[1] Many of these arrhythmias such as atrial fibrillation and atrial flutter (AFL) which are part of the most prevalent ones have shown their correlation with aging, ischemic heart diseases, hypertension, diabetes, and several other

factors.[1–3] The arrhythmia may be sustained or incessant. Dynamic forms with recurrent interruptions and reinitiating may be frequent.[4] Atrial tachycardia (AT), excluding atrial fibrillation (AF) and cavotricuspid isthmus-dependent AFL, account for 10% of supraventricular tachycardia referred for ablation procedures. More than 70% of these cases are focal and occur in patients with no records of cardiac surgery or ablation of AF.[4] AT foci tend to cluster in specific atrial regions. For the right atrium, the structures that most frequently exhibit ectopic activity are the crista terminalis, coronary sinus ostium, and tricuspid annulus. In the left atrium, foci tend to cluster in the pulmonary veins (PV) and the mitral annulus.[5]

Focal atrial tachycardia (FAT) is defined as an organized atrial rhythm >100 beats per minute initiated from a discrete origin and spreading over both atria in a centrifugal pattern.[4,6] On electrocardiogram, it is characterized by discrete P-waves and isoelectric activity between P waves. It is usually the result of one or a combination of these conditions: (1) Reentry (it is seen when activated myocytes in propagation reenter already recovered myocytes), (2) automatic (abnormal initiation of an impulse in one or several myocytes), or (3). triggered arrhythmia (caused by oscillations of membrane potential, early or delayed after-depolarizations).[5] Although patients with AT may be completely asymptomatic, it may result in palpitations, poor quality of life, or induce a form of heart failure known as tachycardia-induced cardiomyopathy. Catheter ablation (CA) with radiofrequency energy has evolved to become the first-line guideline-recommended therapy in recurrent and/or incessant cases.[4]

Here, we present a patient admitted with the initial diagnosis of AFL. Finally, after the electrophysiologist's examination, with the diagnosis of FAT, ablation was successfully performed.

2 | CASE PRESENTATION

2.1 | Case history and examination

The 36-year-old male patient presented with palpitations and mild shortness of breath to the emergency department of our tertiary heart center hospital (Rajaei Hospital of Tehran). The symptoms began 2 h before coming to the ED without a specific trigger when he was watching television. He had the diagnosed medical history of arrhythmia in his records. He had no remarkable familial, surgical, or social history and he was not taking any medication for any medical condition. In his physical examination, he had no abnormal signs in his general appearance. His vital signs were normal except for the heart rate which was 110 beats per minute. No considerable other abnormal symptoms were detected during his physical exam.

3 | METHODS

In his electrocardiogram evaluation regular tachycardia (HR = 110), with discrete P waves was obvious (Figure 1). His blood and urine laboratory evaluation revealed no significant pathologic hint. His blood oxygen saturation was normal and the patient underwent cardiac monitoring. Echocardiography demonstrated normal left ventricular systolic function. An electrophysiological study was performed and, in the electrophysiology (EP) lab, under general IV sedation and local anesthesia, three venous accesses were established. Baseline electrocardiography (ECG) revealed AT with a tachycardia cycle length (TCL) of 300 ms (Figure 2). The patient was admitted with the initial diagnosis of AFL and was prepared for more evaluation and therapeutical procedures.

4 | CONCLUSION AND RESULTS

First, the pacing maneuvers were done from the right atrium (RA), and despite pacing maneuvers from the right atrium (RA) showing no entrainment, including on the cavotricuspid isthmus (CTI), then the decision was made to map the left atrium (LA) after an interatrial septal puncture. The HD Grid catheter and EnSite Precision 3D mapping system revealed a centrifugal pattern in the left atrium, indicating abnormal focal activity in the right superior pulmonary vein (RSPV) (Figure 3). Multiple RF applications in this area resulted in arrhythmia termination and isolation of the vein (Figure 4). The patient had been under observation with continuous cardiac monitoring for 24 h after the procedure and was discharged without any remarkable symptoms. In his 2, 4, and 8-week follow-ups, he had no complaints and cardiac electrocardiograms were normal.

5 | DISCUSSION

FAT originating from the right PV can be challenging to differentiate from AFL due to their proximity and overlapping symptoms. The right PV is near the right atrium, and the abnormal electrical activity in FAT may mimic the organized circuit found in AFL. The differentiation between FAT and AFL lies in their underlying mechanisms and distinct characteristics.[7] FAT typically originates from a single focus within the atria, causing rapid and irregular

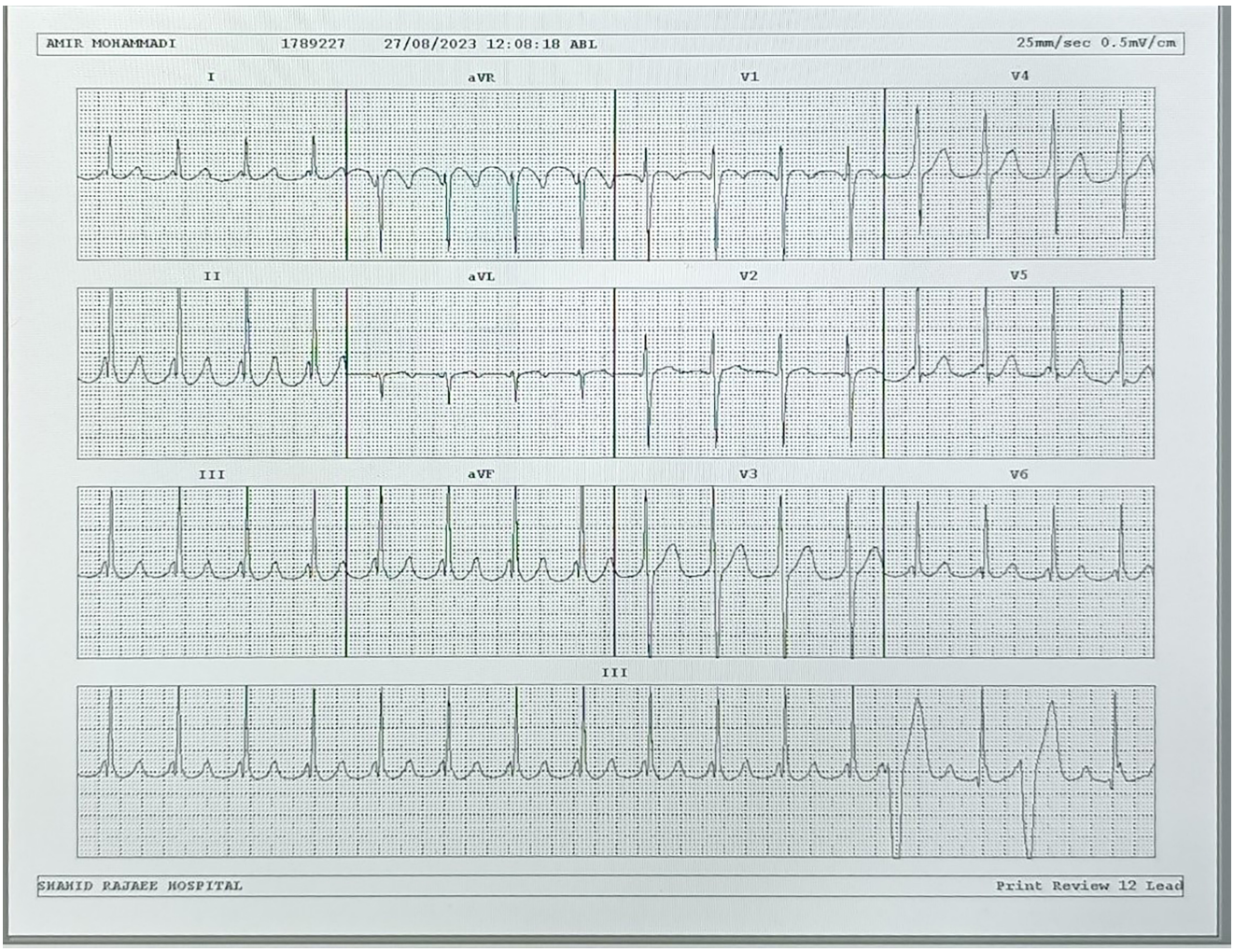

FIGURE 1 The image depicts the 12-lead electrocardiogram tachycardia. The electrocardiogram was checked and it was full standard. The electrocardiogram is performed with paper speed 25 m/s, the voltage is 1.0 mV/10 mm in vertical deflection. It demonstrates regular narrow complex tachycardia (HR = 110), with discrete P waves, and the P–R interval was short. Considering the lead and I and aVF we figured out the left axis deviation.

heartbeats. On the other hand, AFL involves a distinct macro-reentrant circuit within the atria, leading to a characteristic sawtooth pattern on an electrocardiogram (ECG). Understanding these differences is crucial for accurate diagnosis and appropriate management of these cardiac arrhythmias.[8]

Distinguishing between AT originating from the right pulmonary vein and AFL often involves careful analysis of the electrocardiogram (ECG). Here are some key ECG features that may help differentiate the two: AT: (1) Irregular R-R intervals: AT typically presents with irregular R-R intervals due to its non-reentrant nature. (2) Variable P-wave morphology: The P-waves in AT may vary in shape, amplitude, and duration. They may be positive, negative, or biphasic in different leads. However, in AFL: (1) Regular R–R intervals: AFL often produces a regular, sawtooth pattern on the ECG due to a reentrant circuit. (2) Flutter waves (F-waves): Characteristic F-waves (saw tooth or "picket fence" appearance) are seen best in the inferior leads (II, III, and aVF). These are often more apparent during AFL than in AT.[9,10]

There are also important additional points regarding differentiating these two arrhythmias. (1) P-wave timing: In AT, the P-wave may be closely associated with the QRS complex, whereas in AFL, the F-waves are distinct and occur at a different rate than the QRS complexes. (2) Response to adenosine: Administering adenosine may help in diagnosing AT. In AT, adenosine may transiently slow the atrial rate but usually doesn't terminate the rhythm, while in AFL, it often reveals the characteristic F-waves more clearly after a transient AV block. Additionally, the surface electrocardiogram (ECG) may not always clearly distinguish between the two, especially if the FAT focus is located near the tricuspid annulus. This proximity can lead to similar ECG patterns, making an accurate diagnosis more complex[8,11] (Table 1).

FIGURE 2 The image depicts an intracardiac electrocardiogram showing arial tachycardia with 2:1 AV conduction.

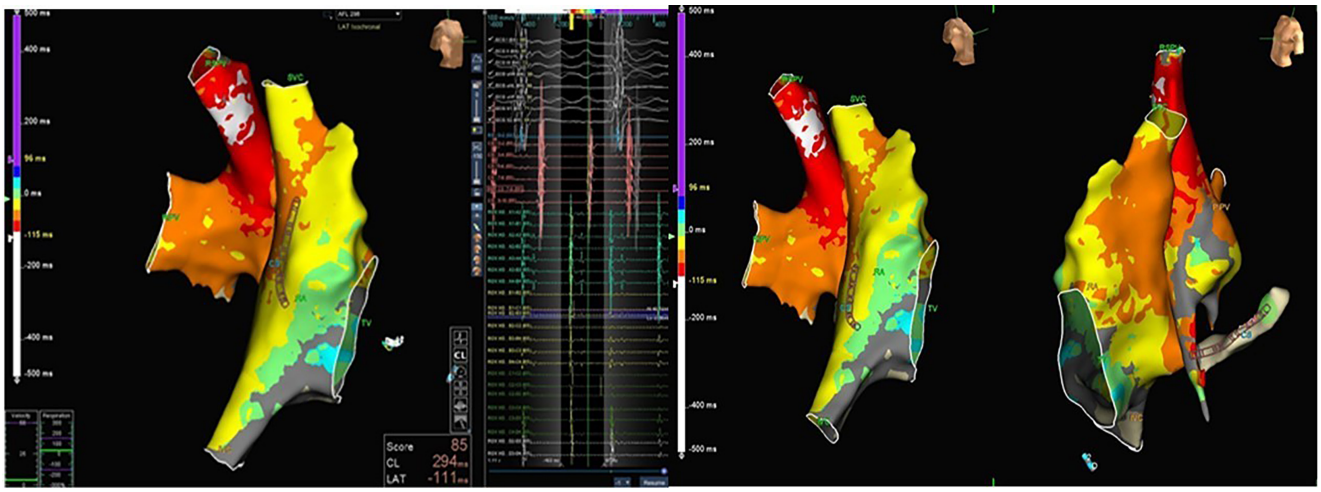

FIGURE 3 The image illustrates the 3D mapping and intracardiac signals during mapping of AT using HD catheter.

In such cases, detailed electrophysiological studies or advanced imaging techniques may be required for a precise diagnosis, emphasizing the importance of thorough evaluation in distinguishing between FAT and AFL originating from the right PV. (1) Entrainment from the High Right Atrium (HRA): Pacing from the high right atrium (HRA) during tachycardia can help differentiate AFL from AT. In AFL, pacing at a site with a fixed relationship to the circuit may result in a consistent response, while in AT, the response may vary. (2) CTI Pacing (Cavotricuspid Isthmus): Pacing maneuvers along the cavotricuspid isthmus can be informative. Entrainment from this area may suggest typical AFL, as the isthmus is often involved in the reentrant circuit of flutter. (3) Decremented Pacing: Gradually decreasing the pacing cycle length during entrainment studies can help identify the critical isthmus of the reentrant circuit. This can be particularly useful in distinguishing AFL. (4) Post-pacing Interval (PPI) Analysis: Assessing the post-pacing interval and comparing it to the tachycardia cycle length can provide insights. A PPI approximating the TCL suggests proximity to the critical circuit, often seen in AFL. (5) Differential Entrainment: Entrainment from various sites within the right atrium and PV can help differentiate focal AT from reentrant arrhythmias. These maneuvers, when applied systematically during electrophysiological studies, contribute to

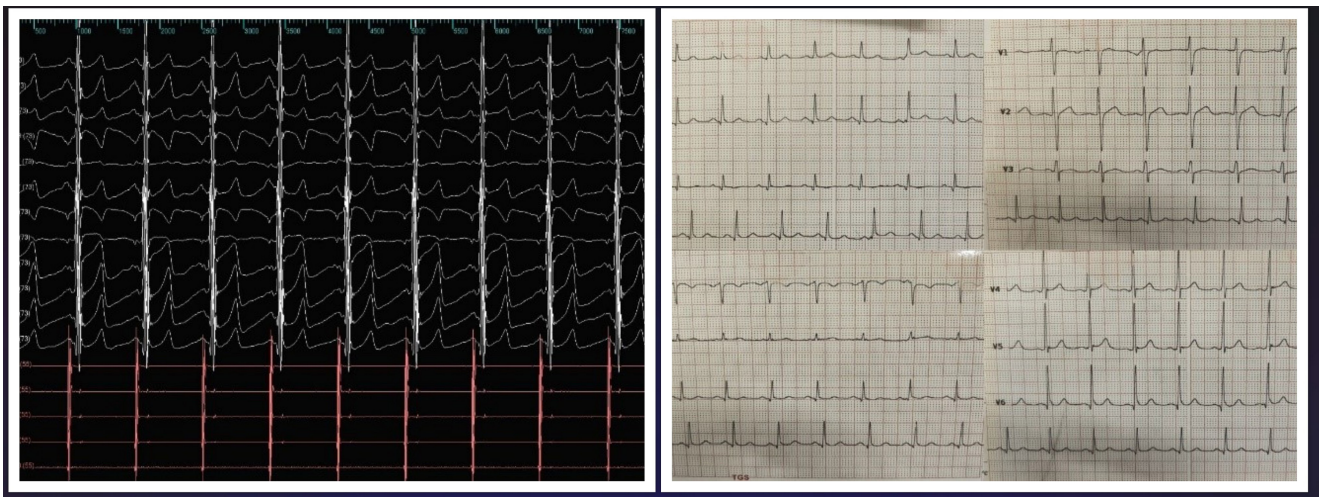

FIGURE 4 The image depicts an intracardiac (left) and surface (right) electrocardiogram showing AT termination and return to normal sinus rhythm during ablation.

TABLE 1 Differences in the presentation of FAT and atrial flutter.[7,12–14]

	Feature	FAT	Atrial flutter
1	Mechanism	Abnormal automaticity or triggered activity	Macro-reentrant
2	ECG	A Visible baseline B Irregular R-R intervals C Variable P-wave morphology	A No visible baseline B Regular R-R intervals C F wave (saw-tooth pattern)
3	Response to adenosine	A. Transiently slows ventricular response B. Termination in triggered activity	Transient suppression of the tachycardia
4	Atrial cycle length	150–250 ms	250–350 ms
5	The most common anatomical origin	Commonly around tricuspid annulus and crista terminalis	Commonly around surgical sutures or Cavotricuspid isthmus
6	Association	Perhaps in a normal heart	Commonly in underlying structural heart disease

the accurate diagnosis and targeted treatment of AT and AFL.[15–17]

5.1 | Conclusion (clinical learning point)

Distinguishing between FAT and AFL is crucial to choose the best treatment. This differentiation can be done by focusing on differences in the pattern of their P and QRS waves, R–R wave intervals, and also their baseline changes on ECG. Other factors such as their atrial cycle length, response tos adenosine and risk factors of the patient can be guiding as well. However, sometimes more complex evaluations such as detailed electrophysiological studies or advanced imaging techniques are necessary.

FAT originating from the right PV can be challenging to differentiate from AFL. In such cases, a comprehensive assessment involving clinical context, electrophysiological studies, and response to interventions such as adenosine is crucial for accurate diagnosis and appropriate management.

AUTHOR CONTRIBUTIONS

Feisal Rahimpour: Supervision; validation; visualization; writing – original draft. **Roohullah Hemmati:** Conceptualization; methodology; resources; supervision. **Mohsen Anafje:** Methodology; project administration; resources; validation. **Hadis Soltani:** Data curation; formal analysis; investigation; project administration; writing – original draft. **Haghjoo Majid:** Methodology; project administration; visualization; writing – original draft; writing – review and editing. **Pouya Ebrahimi:** Data curation; investigation; software; writing – original draft.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

Further data will be available in case of appropriate request by the corresponding author, Dr. Majid Haghjoo. (majid.haghjoo@gmail.com).

CONSENT

The patient provided informed consent for the publication of this report, and the procedure was performed in accordance with the center's ethical policy. Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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