Case report

A cavotricuspid isthmus-dependent flutter with an unexpected left atrial activation sequence: A case report

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Abstract
Objective: The isthmus-dependent right atrial flutter is a known arrhythmia, but few studies described the sequence activation of the left atrium. It is well established that the interatrial connection occurs through different pathways: the coronary sinus (CS), the Bachmann's bundle and the fossa ovalis. We describe a case of a cavotricuspid isthmus-dependent right atrial flutter with an unexpected left atrial activation sequence.
Case presentation: A 47-year-old female with scleroderma and a history of isolated right ventricular cardiomyopathy had recurrent atrial flutter episodes despite medical therapy. The patient was still symptomatic despite full medical therapy. She presented to the electrophysiology laboratory for mapping and ablation of atrial flutter with 2:1 and 3:1 conduction. A decapolar deflectable CS catheter placed in the coronary sinus showed a distal to proximal CS activation with a flutter cycle length of 240 msec. Then, the cavotricuspid isthmus (CTI) demonstrated a concealed entrainment with a post-pacing interval almost equal to the total cycle length confirming the diagnosis of an isthmus-dependent flutter. The CS activation in sinus rhythm also showed a distal to proximal activation.
This confirmed that the CS and the left atrium are being activated most probably through the Bachman bundle anteriorly and superiorly. CTI line was performed under intracardiac echo guidance. Clinical improvement was noticed. A distal to proximal CS activation does not exclude a right atrial arrhythmia.
Conclusion: A systemic entrainment mapping of both the right and left atrium is crucial to prevent unneeded transseptal puncture.
Key words: Left atrial activation sequence, flutter, cavo tricuspid, isthmus dependent, case report
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Introduction
A cavotricuspid isthmus (CTI)-dependent atrial flutter is a macro reentrant arrhythmia that passes through the CTI, a narrow strip of the right atrium tissue formed by the inferior vena cava and the tricuspid annulus, with passive depolarization of the left atrium (1-4). The isthmus-dependent right atrial flutter is a known arrhythmia, but few studies described the sequence activation of the left atrium. It is well established that the interatrial connection occurs through different pathways: the CS, the Bachmann's bundle and the fossa ovalis (5-8).

We describe a case of a cavotricuspid isthmus-dependent right atrial flutter with an unexpected left atrial activation sequence.

Case report
A 47-year-old female with scleroderma and long-standing history of isolated right ventricular cardiomyopathy with dilated right-sided chambers had recurrent atrial flutter episodes despite medical therapy. She was on amiodarone, calcium channel blocker and anticoagulation.

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Graphical abstract

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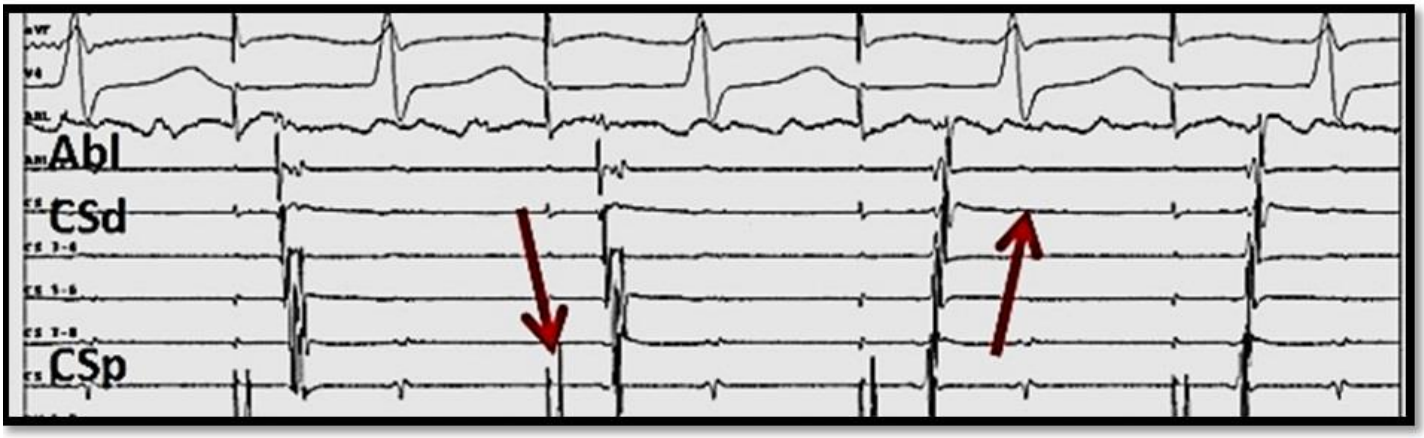

This case showed that distal to proximal CS activation does not exclude a right atrial arrhythmia. A systemic entrainment mapping of both the right and the left atrium is crucial in such procedures to spare patients an unnecessary transseptal approach that could lead to further complications.

Her cardiac ultrasound revealed a preserved left ventricular ejection fraction of 60% and a depressed right ventricular function of less than 20% with no pulmonary hypertension.

Diagnosis was also confirmed with a cardiac magnetic resonance imaging and a right heart catheterization. The patient was still symptomatic despite full medical therapy with dyspnea on exertion NYHA III that is why a decision for atrial flutter ablation was considered due to the patient's debilitating symptoms after consulting her clinical cardiologist, rheumatologist and electrophysiologist. The patient's opinion was taken into consideration. She consented to the given procedure.

She was then admitted at the American University of Beirut Medical Center for mapping and ablation of her flutter. She arrived at the EP laboratory in atrial flutter with 2:1 and 3:1 conduction. A moderate sedation was used. Three sheaths 8 Fr and 10 Fr were placed in the right femoral vein. Ultrasound was used for venous puncture. A 6 Fr decapolar deflectable CS catheter was placed in the coronary sinus. Surprisingly, it showed a distal to proximal CS activation with a flutter cycle length of 240 msec. Entrainment from CS distal and CS proximal showed a long post-pacing interval (PPI). Then the CTI demonstrated a concealed entrainment with a PPI almost equal to the total cycle length (TCL) confirming the diagnosis of an isthmus-dependent flutter. During repeated entrainment, the flutter broke, and the patient reverted to sinus rhythm. The CS activation in sinus rhythm also showed a distal to proximal activation (Fig. 1).

This confirmed that the CS and the LA are being activated most probably through the Bachman bundle anteriorly and superiorly, going laterally, engaging the CS distally and then propagating to the proximal end. Pacing from CS proximal to the medial CTI showed a conduction time of 280 msec as opposed to the lateral CTI that showed a conduction time of 180 msec during CS proximal pacing, once again confirming the superior propagation of the wavefront and engaging the atrium laterally and superiorly. Given this fact, CS proximal cannot be utilized as a medial electrode for CTI conduction. CS catheter was moved to the lateral CTI and recorded a CTI conduction to the medial CTI during lateral CTI pacing at 140 msec. The lateral and the medial CTI points were tagged on the NAVX system (St Jude Medical System).

Given the distorted anatomy and the very dilated right chambers, the CTI line was performed under intracardiac echocardiography (ICE) guidance and was placed via the right femoral vein and parked in the low right atrium.

Figure 1. Intracardiac electrogram showing here the difference between a distal to proximal and a proximal to distal activation sequence

A 3.5 mm Bio sense Thermo Cool irrigated-tip ablation catheter was utilized using an ICE-guided technique and Ensite NavX for additional guidance. A CTI line of ablation was made. After ablation, there was documentation of a jump in the conduction time to 240 msec. The medial CTI to proximal CS area became isolated after completing the CTI line with only minimal electrical activity that was utilized to document the prolonged conduction time after ablation. A power of 40 Watts with a temperature of 42 °C irrigated was applied to achieve a durable CTI block. The bidirectional block was confirmed at the end. Atrial flutter could not be re-induced. Moreover, it is very unlikely to have a pathway on the left given the fact that A (atrium) to V (ventricle) interval on the CS was not short at any level.

The patient tolerated the procedure well and there were no apparent complications.

The patient was kept on anticoagulation and amiodarone. Close follow-up with Holter recordings was done. After the procedure, clinical improvement was noticed.

Electrocardiogram after ablation showed a normal sinus rhythm. The patient acknowledged an important difference in her quality of life (Fig. 2).

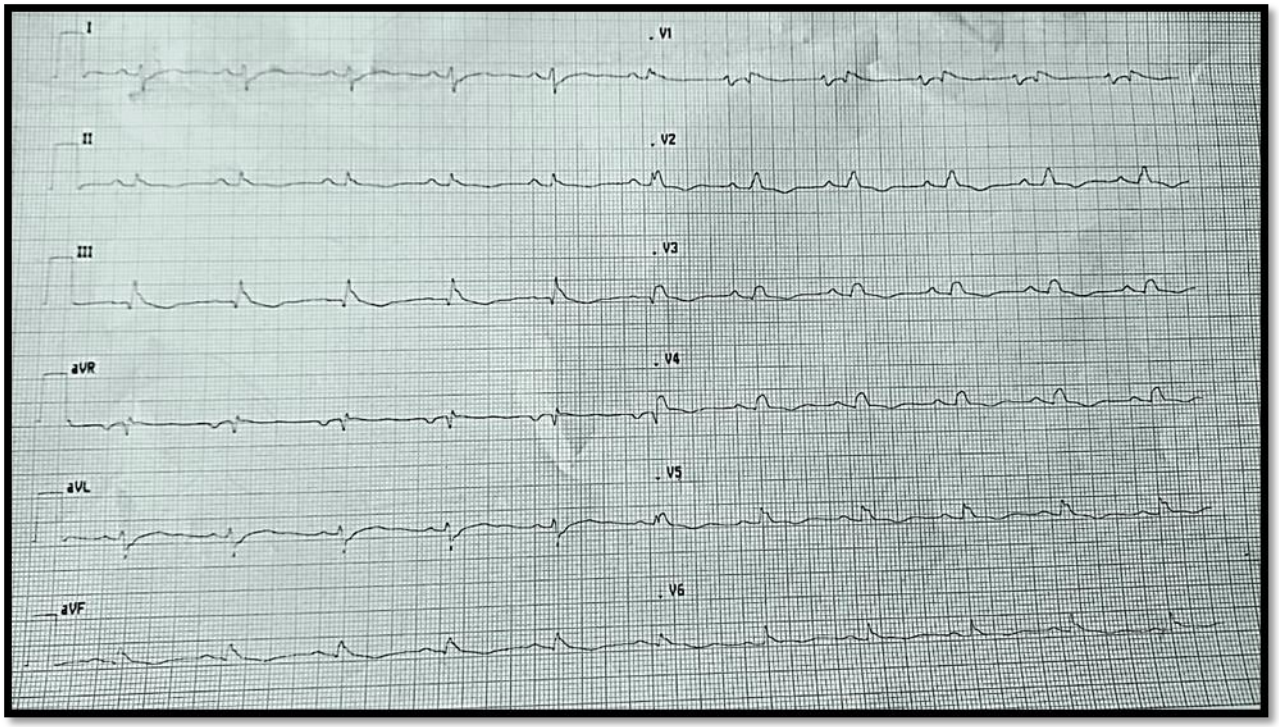

Figure2. Electrocardiogram after ablation shows sinus rhythm

Discussion

Interatrial conduction is often possible through 3 different pathways (6). The anterosuperior one with rapid impulse propagation via the Bachmann bundle, the postero-septal through the CS and the septal one through the fossa ovalis. Counterclockwise (CC) and clockwise(C) are used to describe activation in the right atrium. The left atrial activation has not been systematically evaluated but is reflected by the CS recordings (9,10) Three patterns of the CS activation in CC and C atrial flutter were described: proximal to distal, distal to proximal and a fused pattern. A typical atrial flutter is normally associated with a proximal to distal CS activation. During a clockwise atrial flutter, the left atrium is activated predominantly over the Bachmann bundle. The circuit of isthmus-dependent atrial flutter was entirely in the right atrium. The left atrium activation was a bystander and followed transseptal conduction across the CS, Bachmann bundle, and fossa ovalis (6,10,11).

Recent publications have shown that left-to-right interatrial conduction occurs predominantly through the Bachmann bundle. In addition, multiple connections are capable of right-to-left conduction in contrast to a left-to-right connection, so a distal to proximal CS activation would lead to thinking of a left atrial flutter origin, but the patient had this same activation pattern during arrhythmia and sinus rhythm (1, 9).

We reported a case of a misleading CS activation. This case highlighted the value of performing a systematic entrainment mapping of both the right and left atrium. Concealed entrainment at the Cavo tricuspid isthmus with a PPI=TCL made us aware of a misleading CS sequence and spared the patient an unnecessary transseptal approach.

Moreover, given the complex activation of the atrium and the possibly confusing CS activation, it is important to map both the right and left atrium, mitigating the risks of unnecessary transeptal puncture.

Conclusion: In conclusion, this case showed that distal to proximal CS activation does not exclude a right atrial arrhythmia. A systemic entrainment mapping of both the right and the left atrium is crucial in such procedures to spare patients an unnecessary transseptal approach that could lead to further complications.

Ethics: The patient has consented to the submission of the case report for submission to the journal.
The authors affirm that human research participants provided informed written consent for the publication of the images in Figure(s) 1 and 2. Patient signed informed consent regarding publishing their data and photographs.
The participant has consented to the submission of the case report to the journal.
A local institutional review board approved the patient consented to the case presentation.
Peer-review: External and Internal
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