CASE REPORT

Atrial Flutter Ablation Using a Three-Dimensional Electroanatomical Mapping System

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Abstract

Typical atrial flutter ablation is usually performed conventionally, by creating a line across the cavotricuspid isthmus under fluoroscopic guidance. In this article, we present the case of a middle-aged male who was submitted to flutter ablation through use of a three-dimensional electroanatomical mapping system, yielding highly accurate and pedantic images. ***Rhythmos 2017;12(1):12-14.***

Key Words: atrial flutter; catheter ablation; cavotricuspid isthmus; electroanatomical mapping

Abbreviations: CTI = cavotricuspid isthmus; ECG = electrocardiogram; LOE = level of evidence; RF = radiofrequency

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Introduction

Atrial flutter can be managed with radiofrequency (RF) catheter ablation at the cavotricuspid isthmus (CTI) with success rates exceeding 90% and recurrence rates <5-10%.[1] Indeed, ablation of the CTI is one of the most frequently performed procedures in electrophysiology laboratories. Several tools are employed to facilitate the procedure. With the conventional approach, multipolar catheters are placed in the right atrium and in the coronary sinus that can detect bidirectional conduction block at the level of CTI, which is the prerequisite for durable effective ablation.[2, 3] Electroanatomic mapping systems may facilitate the procedure and significantly reduce fluoroscopy exposure, albeit at increased cost and resource utilization compared with conventional ablation.[4] We herein report a case of employing this mapping tool which guided and greatly facilitated the ablation procedure.

Case presentation

A 59-year-old man with a history of hypertension and normal coronaries on prior coronary angiography performed to investigate episodes of dyspnea, was diagnosed with atrial flutter detected by ambulatory 24-hour rhythm monitoring. Morphology of F-waves on ECG suggested typical isthmus-dependent atrial flutter (Fig. 1). Arrhythmia relapsed two months after electrical cardioversion, while the ventricular rate was adequately controlled only after maximal doses of anti-arrhythmic agents. Patient remained in atrial flutter for 4 months prior to consenting to ablation due to persistence of symptoms.

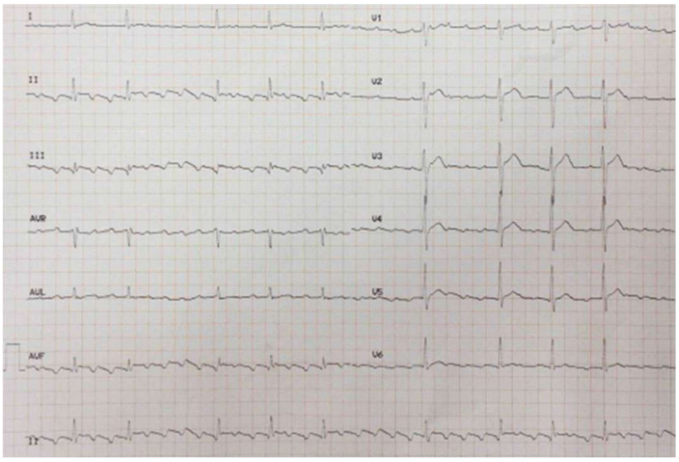

Figure 1. Admission 12-lead ECG. Atrial flutter, featuring typical sawtooth pattern F waves in inferior leads (isthmus-dependent flutter) at a rate ~200/min. Additionally, negative F waves denote typical (counter-clockwise) flutter. Note presence of variable AV conduction.

Ablation Procedure

Under local anesthesia, while in atrial flutter, two 7Fr and one 8Fr sheaths were inserted in the femoral veins. A duodecapolar halo-type catheter was placed in the right atrium in a clockwise conformation, i.e. with the distal poles in the CTI and clockwise course of the proximal shaft, and a deflectable decapolar catheter was introduced into the coronary sinus. An irrigated mapping catheter (NaviSTAR Thermocool SF®, Biosense Webster, Diamond Bar, CA, US), compatible with 3D electroanatomical mapping, was then advanced to the right atrium. Electroanatomical mapping was then performed using CARTO® 3 system (Biosense Webster, Diamond Bar, CA, US).

Based on the Halo catheter electrograms (Fig. 2), typical atrial flutter was confirmed, and according with ECG findings and activation mapping using the De Ponti algorithm,[5] the critical CTI was located. Application of RF current energy to the area and formation of a continuous line of block from the tricuspid annulus to the inferior vena cava, parallel to the "early meets late" boundary, converted the rhythm into sinus (Fig. 3-5). Bidirectional block in the CTI was demonstrated by pacing from either the distal Halo (Fig. 6a) or proximal coronary sinus (Fig. 6b) catheter electrodes and measuring the conduction time between them (~140 ms) and persisted more than 30 min after the last RF application. Patient remained in sinus and all catheters and sheaths were removed. No procedure-related complications were observed and he resumed anticoagulation on the same night. Following the ablation procedure, the patient has remained symptom free with no flutter detected in serial ECGs over the next 2 months.

Figure 2. ECG leads II, III, aVF and V1 and intracardiac electrograms from the CS (DCS-PCS) & Halo (HALO 1-2 to HALO 19-20) catheters. Note the direction of impulse propagation in the Halo electrograms, denoting counterclockwise (typical) atrial flutter. F waves negative in inferior ECG leads. Mapping catheter (Map and Map p) not yet inserted.

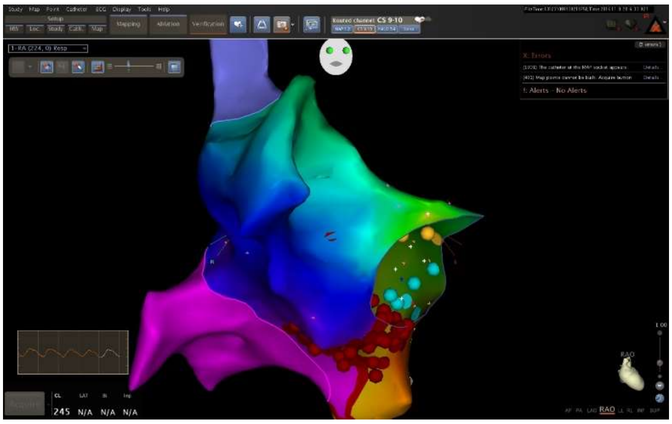

Figure 3. Three-dimensional electroanatomical mapping image of the right atrium post ablation (RAO view). Magenta structure on top is the superior and pink structure at bottom the inferior vena cava. Tricuspid annulus is demarcated, as well as His bundle location (yellow dots). Colors denote activation sequence, from early (red) to late (purple). Red dots are ablation points and can be seen spanning the entire CTI.

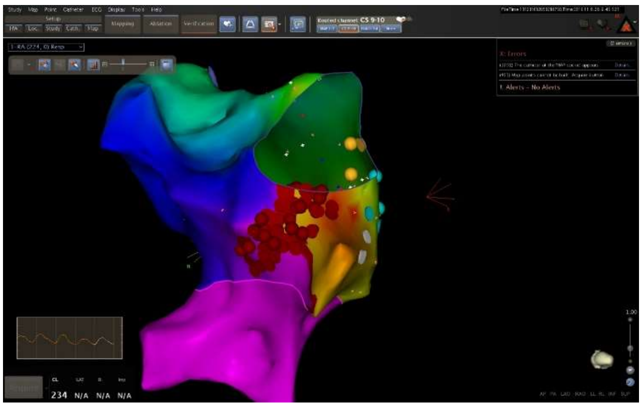

Figure 4. Three-dimensional electroanatomical mapping image of the right atrium post ablation (view from inferior vena cava). “Early-meets-late” area is seen and, by merit of the DePonti approach, localizes the critical isthmus of the circuit (here the cavotricuspid isthmus). Ablation line parallel to the boundary. Marking and color code as in Fig. 2.

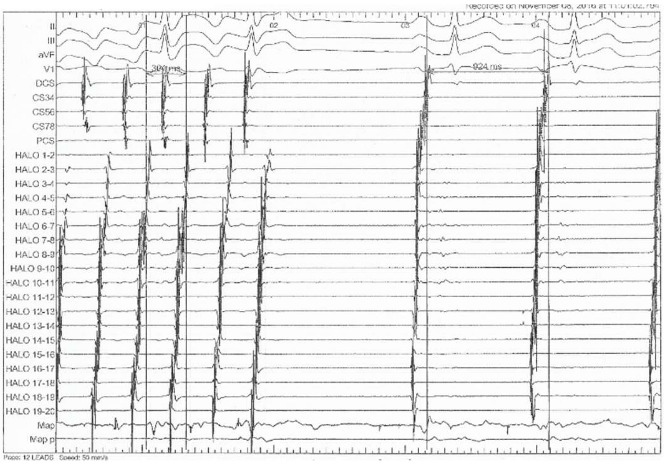

Figure 5. Conversion to sinus rhythm; note delay change in left atrial electrograms, indicating interatrial conduction delay during flutter.[15]

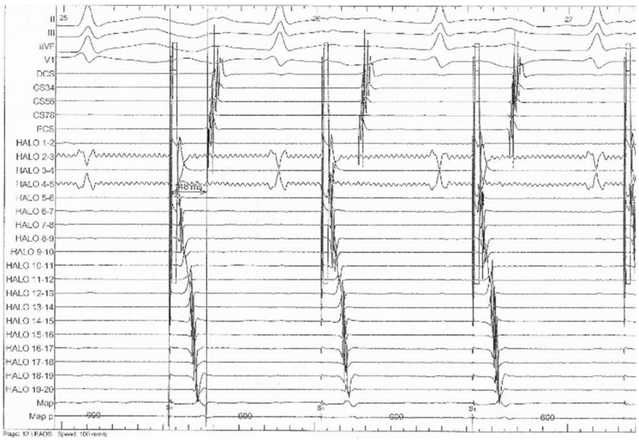

Figure 6. Bipolar pacing from the Halo catheter (electrodes 2 & 3, lateral to CTI). Activation at the proximal pair of electrodes of the CS catheter (located at the CS ostium) clearly occurs after the rest of the Halo catheter electrode pairs have been counterclockwise activated. Furthermore, conduction time is >140 ms, supporting the presence of conduction block. Halo electrode pair 1-2 was not used due to intermittent capture (potentially due to adjoining ablated area).

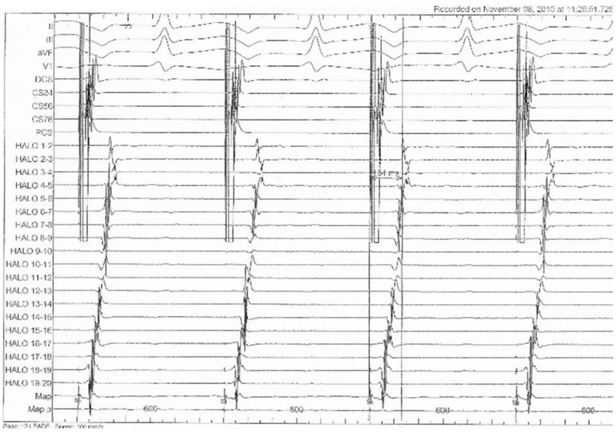

Figure 7. Bipolar pacing from the coronary sinus catheter (proximal electrode pair). In analogy to the previous phenomenon, Halo pairs 1-2 and 2-3, located distally to the ablation line, are activated last, proving bidirectional conduction block at the isthmus (conduction time 134 ms).

Discussion

Atrial flutter constitutes the archetypal macroreentrant atrial tachycardia, although its prevalence is estimated at <10% of that of atrial fibrillation.[6] The sawtooth pattern of F waves in inferior leads allows for diagnosis of right atrial isthmus dependent flutter, either typical (counterclock-wise-negative, 90%) or atypical/clockwise-positive, with major ramifications for potential treatment options. Atrial flutter is notoriously difficult to treat pharmacologically. Current American guidelines offer specific guidance on atrial flutter ablation, recommending it as a first-line treatment in isthmus-dependent cases of symptomatic patients (Class I, LoE B), as was our case, or in cases of non-isthmus-dependent flutter (Class I, LoE C) or in flutter arising after drug therapy for atrial fibrillation. In asymptomatic recurrent flutter, indication is Class IIb (LoE C).[7]

Available studies suggest that an early ablation approach of the CTI can lead to reduced mortality, healthcare utilization, and, possibly, stroke occurrence.[8, 9] In a recent large meta-analysis of safety outcomes post-flutter ablation, overall complication rates were 3.17%, with in-hospital mortality at 0.17%.[10] However, the above are based on procedures performed as early as 2001, consequently, effects of using modern electroanatomical mapping (e.g. to identify perforations) may have been blunted. Bidirectional conduction block across the isthmus has been consistently used to assess acute success,[11] yielding rates as high as 97%.[12] Notably, recurrence rates are relatively low (~9% at 17-30 months).[2, 13] Main cause for procedure failure is recovery of excitability at the ablated area, usually, but not always, occurring within 30 minutes post-procedure. In general, ablation utilization in the flutter population remains suboptimal, since less than 10% of patients are submitted to it.[9]

Given that by definition the critical isthmus of typical and atypical flutter is located in a demarcated area between lines of fixed (anatomical) conduction block (Eustachian ridge, tricuspid valvular annulus and inferior vena cava), the usual ablation strategy involves conventional, non-3D mapping compatible, catheters.[3] However, 3D mapping catheters are used in cases of atypical, scar related, flutter,[14] as they could offer invaluable insights concerning chamber geometry and circuit course. Moreover, the De Ponti method for defining the window of interest in the 3D mapping system calibrates its relation to the arrhythmia so as to ensure co-localization of the critical isthmus and the early-meets-late color-coded recording, allowing for clearer perception of the ablation target.[5] An electroanatomical mapping approach was chosen in order to further validate the nature of the arrhythmia and vulnerable part of the circuit, and in the context of an organized effort for fluoroscopy time minimization. Although cost may be prohibitive for an overstretched healthcare system, with cost increases up to 30% for 3D mapping systems, [4] it is believed that the added patient-doctor safety (fluoroscopy exposure almost halved) with similar effectiveness, one may occasionally select this method in certain cases in the context of clinician-patient relationship in a shared decision-making approach.

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