



Case Report

Successful Ablation of Decrementally Conducting Atrioventricular Fiber (Mahaim) at The Distal Ventricular Insertion Site by Using 3D-High Density Mapping after Previous Multiple Failed Conventional Ablation Attempts

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Abstract

Long decrementally conduction accessory atrioventricular (AV) fibers are rare and their successful mapping and ablation is often challenging due to its predominately intramuscular course. The use of 3D-mapping systems have the potential to improve successful mapping and ablation of these special pathways. We describe a case of a young healthy woman with a Mahaim fiber, who had six previous failed ablation attempts in three different high volume EP centers in Germany. Using high density mapping with the Advisor™ HD-Grid Catheter (Abbott), the ventricular insertion site of the long atrioventricular fiber could be visualized with finally consecutive successful ablation.

Introduction

So-called “Mahaim” fibers are rare accessory pathways with properties similar to those of the AV node. They arise along the tricuspid annulus or AV node and insert into the right ventricle, mostly with connection to the specific conduction system. [1] These fibers can be either short or very long with a predominantly intramuscular course.

They lead to symptomatic antidromic tachycardia with 1:1 AV conduction with a left bundle branch block (LBBB) morphology. Since Mahaim fibers are very rare, they are often not recognized as such, even by electrophysiologists. Moreover, once adequately identified, their ablation is often challenging. We describe a case of a young healthy woman with a Mahaim fiber, who had six previous failed ablation attempts in three different high volume electrophysiological (EP) centers in Germany.

Case Presentation

In January 2010, a 19-year old woman was admitted to a high volume EP center in Germany due to daily symptomatic tachycardias characterized by regular palpitations with sudden onset and sudden end. The tachycardia documented on ECG was suspected to be a supraventricular tachycardia with a rate-dependent LBBB. During invasive EP study a concentric decremental antegrade as well as retrograde atrioventricular conduction was reported. Under administration of orciprenaline the clinical tachycardia with LBBB pattern and 1:1 AV-conduction with cycle length of 300ms with a long RP-interval of 180ms was induced. Earliest atrial activation was recorded at proximal coronary sinus (CS) measured by a decapolar diagnostic catheter positioned within the CS. Due to the presence of a dual AV node physiology, the tachycardia was rated as an atypical AVNRT with a fatigue block of the left conduction system. After non-irrigated radiofrequency (RF) - ablations in the right posteroseptal region, tachycardia could no longer be induced. However, after 5 months the tachycardia recurred. The patient was re-admitted in November 2010 at the same EP center. EP study was performed this time by two other electrophysiologists. Adequate mapping of the tachycardia was described as hardly possible due to an almost incessant tachycardia with repeated acceleration into atrial fibrillation with need of cardioversion. Finally non-irrigated RF ablations were performed at earliest atrial activation site, which was still at the right posteroseptal region - measured again by decapolar catheter within the CS. After several RF energy deliveries, even at the CS ostium, tachycardia showed no spontaneously induction any more. However, under programmed atrial stimulation it was still inducible.

The patient was laid down for a two-stage 3D-guided left atrial mapping and ablation procedure, scheduled in December 2010. Due to unexpected technical problems of the EP System in this EP center at time of patient's re-re-admission, the patient was transferred to a second high volume EP-center. There, EP study was performed conventionally again without the use of a 3D system. With the idea of a possible atrio-fascicular pathway due to the LBBB pattern the colleagues performed pacing at the high right atrium during sinus rhythm. Using this maneuver the LBBB pattern was not reproducible in absence of the tachycardia. Under the imagination of an epicardial course of the pathway, irrigated RF ablations were performed at the roof of the CS ostium where the earliest atrial activation was measured, again by decapolar catheter within the CS. After irrigated RF-ablations no tachycardia was inducible any more. After a few days the tachycardia returned. In May 2011 the patient was re-admitted at the second EP center. This time, to prove or to rule out the presence of an accessory pathway, administration of adenosine was performed. Due to a consecutive third degree AV-block under adenosine, the

presence of an accessory pathway was supposedly ruled out by the investigator. Moreover, the initial diagnosis of an atypical AVNRT was resumed. Several non-irrigated ablations in slow pathway position were performed. Afterwards, no tachycardia could be induced any more. But this time, too, the tachycardia returned after a few days. In January 2012 the patient was admitted in one of the biggest EP centers in Europe.

During 3D-system (Carto-XP, Biosense Webster, and Irvine, CA, USA) assisted diagnostic EP study, the well-known tachycardia with earliest atrial activation in the proximal CS could be reproduced. Under pacing along the tricuspid valve pre-excitation of the decrementally conducting atrioventricular fiber with the LBBB ECG pattern could be clearly demonstrated. During mapping complete right bundle branch block (RBBB) was mechanically induced in the right lateral position of the tricuspid ring. The RBBB persisted and the tachycardia could no longer be induced after this. Under the assumption that the Mahaim fiber has its origin there, irrigated RF ablations were performed at the lateral tricuspid valve ring. After a few days, the Mahaim fiber recovered with consecutive tachycardia. After daily episodes lasting up to an hour, there was another admission in April 2013 in the last-named center. 3D-Mapping at the ventricular and/or atrial site of the tricuspid annulus showed no Mahaim potential. In the right lateral position, another "bumping" of the Mahaim fiber led again to a RBBB without recovery during the procedure time.

Irrigated RF-ablations in this area were unsuccessful for the patient. In the following 9 years the patient was under flecainide medication. After an initial improvement in symptoms with flecainide, the effect steadily diminished over the years. In February 2022 the patient was admitted at our hospital due to daily tachycardia with a duration up to 30 minutes under flecainide. Based on previous experience, the procedure was performed under general anesthesia at the patient's request. A steerable duodecapolar catheter positioned around the tricuspid valve ring was used for continuous stimulation with generation of maximum pre-excitation at the lateral ring. Furthermore, a non-steerable quadripolar catheter was in HIS position as well as a steerable decapolar within the CS as 3D-reference catheter. To avoid bumping of the Mahaim fiber at the tricuspid valve ring, we decided to map the distal ventricular insertion site of the fiber. High density mapping of the right ventricle using the EnSite Precision™ System (Abbott, Chicago, Illinois, USA) with the Advisor™ HD-Grid Mapping Catheter (Abbott, Chicago, Illinois, USA) - guided via the steerable Agilis sheath (Abbott, Chicago, Illinois, USA) - allowed us to visualize the distal insertion site of the Mahaim fiber (Figure 1A). Earliest ventricular activation (-86ms earlier to ventricular signal in HIS position) was localized at the distal lateral part of the right ventricle (Figures 1A and B). The floppy body of HD-Grid catheter made recurrent and quick conduction

recovery of the Mahaim fiber possible after mechanical bumping's at the site of its intramyocardial course (Figure 1A). Irrigated RF-ablations with the TactiCath-SE catheter (Abbott, Chicago, Illinois, USA) with 35 W, 43°C, 30 cc/min, 10-30g - followed by several safety energy applications - at the earliest local ventricular activation led to immediate RBBB without possibility of reinducing the well-known tachycardia (Figure 1C). In an actually observation period over 8 months, the patient had no tachycardias any more in absence of any antiarrhythmic drug therapy.

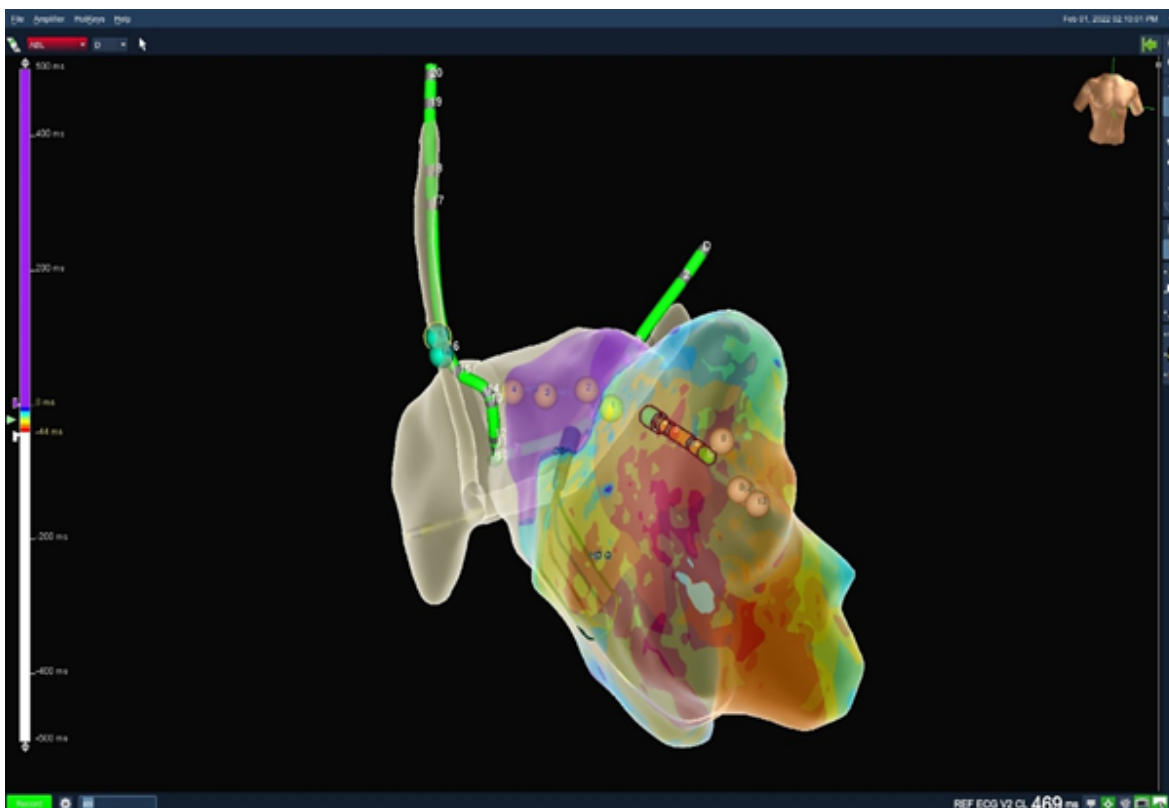


Figure 1A: EnSite Precision™ high density activation MAP with the Advisor™ HD-Grid catheter visualize the electroanatomic endocardial insertion site of the long atrio-ventricular fiber with predominantly intramuscular course (white spot). Green dots: site of maximal preexcitation during pacing. Yellow dots: course of AV node and right bundle branch.

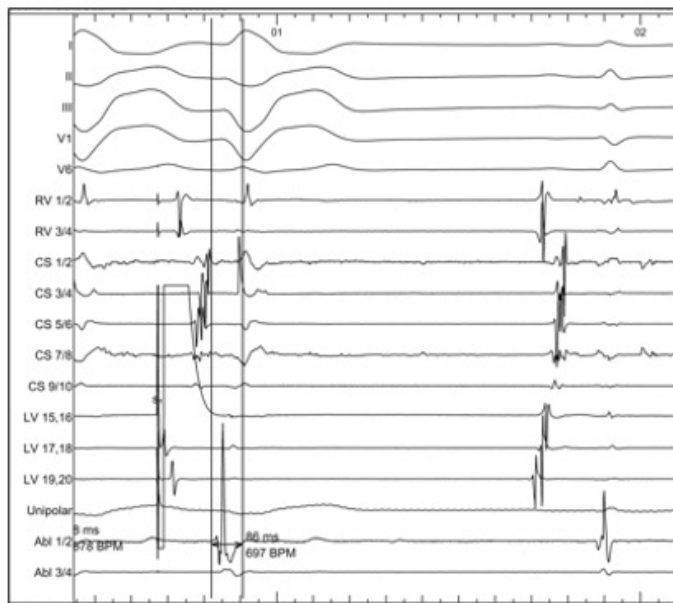


Figure 1B: Intracardiac electrograms signals shows earliest ventricular activation at the distal lateral part of the right ventricle (-86ms earlier to ventricular signal in HIS/RV position).

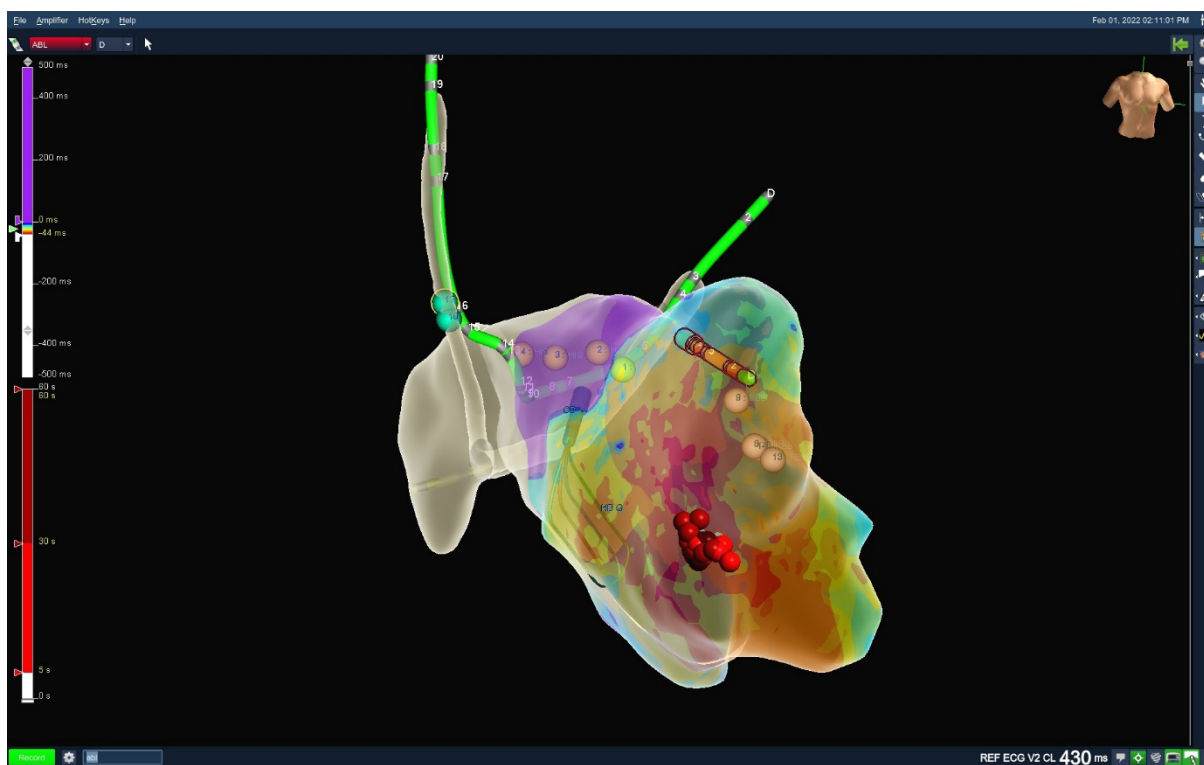


Figure 1C: EnSite Precision™ guided successful ablation (red dots) of the endocardial insertion site of the long atrio-ventricular fiber with predominantly intramuscular course.

Discussion

Recently, some reviews have been published for better understanding of unusual variants of preexcitations like in Mahaim fibers. [2,3] In these guides of clinical presentation, electrophysiologic characteristics and ablation strategies of decrementally conducting accessory pathways, the use of 3D mapping systems was encouraged, suggesting increased ablation efficacy - in spite of the lack of evidence. [2] Since then, several authors have been able to show that accessory pathways can be safely and successfully ablated using different 3D mapping systems.

Steinfurt et al. [4-6] revealed Mahaim fiber in the right ventricle by high-resolution 3D mapping using the CARTO 3 system (Biosense Webster, Irvine, CA, USA). [5] *Nishimura et al.* tracked the course of Mahaim pathway using the Rhythmia™ system (Boston Scientific). [6] *Schricker et al.* showed in symptomatic Wolff-Parkinson-White patients, that with the use of a novel high density technique with the EnSite Precision™ System and the HD-Grid mapping catheter, accessory pathways can be rapidly and successfully map and ablate at the level of tricuspid- or mitral-anulus. [6] To best of our knowledge, we report the first case using high density mapping with the Advisor™ HD-Grid catheter for visualization of the distal ventricular insertion site of a long Mahaim fiber with intramuscular course and consecutive successful ablation after multiple failed previous ablations. The visualization of the ventricular insertion site by activation map underlines a significant simplification of the ablation after previous multiple failed ablation attempts. Considering the case presented here with retrospectively unnecessary and avoidable multiple electrophysiological investigations, attention should be paid to the following:

- In supraventricular tachycardia with a 1:1 AV conduction, left bundle branch block morphology and long PR interval, presence of a Mahaim fiber should always be considered in the differential diagnosis.
- Stimulation along the tricuspid valve ring, instead of pacing at the upper right atrium, allows unmasking the Mahaim fiber by pre-excitation.

- Mapping the earliest atrial activation during tachycardia in this case only reflected the retrograde atrial activation via the AV node and should be avoided as ablation strategy.
- Administration of adenosine do not rule out presence of Mahaim fiber due to its conduction properties similar to those of the AV node.
- High density mapping with the Advisor™ HD-Grid Catheter for ventricular insertions sites of atrioventricular fibers is an alternative and effective approach in challenging cases and allows fast recovery of the fiber in case of mechanical bumping.

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