CASE REPORT

Modulation of the slow pathway in the presence of a persistent left superior caval vein using the novel magnetic navigation system Niobe

Sabine Ernst, Feifan Ouyang, Christian Linder, Klaus Hertting, Fabian Stahl, Julian Chun, Hitoshi Hachiya, Ulrike Krumsdorf, Matthias Antz, Karl-Heinz Kuck*

II. Med. Abteilung (Kardiologie), Allgemeines Krankenhaus St. Georg, Lohmühlenstr. 5, 20099 Hamburg, Germany

Submitted 31 July 2003, and accepted after revision 21 September 2003

Abstract

Aims This is the first report of a young female with typical AVNRT in the presence of a persistent left superior caval vein that underwent catheter ablation using the novel magnetic navigation system (MNS) Niobe (Stereotaxis Inc.).

Methods The MNS consists of two outer permanent magnets (about 0.1 T) that align a third small magnet integrated in the tip of a mapping and ablation catheter along its magnetic field lines. By changing the orientation of the outer magnets, the orientation of the magnetic field lines also change, thereby allowing navigation of the ablation catheter. In combination with an automated advancer system, this novel technique allows for the first time complete remote catheter ablation.

Results Successful slow pathway modulation was performed using a total of seven radiofrequency current applications via the magnetic ablation catheter. No complication occurred.

Conclusions The novel magnetic navigation system proved to be a safe and feasible tool for remote catheter ablation of common type AVNRT in the presence of a persistent left superior caval vein.

© 2003 Published by Elsevier Ltd on behalf of The European Society of Cardiology.

KEYWORDS

catheter ablation; atrio-ventricular reentry tachycardia; navigation

Introduction

Typical supraventricular tachycardia (SVT) is curable by radiofrequency current (RFC) ablation at distinct locations (slow AV nodal pathway, accessory pathway) using standard catheters [1–4]. Steering of those electrodes is performed via a pull wire mechanism integrated in the handle of the catheter produced by specific material allowing a reliable deflection with a fixed radius. In the presence of cardiac malformations, accessing the target site may be challenging or does not allow a stable electrode position during changing rhythms.
A persistence of the left superior caval vein is an unusual and mostly haemodynamically insignificant malformation [3]. Because of the wide ostium of the coronary sinus, the location of the slow AV nodal pathway may be displaced, rendering the site for slow pathway modulation or ablation a challenging task [5].

We report on a young female patient with persistent left superior caval vein and recurrent atrio-ventricular nodal reentrant tachycardia (AVNRT), who underwent catheter ablation using the novel magnetic navigation system Niobe (Stereotaxis Inc.).

**Methods**

As part of the first protocol for catheter ablation of SVT with ablation sites confined to the right atrium (RA) using the novel magnetic navigation system Niobe (Stereotaxis Inc.), we studied a 26 year old female presenting with typical SVT about two to three times per week. After a careful physical examination, the patient gave her written permission after informed consent was obtained. There was no contraindication for magnetic navigation (pacemaker or ICD device, metallic implants, claustrophobia), and the patient was studied in a fasting state under continuous sedation by intravenous propofol infusion (1–4 mg/kg bodyweight/h) and/or a bolus of midazolam iv. The study protocol was approved by the ethics committee of the Hamburg Chamber of Physicians.

**Electrophysiological study**

Four standard catheters were positioned. A His bundle recording catheter (Parahis®, Biosense Webster) advanced via femoral vein access, as well as a multipolar catheter (Parahis®, Biosense Webster) advanced to the proximal coronary sinus (CS) via the left subclavian vein, after depiction of the persistent left superior caval vein by contrast injection in the left subclavian vein (Fig. 1A). In addition, quadripolar non-deflectable catheters (Soloist®, Medtronic) were positioned in the right ventricular apex (RVA) and the high right atrium (HRA). A programmed electrophysiological study was performed to exclude accessory pathway conduction and investigate the underlying tachycardia mechanism. All intracardiac signals (filter settings 30–400 Hz) and surface lead electrograms were stored on a multichannel recording system (AXIOM Sensis®, Siemens, Germany) for postprocessing purposes.

**Magnetic navigation**

The second generation magnetic navigation system Niobe® (Stereotaxis Inc.) consists of two permanent magnets which are positioned inside two movable housings on both sides of the fluoroscopy table (AXIOM Artis®, Siemens, Germany). While positioned in “navigate” position, they code a composite magnetic field (0.1 T) around the chest of the patient. The mapping and ablation catheter (Helios®, IBI), equipped with a small permanent magnet positioned at the tip, interacts with the outer magnetic fields in such a way that it aligns parallel to the magnet field lines. By changing the orientation of the outer magnets, the orientation of the magnetic field changes and thereby leads to the deflection of the catheter in parallel. The graphical workstation in conjunction with the cardiodrive unit allows the change of the magnetic catheter

![Figure 1](https://example.com/image1.png)

**Figure 1** Panel A: Contrast angiography of a persistent left superior caval vein in a patient with common type AV nodal reentrant tachycardia in a left anterior oblique (LAO) projection. Panel B: Depiction of successful ablation site in LAO (left) and right anterior oblique (RAO) projection. Abbreviations: HRA, high right atrium; His, His bundle electrode; CS, coronary sinus; Map, ablation catheter.
position by 1° for angulation and 1 mm steps for advancing or retraction (Fig. 2). Having identified the underlying tachycardia mechanism as common type AVNRT, the magnetic mapping and ablation catheter (Helios®, IBI) was manually advanced via the right femoral vein access into the right atrium and was then remotely navigated to the side of ablation (Fig. 2). Thereby the positioning of the magnetic catheter and the subsequent RFC ablation were performed by an investigator in the control room without any manual contact with the ablation catheter.

Ablation

Radiofrequency current (RFC) catheter ablation was performed using the 4 mm tip magnetic ablation catheter in a temperature-controlled mode (maximum temperature 55 °C, maximum duration of 120 s, maximum 40 W) using a Stockert RF® generator (Biosense Webster, Europe). At a stable position with a typical slow pathway potential on the bipolar electrogram of the ablation catheter (Fig. 3A), RFC applications resulted in a junctional rhythm during energy delivery (Fig. 3B). Endpoint for catheter ablation was the non-inducibility of the clinical tachycardia as proven by conventional electrophysiological pacing manoeuvres [1,2,4].

Results

Remote catheter modulation of the slow AV nodal pathway was successfully performed using a total of seven RFC applications (Fig. 3). Procedure duration (calculated from sheaths insertion to extraction) amounted to 140 min with 18.4 min of intermittent fluoroscopy. No complication occurred and the patient was transferred to the normal ward after the procedure. After exclusion of a resulting pneumothorax or pericardial effusion, the patient was discharged the next day.

Discussion

Safety

We report the use of a magnetically guided navigation system in a patient with AVNRT in the presence of a persistent left superior caval vein. Because of the large opening of the coronary sinus ostium, the boundaries of Koch’s triangle are displaced in such a fashion that an ablation attempt is rather challenging [5].

Catheter navigation by magnetic force has been introduced previously in the early 1990s for diagnostic studies in neonates [6]. However, the development of conventional steerable electrodes with integrated pullwires to deflect the catheter tip was pursued, and this constitutes today’s state-of-the-art technique for catheter ablation. The conventional technique is limited by the fixed maximal catheter deflection and relies mostly on the skill of the investigator to assure stable catheter positioning. Only recently, a novel magnetic navigation system was introduced to clinical

Figure 2 Depiction of the remote navigation of the ablation catheter by application of a magnetic vector (yellow) in LAO (left) and RAO (right) projections to the site of successful RFC ablation. The middle panel depicts the applied vector in three perpendicular planes (from top to bottom: anteroposterior (AP), inferior (INF) and right lateral (RL)). The diagnostic catheters are shown as coloured lines: HRA in red, His in yellow, CS in green, the white star marks the site of ablation. For abbreviations refer to Fig. 1.
practice [7]. It proved to be a safe and feasible tool for catheter ablation with all degrees of freedom, but hence did not allow remote catheter ablation. The second generation system (Niobe, Stereotaxis Inc.) now allows for the first time complete remote RFC catheter ablation. As a side effect, it also reduced the fluoroscopy exposure time for the patient and investigator who has less need to wear lead protection gear. The ablation catheter held a stable position even with changing cardiac rhythms (such as junctional beats).

Besides the successful ablation in this anatomically challenging situation, further testing of the magnetic navigation system is necessary to demonstrate its effectiveness also in the presence of more complex tachycardia substrates or other congenital heart malformations.

Conclusions

The novel magnetic navigation system, in conjunction with the catheter advancer system, proved to be a safe and feasible tool for remote catheter ablation of common type AVNRT in the presence of a persistent left superior caval vein.

Acknowledgements

We gratefully acknowledge the assistance of Detlef Henning for figure preparation.

References


