

Three-Dimensional Electroanatomic Mapping-Guided Low-Voltage Bridge Ablation in Atrioventricular Nodal Reentrant Tachycardia: A Case Report

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ABSTRACT

Background: Atrioventricular nodal reentrant tachycardia (AVNRT) is a common form of regular supraventricular tachycardia, and catheter ablation targeting the slow pathway is an established treatment strategy. Three-dimensional voltage mapping of Koch's triangle may facilitate identification of the presumed slow-pathway region by demonstrating a low-voltage bridge (LVB) and may provide additional guidance for ablation target selection.

Case Summary: A 58-year-old man with a history of hypertension presented to the emergency department with palpitations. On admission, his blood pressure was 115/75 mmHg and heart rate was 180 beats/min. A 12-lead electrocardiogram demonstrated a regular narrow-QRS tachycardia, which was terminated with intravenous adenosine, restoring sinus rhythm. An electrophysiological study was subsequently performed using a two-catheter approach and the EnSite three-dimensional electroanatomic mapping system. Supraventricular tachycardia was induced and diagnosed as AVNRT based on electrophysiological findings. Three-dimensional voltage mapping of Koch's triangle demonstrated a discrete LVB in the inferior region adjacent to the coronary sinus ostium, corresponding to the presumed slow-pathway region. Radiofrequency ablation was performed targeting the LVB. Following ablation, AVNRT was no longer inducible during programmed stimulation.

Conclusion: Three-dimensional voltage mapping may allow visualization of a low-voltage bridge within Koch's triangle and provide additional guidance for slow-pathway localization during AVNRT ablation. This case demonstrates the feasibility of an EnSite-guided LVB-targeted radiofrequency ablation strategy using a two-catheter approach, with successful acute elimination of AVNRT inducibility.

Keywords

Atrioventricular nodal reentrant tachycardia, Low-voltage bridge, Three-dimensional electroanatomic mapping, slow pathway, Radiofrequency ablation, EnSite.

Introduction

Atrioventricular nodal reentrant tachycardia (AVNRT) is one of the most common forms of regular supraventricular tachycardia encountered in clinical electrophysiology. Catheter ablation

targeting the slow pathway is an established treatment strategy for symptomatic AVNRT, with high procedural success and low complication rates. Conventional slow-pathway ablation is generally guided by anatomical landmarks within the inferior portion of Koch's triangle together with characteristic local electrogram findings. However, anatomical variability and difficulties in identifying specific slow-pathway electrograms may occasionally make precise localization of the optimal ablation site challenging [1].

Three-dimensional voltage gradient mapping has been proposed as an additional strategy for visualization of the presumed slow-pathway substrate within Koch's triangle. With this approach, a low-voltage bridge (LVB) can be identified within the voltage gradient of Koch's triangle and used as an additional electrophysiological marker for selection of the ablation target [1,2]. In a prospective multicenter registry including 200 adult patients undergoing AVNRT ablation, an LVB was identified in 79.5% of patients and corresponded to the successful ablation site in 86% of cases in which it was visualized [2]. More recent technical reports have emphasized that individualized voltage settings and detailed mapping of Koch's triangle may facilitate identification of the LVB and potentially improve targeting of the slow pathway [3]. In this report, we present a 58-year-old man with AVNRT successfully treated with radiofrequency ablation targeting a low-voltage bridge identified using the EnSite three-dimensional electroanatomic mapping system.

Case Presentation

A 58-year-old man with a history of hypertension presented to the emergency department with palpitations. On admission, his blood pressure was 115/75 mmHg and heart rate was 180 beats/min. A 12-lead electrocardiogram demonstrated a regular narrow-QRS tachycardia (Figure 1). Intravenous adenosine was administered, resulting in termination of the tachycardia and restoration of sinus rhythm. Given the symptomatic supraventricular tachycardia, an electrophysiological study (EPS) and catheter ablation were planned.

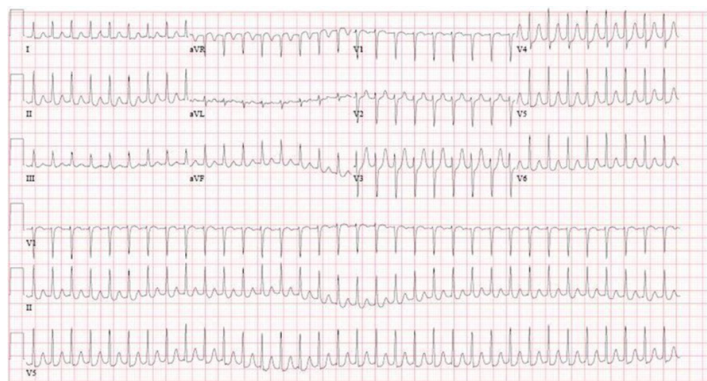


Figure 1: Twelve-lead electrocardiogram obtained at presentation demonstrating a regular narrow-QRS tachycardia.

The electrophysiological study was performed using a two-catheter approach with the EnSite three-dimensional electroanatomic mapping system (Abbott, USA) (Figure 2A). A diagnostic catheter was positioned in the coronary sinus, while a mapping/ablation catheter was used for electroanatomic mapping and radiofrequency ablation. During programmed electrophysiological stimulation, supraventricular tachycardia was induced, and the electrophysiological findings were consistent with atrioventricular nodal reentrant tachycardia (AVNRT).

Following confirmation of AVNRT, a three-dimensional voltage

map of Koch's triangle was created. Detailed voltage mapping demonstrated a discrete low-voltage bridge in the inferior region of Koch's triangle adjacent to the coronary sinus ostium, corresponding to the presumed slow-pathway region (Figure 2B). The low-voltage bridge was selected as the target for slow-pathway modification, and radiofrequency energy was delivered at this site under three-dimensional electroanatomic guidance. After ablation, programmed stimulation was repeated, and AVNRT could no longer be induced. The procedure was therefore considered acutely successful.

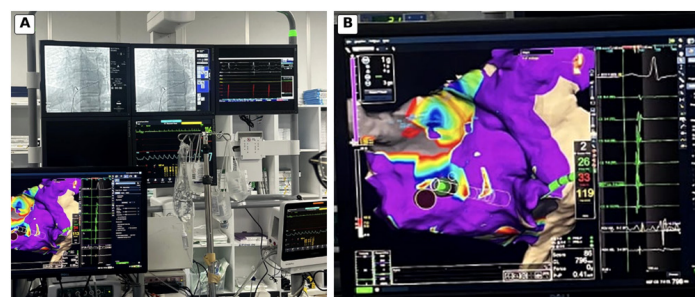


Figure 2: Intraprocedural EnSite-guided low-voltage bridge mapping and ablation. (A) Procedural view during the two-catheter electrophysiological study with simultaneous three-dimensional electroanatomic mapping and fluoroscopic monitoring. (B) Close-up of the EnSite voltage map of Koch's triangle demonstrating the mapped low-voltage bridge region adjacent to the coronary sinus ostium with the mapping/ablation catheter positioned at the target area.

Discussion

Catheter ablation of the slow pathway is an established treatment strategy for symptomatic AVNRT. Conventionally, the ablation target is selected according to anatomical landmarks within the inferior portion of Koch's triangle together with local electrogram characteristics. However, anatomical and electrophysiological variability may occasionally make precise localization of the optimal ablation site challenging. Voltage gradient mapping has therefore been proposed as an additional method for visualization of the presumed slow-pathway region [1,3].

The low-voltage bridge (LVB) represents a relatively low-voltage connection within the voltage gradient of Koch's triangle and may provide an additional marker for slow-pathway localization. Bailin et al. demonstrated that three-dimensional voltage mapping could facilitate visualization and ablation of this region [1]. In a prospective multicenter registry of 200 adult patients, Costa et al. identified an LVB in 79.5% of patients, with its location corresponding to the successful ablation site in 86% of cases in which it was visualized [2]. These findings support LVB mapping as a complementary tool for selecting the ablation target. An important technical aspect of LVB mapping is the individualized adjustment of voltage settings to delineate the voltage gradient within Koch's triangle [3]. Combining voltage mapping with additional electrophysiological information may further improve target selection [4]. Moreover, Książczyk et al. reported that

LVB-guided radiofrequency ablation was associated with fewer RF applications and shorter total RF application time compared with a conventional approach [5]. Nevertheless, LVB should not be considered diagnostic of AVNRT or an absolute surrogate for the slow pathway, as low-voltage bridges may also be observed in patients without AVNRT [6].

In the present case, EnSite-guided three-dimensional voltage mapping demonstrated a discrete LVB in the inferior portion of Koch's triangle adjacent to the coronary sinus ostium. Using a two-catheter approach, radiofrequency ablation was targeted to this region, after which AVNRT was no longer inducible. This case demonstrates the feasibility of integrating LVB visualization into a three-dimensional mapping-guided slow-pathway ablation strategy in an adult patient with AVNRT.

Conclusion

Three-dimensional voltage mapping with the EnSite system enabled visualization of a low-voltage bridge within Koch's triangle and guided targeted slow-pathway ablation in this patient with AVNRT. Following radiofrequency ablation, AVNRT was no longer inducible. LVB mapping may serve as a useful complementary strategy for identifying the ablation target during AVNRT procedures, particularly when precise slow-pathway localization is challenging.

References

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