The Use of Nonfluoroscopic Catheter-Based Mapping System to Perform Radiofrequency Ablation in Complex Ventricular Tachycardia after Cardiac Surgery in Congenital Heart Disease : A Case Report

CHARN SRIRATANASATHAVORN, M.D.*,
ONGKARN RAUNGRATANAAMPORN, M.D.*,
KOONLAWEE NADEMANEE, M.D.***,
SUPHACHAI CHAITHIRAPHAN, M.D.*
KERTIJAI BHURIPANYO, M.D.*,
RUNGROJ KRITTAYAPHONG, M.D.**,
BURIN KWO-SA-ARD, B.Sc.*,

Abstract

A nonfluoroscopic electroanatomical cardiac mapping system (CARTO) integrates anatomical and electrophysiological information to reconstruct a three-dimensional activation map. Information from the CARTO system helps to reveal the mechanism and perform successful ablation in scar re-entry ventricular tachycardia after cardiac surgery. Three-dimensional activation and propagation mapping was performed in a patient with ventricular tachycardia after surgical correction of a double outlet right ventricle. The ventricular tachycardia appeared in two morphologies and were refractory to antiarrhythmic medication including amiodarone. Both ventricular tachycardias were re-entered using the ventriculotomy scar but rotated in different directions. Successful radiofrequency ablation was performed by creating a line of conduction block from the pulmonic valve to the ventriculotomy scar using entrainment mapping and the ablation lesion tagging technique. The CARTO system is useful in mapping and guiding the ablation of complex ventricular tachycardia after surgical correction in congenital heart disease

Key word : Nonfluoroscopic Electroanatomical Cardiac Mapping System, Ventricular Tachycardia, Radiofrequency Ablation, Congenital Heart Disease

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* Her Majesty Cardiac Center,
** Division of Cardiology, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok 10700, Thailand.
*** Division of Cardiology, Department of Medicine, University of Southern California School of Medicine, LA, USA.

Ventricular tachycardia (VT) associated with surgical repair of some congenital heart diseases, such as tetralogy of Fallot and a double outlet right ventricle are commonly due to re-entry (1-7). Ablation performing with a standard fluoroscopic system would target at the slow conduction isthmus zone of the re-entry circuit.(5) However, some re-entry circuits may not have narrow isthmus zone and some isthmus zones could not be identified on the endocardium(8). To create a line of conduction block to a relatively broad endocardial region of the circuit would be difficulty with the fluoroscopic system. Three-dimensional mapping created from the CARTO™ system (Biosense, Ltd., Israel) with the tagging ablation site technique would be useful in ablating such re-entry circuits. This report demonstrated the use of the electroanatomical mapping system to perform electrophysiologic study and radiofrequency catheter ablation (RF ablation) in a patient with refractory ventricular tachycardia after surgical correction of a double outlet right ventricle.

The patient was a 15 year old male who had corrective surgery for double outlet right ventricle. Nine months after surgery he was admitted to the hospital for sustained ventricular tachycardia with the symptom of near syncope. The patient was treated with electrical cardioversion after IV lidocaine failed to convert his tachyarrhythmia. Oral amiodarone 600 mg a day was used to control his VT. However, he developed the same VT 3 months after the initiation of amiodarone and again required electrical cardioversion to restore the sinus rhythm. The patient was then referred for RF ablation of his VT.

MATERIALS AND METHOD

System Components

Detailed information of the system component have been described(9,10). The mapping and navigation system comprises a miniature passive magnetic field sensor, an external ultraflow magnetic field emitter (location pad), and a processing unit (CARTO, Biosense).

The location mapping and location reference catheters (NAVI-STAR and REF-STAR, Cordis-Webster, Baldwin Park, CA, USA) have several electrodes that record unipolar and bipolar signals.

In brief, the spatial information is obtained by magnetic fields emitting from the location pad, received by a sensor on the mapping catheter with the processing in the main unit. The electrical activation recording from the mapping catheter compared to the reference electrogram is used to create a color coded activation sequence map.

Electrophysiological studies, Catheter Mapping and Catheter Ablation

A multi-electrode catheter was introduced to the right ventricular apex *via* the right femoral vein. This catheter was used to perform programmed ventricular stimulation to induce ventricular tachycardia and bipolar recording was used as the electrical reference. A location reference catheter was placed on the patient's back at the interscapular area. A mapping catheter was introduced to the right ventricle *via* the right femoral vein. The system gated the location of the mapping catheter to a fiducial point in the cardiac cycle and recorded it in relation to the location of the fixed reference catheter. After ventricular tachycardia was induced, the mapping catheter was moved with the use of both fluoroscopic and nonfluoroscopic system to create a three-dimensional geometrical color coded map with electrophysiological information.

Radiofrequency energy was delivered between the distal electrode of the mapping catheter and a large patch electrode placed on the patient's back, from an EPT generator.

Ventricular Tachycardia mapping

Mapping was performed in the bipolar and unipolar recording modes. The timing reference was an intracardiac electrogram from the catheter placed at the right ventricular apex. Programmed ventricular stimulation was performed and easily induced ventricular tachycardia. The ventricular tachycardia had two morphologies. One form was LBBB and the inferior axis (Fig. 1) and the other one was RBBB and the inferior axis (Fig. 2).

Activation sequence mapping was performed for both forms of ventricular tachycardia. Both ventricular tachycardias originated from the ventriculostomy scar below the pulmonic valve. However, the propagation maps showed that the LBBB inferior axis VT was re-entered and rotated clockwise around the scar (Fig. 1) but the RBBB inferior axis had two loops with a common pathway in the middle. One loop rotated clockwise but the other rotated counterclockwise (Fig. 2).

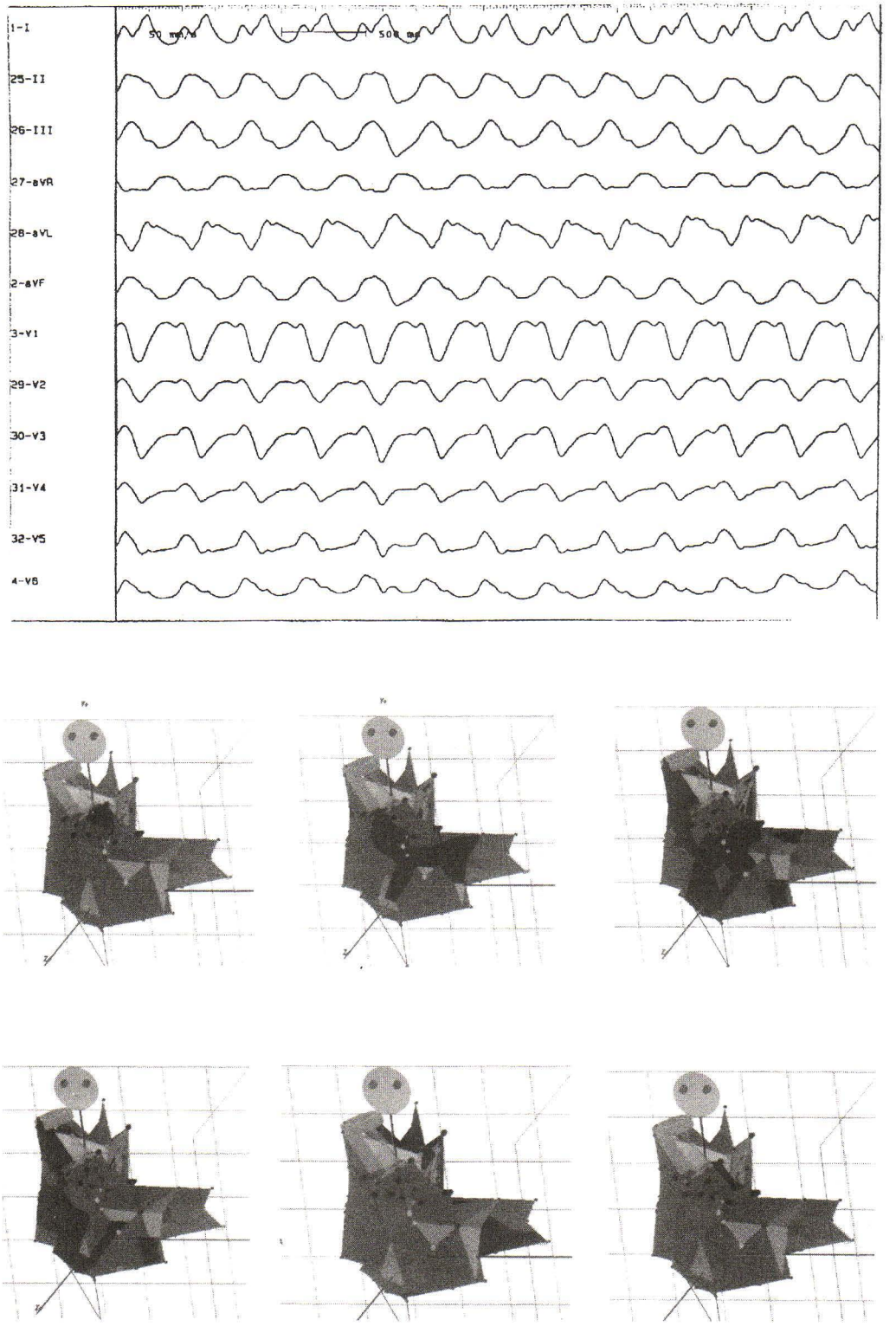

Fig. 1. The EKG showed an LBBB inferior axis. The activation map showed the activation color coded map with anatomical information. The propagation map showed the sequence of activation to be re-entry, rotated clockwise around the scar.

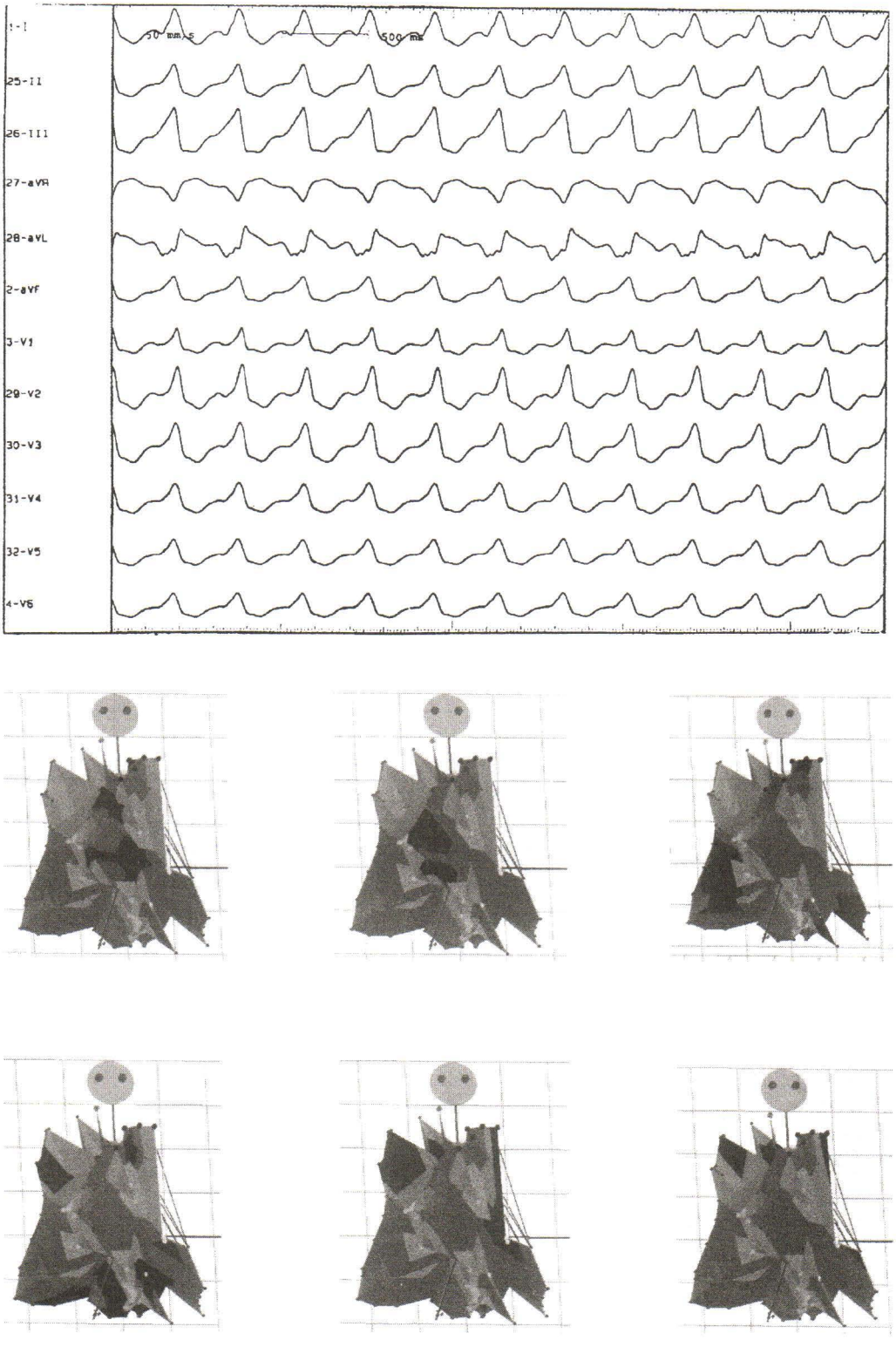

Fig. 2. The EKG showed an RBBB inferior axis VT with the activation map. The propagation map showed the sequence of activation which appeared to be two loops with the common pathway in the middle. The loop on the right side of the scar rotated clockwise and the left loop rotated counterclockwise.

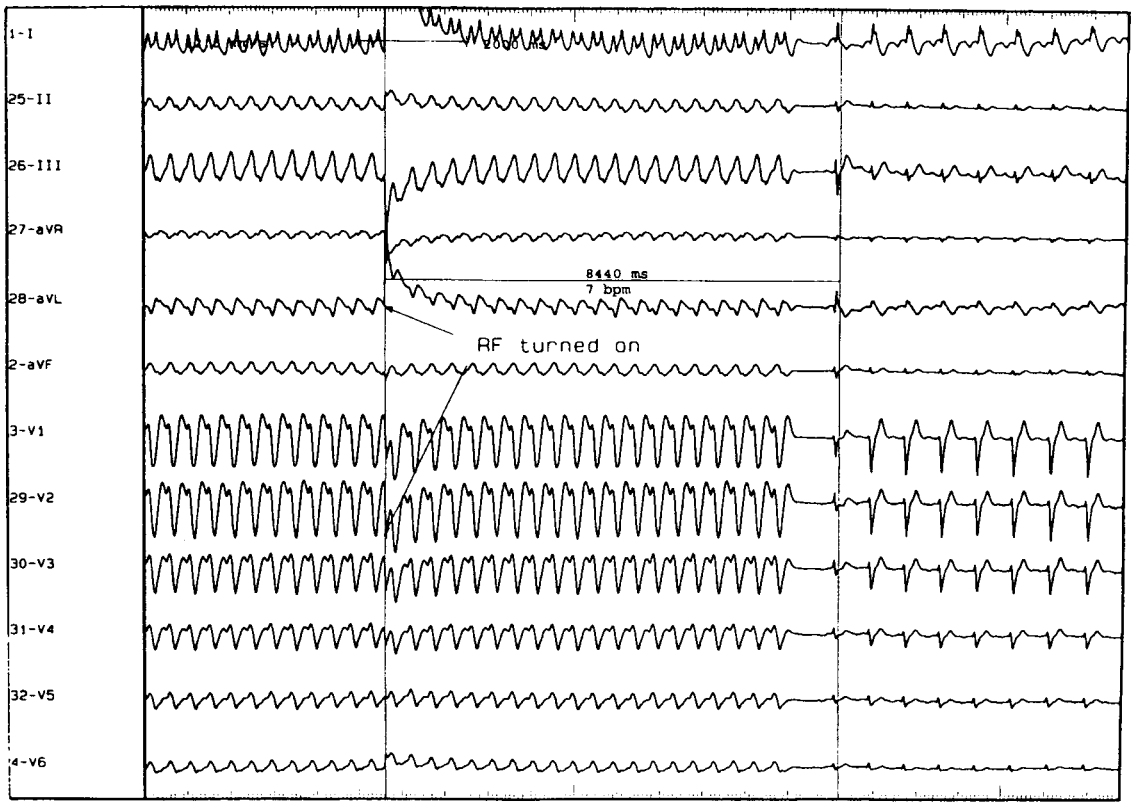

Fig. 3. The termination of ventricular tachycardia with RF ablation.

RF Ablation

Radiofrequency ablation was performed using the anatomical approach from the three-dimensional activation sequence map and the concealed entrainment technique[11]. The CARTO system allowed the ablation lesions to be tagged and created a line of complete conduction block from a series of ablation lesions. The line of conduction block was created from the pulmonic valve to the ventriculostomy scar in this patient. This required 29 RF ablation lesions. The RF ablation was performed during the LBBB inferior axis VT. The VT was terminated during RF ablation (Fig. 3). However, the ablation was continued to complete the line of conduction block. At the end of the procedure, VT was no longer induced using the aggressive programmed ventricular stimulation with isoproterenol infusion. The patient has remained free from ventricular tachycardia without any antiarrhythmic medication since his RF ablation 16 months ago.

SUMMARY

This report demonstrated the use of the CARTO electroanatomical mapping system to perform electrophysiological study and radiofrequency ablation in complex ventricular tachycardia after cardiac surgery in congenital heart disease. Both the activation sequence and propagation map helped to reveal the mechanism of ventricular tachycardia. The tagging ablation lesion technique would facilitate the creation of a line of complete conduction block, required for a successful procedure, from a series of small RF ablation in some difficult ventricular tachycardias.

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การใช้ Nonfluoroscopic Catheter – Based Mapping System ในการศึกษาและทำ Radiofrequency Ablation ในผู้ป่วยที่เกิด Ventricular Tachycardia หลังการทำผ่าตัดแก้ไขภาวะหัวใจผิดปกติแต่กำเนิด

ชาญ ศรีรัตนสถาวร, พ.บ., เกียรติชัย ภูริปัญโญ, พ.บ.*,*
องค์การ เรืองรัตนอัมพร, พ.บ., รุ่งโรจน์ กฤตยพงษ์, พ.บ.**,*
*กุลวี เนตรมณี, พ.บ.***, บุรินทร์ ขาวสอาด, วท.บ*, ศุภชัย ไชยธีระพันธ์, พ.บ.**

Nonfluoroscopic Electroanatomical Cardiac Mapping System (CARTO) เป็นระบบเครื่องมือที่ผสมผสานข้อมูลทาง cardiac anatomy และ cardiac electrophysiology โดยแสดงออกในรูป 3 มิติที่มีสีแตกต่าง บ่งบอกถึงการ activation ที่แตกต่างกันในส่วนต่าง ของหัวใจ นอกจากนี้ยังให้ข้อมูลของการกระจายกระแสไฟฟ้าในส่วนต่าง ๆ ของหัวใจ ข้อมูลจาก CARTO System ช่วยทำให้เกิดความเข้าใจในการเกิด ventricular arrhythmia ที่ซับซ้อนจากแผลเป็น หลังการผ่าตัดหัวใจ ซึ่งนำไปสู่การทำ radiofrequency ablation ที่ประสบความสำเร็จ

รายงานนี้แสดงถึงการใช้ CARTO System ในผู้ป่วยที่มี ventricular tachycardia 2 รูปแบบ หลังการผ่าตัดแก้ไขภาวะ double outlet right ventricle จากการศึกษาด้วย CARTO System พบว่า ventricular tachycardia ทั้ง 2 รูปแบบ เป็นชนิด reentry ที่วิ่งวนรอบแผลผ่าตัดแต่ในทิศทางที่แตกต่างกัน การทำ radiofrequency ablation ด้วย ablation tagging technique จาก CARTO System ทำให้เกิด conduction block ระหว่าง pulmonic valve และแผลเป็นจากการผ่าตัด ช่วยกำจัด ventricular tachycardia ทั้ง 2 รูปแบบได้

คำสำคัญ : Nonfluoroscopic Electroanatomical Cardiac Mapping System

ชาญ ศรีรัตนสถาวร, เกียรติชัย ภูริปัญโญ, องค์การ เรืองรัตนอัมพร, และคณะ
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* สำนักงานศูนย์โรคหัวใจสมเด็จพระบรมราชินีนาถ,
** สาขาหทัยวิทยา, ภาควิชาอายุรศาสตร์, คณะแพทยศาสตร์ศิริราชพยาบาล, มหาวิทยาลัยมหิดล, กรุงเทพ ฯ 10700
*** Division of Cardiology, Department of Medicine, University of Southern California School of Medicine, LA, USA