



Principles and Techniques of the Three-Dimensional Electroanatomic Cardiac Mapping Approach in the Treatment of Intractable Atrial Macroreentrant Tachycardia Ablations

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ABSTRACT

Introduction: Challenging and intractable macroreentrant atrial tachycardias mostly occur after cardiac surgeries, and the response of such arrhythmias to conventional treatments is poor. Also, arrhythmias with previous unsuccessful ablations are compulsive arrhythmias. This study represents our approach for the ablation of challenging atrial macroreentrant tachycardias.

Patients and Methods: Five consecutive patients with atrial flutter and a previous history of cardiac surgery and/or radiofrequency ablation were enrolled to this study. The focal point of the clinical arrhythmia was defined in the CARTO® and Columbus™ map and the critical isthmus was targeted for ablation. Radiofrequency ablation was performed until the arrhythmia stopped or until a change in cycle length or activation wave front was seen.

Results: All the complex atrial macroreentrant tachycardias were ablated from the right atrium. Overall, all the cases were successfully mapped and ablated. None of the patients had recurrence even after 6 months of follow-up. The mean (\pm SD) procedure time was 49.0 ± 22.4 min. Three-dimensional electroanatomic cardiac mapping technologies, including CARTO and Columbus™, are highly effective in revealing atrial arrhythmias and facilitating ablation of the scar-related potential circuits.

Conclusion: This study highlights success and usefulness of three-dimensional electroanatomic cardiac mapping in complex atrial macroreentrant tachycardia ablations.

Key Words: Cardiac mapping; three-dimensional technology; complex atrial macroreentrant tachycardias

Üç Boyutlu Elektroanatomik Kardiyak Haritalama ile Zor ve Tedaviye Dirençli Atriyal Makroreentran Taşikardi Ablasyonlarına Yaklaşım Prensipleri ve Teknikleri

ÖZET

Giriş: Zorlu ve dirençli makroreentran atriyal taşikardiler çoğunlukla kardiyak cerrahi sonrası oluşur ve konvansiyonel tedaviye verdikleri yanıt zayıftır. Ayrıca, daha önceden başarısız ablasyon geçiren hastaların tedaviye yanıtları daha dirençlidir. Bu çalışma ile zorlu atriyal makroreentran taşikardilere yaklaşımımızı paylaştık.

Hastalar ve Yöntem: Daha önceden kardiyak cerrahi geçiren ve/veya radyofrekans ablasyon geçirmiş olan 5 atrial flutter hastası çalışmaya dahil edildi. Klinik olarak izlenen aritmi odağı CARTO® ve Columbus™ haritalama yöntemi ile istmus işaretlenerek belirlendi. Aritmi sonlanana kadar veya siküs uzunluğunda veya aktivasyon dalga boyunda değişiklik elde edilene kadar radyofrekans enerji uygulandı.

Bulgular: Tüm kompleks atriyal makroreentran taşikardiler sağ atriyumdan orjin alıyordu. Tüm olgular başarılı bir şekilde haritalandı ve ablasyon işlemi uygulandı. Başarılı ablasyon uygulanan hastalarda 6 aylık takip süresince rekürrens izlenmedi. Ortalama işlem süresi (\pm SS) 49.0 ± 22.4 dakikadır. Atriyumda CARTO ve Columbus™ üç boyutlu elektroanatomik kardiyak haritalama teknolojileri kullanılarak tüm potansiyel devrelerin başarılı ablasyonu skar ilişkili makroreentran atriyal taşikardilerin ablasyonunda yüksek oranda etkili bir yöntemdir.

Sonuç: Bu çalışma, kompleks makroreentran atriyal taşikardilerin ablasyonunda, üç boyutlu elektroanatomik kardiyak haritalamanın başarısını ve kullanılabilirliğini vurgulamaktadır.

Anahtar Kelimeler: Kardiyak haritalama; üç boyutlu teknoloji; kompleks atriyal makroreentran taşikardiler

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INTRODUCTION

Cardiac electrophysiology has made a remarkable progress during the recent years in revealing complex atrial arrhythmias and facilitating ablation of the scar-related potential circuit. Electrophysiologic studies and radiofrequency ablations have been developed to treat several types of tachyarrhythmias. More complex rhythm disturbances gradually complicated cases to define ablation side. The complex and challenging macroreentrant atrial tachycardia is common after surgeries for atrial and ventricular septal defects, as well as Fontan, Mustard, Senning procedures^(1,2). Following to an ablation procedure, second procedures are usually getting more challenging. Conventional radiofrequency catheter ablation of these intractable arrhythmias is difficult and is associated with prolonged procedure times, prolonged fluoroscopic times, and high recurrence rates⁽³⁾. Currently, advanced three-dimensional electroanatomic cardiac mapping systems such as CARTO (Biosense, Diamond Bar, CA, USA), EnSite NavX (St. Jude Medical, Saint Paul, MN, USA), and Columbus™ (Shanghai MicroPort EP Medtech. CO. Ltd), which have the ability of advanced signal recording, represent critical information simultaneously during ablation procedures, and reduce the fluoroscopic time and radiation dosage, have been widely used in catheter ablation of cardiac arrhythmias⁽⁴⁾. Additionally, real-time view of catheters facilitate the procedure and enhance the success rates. These systems reconstruct the cardiac anatomy and demonstrate the ablation territory with a low margin of error. In this study, we represent our approach for the ablation of complex atrial macroreentrant tachycardias.

PATIENTS and METHODS

Five consecutive patients (3 men, 2 women) with mean age of 48 years old with atrial flutter and a previous history of cardiac surgery and/or radiofrequency ablation were submitted to an electrophysiologic study. All patients received anticoagulation with warfarin sodium to maintain an international normalized ratio (INR) between 2 and 3 for at least 3 weeks before the procedure. They also received antiarrhythmic drugs to control the ventricular rate. Antiarrhythmic drugs were stopped 5 days before the procedure. Informed consent for inclusion to the study was obtained from all the patients. The investigation conforms to the principles outlined in the Declaration of Helsinki. Three femoral venous punctures were done and three sheaths were placed in the femoral vein. A decapolar catheter was placed in the coronary sinus. A quadripolar catheter was positioned in the right atrium or His, and an irrigated-tip catheter was used for mapping and ablation. Previously, a bolus of 2500 IU of heparin was administered intravenously. Firstly, assessment of the arrhythmia was started from setting the cycle length and activation wave front. Catheter was introduced into the cavo-tricuspid isthmus, proximal coronary sinus, low and high lateral walls to determine the possible origin of arrhythmia. An activation/voltage map was gained and scar tissue was described with the smallest local potential, which could not be differentiated from the noise. The circuit of the clinical arrhythmia was defined in the CARTO® and Columbus™ map and the critical isthmus targeted for ablation (Figure 1A,1B). Radiofrequency energy was applied until the arrhythmia stopped or until a change in cycle length or activation wave front were observed. Patient information, including age,

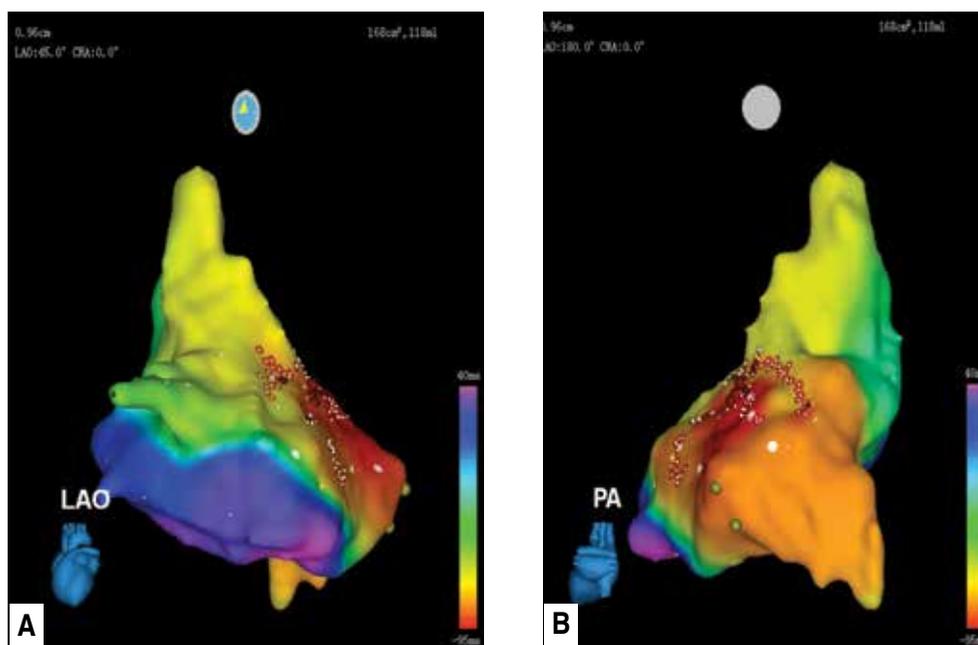


Figure 1(A,B). The circuit of the clinical arrhythmia was defined in the Columbus™ map and the critical isthmus (around the atrial septal defect patch) targeted for ablation.

Table 1. Patient age, sex, processing time, echocardiographic, and laboratory findings

Age (years)	57.4 ± 7.6
Ejection fraction (%)	58.40 ± 2.30
Left atrium diameter (cm)	4.40 ± 0.18
Creatinine (mg/dL)	0.86 ± 0.15
Sodium (mmol/L)	141.80 ± 1.30
Potassium (mmol/L)	4.55 ± 0.38
Thyroid stimulating hormone (uIU/mL)	2.24 ± 1.61
Hemoglobin (mg/dL)	13.70 ± 0.88
Processing time (min)	49.0 ± 22.4

sex, processing time, echocardiographic and laboratory findings, was collected. Transthoracic echocardiographic evaluation was performed before ablation procedure. SPSS 13.0 (IBM, Armonk, NY) was used for performing statistics analyses. All the values were determined as mean ± standard deviation.

RESULTS

Five consecutive patients (3 men, 2 women) with a mean age (±SD) of 57.4 ± 7.6 years (median: 58, range: 44-68) who fulfilled the inclusion criteria underwent radiofrequency ablation (Table 1). The study patients had a mean (±SD) ejection fraction of 58.40% ± 2.30, with left atrial diameters of 4.40 ± 0.18 mm. Each of the five patients were successfully mapped and also all of them (100%) were terminated during radiofrequency ablation. All of the cases were revealed macroreentry. The mean (±SD) procedure time was 49.0 ± 22.4 minutes. There were no complications during the procedure and until discharge. At the 6-months follow-up, all of the five patients were free of atrial flutter recurrences.

DISCUSSION

Congenital cardiac operations augment arrhythmia rates, particularly atrial macroreentrant arrhythmias. Atrial septal defect closure operations, induced arrhythmias especially generating from atypical origins. Considering to studies, atrial arrhythmias seen in preoperative period was nearly 20%, however the incidence of arrhythmias increased up to 60% in postoperative period⁽²⁾. Among the electrophysiologic sequelae of corrective surgery for congenital heart disease, there are a number of delivery lines favoring reentrant arrhythmias, which associated with recurrence and fibrosis. Radiofrequency catheter ablation trials, that performed to patients who underwent cardiac surgery or had an unsuccessful radiofrequency ablation experience, are challenging and associated with prolonged procedure times which bring high radiation doses with longer fluoroscopy times and high rates recurrences⁽⁵⁾. Recently used cardiac mapping systems provide the association of intracardiac electrical activity with anatomic origin of arrhythmia with high accuracy⁽⁶⁾.

Three-dimensional view of cardiac anatomy, determining certain points of ablation area and landmarks, manipulation of catheters without necessity of fluoroscopic are improving procedural performances and rising success rates particularly in intractable arrhythmias with unusual anatomic varieties. The use of advanced electroanatomic mapping systems significantly reduce the recurrence rates and antiarrhythmic drug treatment requirements after complex and intractable arrhythmia ablations. Atypical atrial flutter, atrial fibrillation, and ventricular tachycardias are mostly associated with ischemic etiology, structural heart disease. Electroanatomical mapping systems facilitate complete treatment of intractable rhythm disturbances and are associated with a high success rate⁽⁷⁾.

CONCLUSION

Medical management of complex atrial macroreentrant tachycardias are often unsuccessful and therefore require invasive procedures. Electroanatomic cardiac mapping may be an advantage in the treatment of complex atrial tachycardias.

CONFLICT of INTEREST

The authors reported no conflict of interest related to this article.

AUTHORSHIP CONTRIBUTIONS

Concept/Design: DO, MY

Analysis/Interpretation: GM, MY

Data Acquisition: GM

Writing: GM, DO, MY

Critical Revision: MY, DO

Final Approval: All of authors

REFERENCES

- Garson A Jr, Bink-Boelkens M, Hesslein PS, Hordof AJ, Keane JF, Neches WH, et al. Atrial flutter in the young: a collaborative study of 380 cases. *J Am Coll Cardiol* 1985;6:871-8.
- Gatzoulis M, Freeman M, Siu S, Webb GD, Harris L. Atrial arrhythmia after surgical closure of atrial septal defects in adults. *N Engl J Med* 1999;340:839-46.
- Kalman JM, VanHare GF, Olgin JE, Saxon LA, Stark SI, Lesh MD. Ablation of "incisional" re-entrant atrial tachycardia complicating surgery for congenital heart disease: use of entrainment to define a critical isthmus of conduction. *Circulation* 1996;93:502-12.
- Ueda A, Suman-Horduna I, Mantziari L, Gujic M, Marchese P, Ho SY, et al. Contemporary outcomes of supraventricular tachycardia ablation in congenital heart disease: a single-center experience in 116 patients. *Circ Arrhythm Electrophysiol* 2013;6:606-13.
- Gokdeniz T, Aykan AC, Yildiz M, Celik S. Transvenous radiofrequency ablation therapy in the treatment of arrhythmias: A single center experience. *Kosuyolu Kalp Derg* 2013;16:36-41.
- Drago F, Russo MS, Marazzi R, Salerno-Uriarte JA, Silvetti MS, De Ponti R. Atrial tachycardias in patients with congenital heart disease: a minimally invasive simplified approach in the use of three-dimensional electroanatomic mapping. *Europace* 2011;13:689-95.
- Bhakta D, Miller JM. Principles of electroanatomic mapping. *Indian Pacing Electrophysiol J* 2008;8:32-50.