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Remote Magnetic Navigation System Guided Radiofrequency Ablation of Intra Atrial Reentrant Tachycardia in Corrected Transposition of Great Arteries

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Abstract

Atrial arrhythmias are delayed manifestations after atrial switch procedures for d-transposition of the great arteries. Often times, these arrhythmias are intraatrial reentry tachycardias that arise in the pulmonary venous neo-atrium. Access and ablation in the pulmonary venous neo-atrium may require baffle puncture, risking damage to the baffle. We describe a case of neoatrial arrhythmia ablation in d-transposition of the great arteries using remote magnetic guided catheter navigation system using a retrograde approach without doing a baffle puncture.

Keywords: d-Transposition of Great Arteries, Atrial arrhythmia, magnetic navigation, ablation.

Introduction

Atrial arrhythmia is a common, late complication after atrial switch (Mustard or Senning) procedures for d-transposition of the great arteries (d-TGA). Atrial switch involves excision of the atrial septum. A baffle directs caval vein flow to the mitral valve and subpulmonary left ventricle. Pulmonary vein flow passes posterior to the baffle to the tricuspid valve and systemic right ventricle. Ablation in the pulmonary venous neo-atrium (PVA) has required baffle puncture, risking possible damage to the baffle, embolization of debris, and a persistent intracardiac shunt. Retrograde approach to the tricuspid isthmus in Mustard patients has been accomplished with conventional catheters in experienced hands.¹⁻³ However, it could be difficult to maneuver a conventional catheter in the Neo-Left Atrium (LA). Remote magnetic navigation system improves the ability to navigate, and therefore shortens procedure and fluoroscopy time.

Case Report

A 30 year old female with d-TGA post Mustard procedure presented with a 2-year history of episodic palpitations requiring electrical cardioversion on 5 occasions. ECGs showed a narrow complex tachycardia with distinct P waves and variable AV conduction. Atrial cycle length ranged

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Figure 1A: 12 lead surface electrocardiogram showing intra atrial reentry tachycardia



from 230-320ms with negative P waves in inferior leads and V1, positive P waves in I & aVL indicative of possible cavo-tricuspid isthmus dependent tachycardia (Figure 1A). Calcium channel and beta receptor blockers were avoided due to sinus node dysfunction. Disopyramide and dofetilide were not effective and ablation was recommended. It was expected that the access to the cavotricuspid isthmus could be difficult as the right atrium was reconstructed.

Operative report from 1979 was reviewed. A Dacron baffle and pericardial patch was used to perform the Mustard procedure (Figure-1B). A 64 slice CT scan of the heart showed a baffle directing the SVC and IVC into the left atrium to the mitral

Figure 1B: Line diagram of the creation of the Mustard Surgery and the creation of the baffle to create the neo atria to divert the systemic and venous returns appropriately



valve (Figure-2A). The pulmonary veins were directed to the right atrium leading to the tricuspid valve, systemic RV, and aorta. Mild tapering was noted at the SVC/RA junction. Transthoracic echocardiogram showed no baffle obstruction and no increase in Doppler velocity.

Procedural Details

Four femoral venous sheaths and one arterial sheath were placed and patient was anticoagulated for retrograde approach. A catheter was placed through the baffle (the inferior horn of the systemic venous neo-atrium), via the IVC, into the systemic venous neo-atrium (SVA) that drains into the sub-pulmonary LV and a second catheter was advanced into the LV apex. Intracardiac echo was used to assess the anatomy of the heart and the baffle and the switched great vessels and dilated hypertrophied subaortic RV were noted. Baffle cine angiography was performed to outline the

Figure 2A: 64 slice CT scan of the heart showing a baffle directing the SVC and IVC into the left atrium to the mitral valve



chambers on the systemic venous side (Figure-2B). The tachycardia was reproducibly induced and sustained with atrial burst pacing at 250ms and 3-D intra-cardiac mapping performed. The systemic venous neo-atrium (SVA) was mapped with a 3.5mm Biosense-Webster Thermocool catheter (Biosense Webster, Inc., CA, USA) via the IVC, accounting for only half of the tachycardia circuit. The PVA was mapped using remote magnetic navigation system technology via a retrograde approach (femoral artery to RV to PVA) (Figure-

Case Report

Figure 2B: Baffle cine angiography outlining the chambers on the systemic venous side



3A). The rest of the circuit was identified. The two maps were merged, demonstrating cavo-tricuspid isthmus (CTI)-dependent flutter. The CTI extended from the PVA to the SVA. The arrhythmia circuit was confirmed with pace mapping and entrainment mapping. Ablation was performed on both sides of the baffle (Figure-3B). A Navistar RMT catheter (Biosense-Webster, Inc., CA, USA) was used to ablate from the tricuspid annulus to the baffle (PVA). A Navistar ThermoCool catheter was used to ablate from the baffle to the IVC (SVA). The tachycardia terminated during ablation as the lesions sets met towards the wall of the

Figure 3A: Right anterior oblique fluoroscopic view of the catheters with the remote magnetic navigation system RMT ablation catheter in the neo-left atrium and the Thermocool Navistar Catheter in the neo-right atrium on either side of the baffle



Figure 3B: The 3-dimentional activation map of the tachycardia circuit distributed on either side of the baffle suggesting the critical isthmus is distributed between the two neo-atria and tachycardia terminated as the lesions sets meet towards the wall of the baffle



baffle on both sides and was no longer inducible. The CARTO images of the merged activation maps and the ablation lesions are shown in Figure 4A and 4B.

Discussion

TGA is the most common form of cyanotic congenital heart disease and late complications of atrial repair include right ventricular dysfunction, tricuspid dysfunction, baffle-related prob-

Figure 4A: CARTO image of the merged activation maps of the tachycardia and ablation lesions in the right anterior oblique projection



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Figure 4B: CARTO image of the merged activation maps of the tachycardia and ablation lesions in the left anterior oblique projection



lems, and rhythm disturbances .⁴ It is intuitive that the atrial switch surgery has a higher risk of atrial tachycardia compared to arterial switch, the latter leaving no atrial scars. A large number of patients have survived to their adulthood, and are expected to have more atrial tachyarrhythmias as their ages increase.⁶ Intraatrial reentry tachycardias (IART) have been reported in 10-20% of patients at 10 years after Mustard and Senning operations and are often poorly tolerated. Ablation therapy in these patients has success rate of 70 – 80%.³

It is important to rule out baffle obstruction or RV failure as a cause of arrhythmia and understand the anatomy before considering RF ablation. Ablation of the IART in repaired congenital heart disease is mostly limited by proper access to the target chamber due to occlusion of vessels or abnormal vascular anatomy.⁵ The complicated anatomy and lack of proper tools that can facilitate catheter entry and manipulation to the target sites limits success rates and operator's ability to successfully ablate these arrhythmias, which have significant morbidity for these patients. Ablation in the PVA is usually needed and has required baffle puncture, risking damage to the baffle and a persistent intra-cardiac shunt. Although, baffle punctures have been demonstrated to have been done safely, the possibility of persistent shunt and systemic embolization always remains. Remote magnetic guided navigation systems make

catheter manipulation in these complicated repaired chambers much amenable and help reach the target site more precisely and predictably. In our case we avoided baffle puncture by using a retrograde approach with remote magnetic technology and were able to successfully identify and ablate the second half of the tachycardia circuit.

Conclusions

Remote magnetic guided catheter navigation systems aid greatly in reaching the target chambers with greater precision and ease. In patients undergoing repair procedures for d-TGA malformations, manual ablation without the use of remote magnetic navigation system would be very difficult and in some cases can be impossible due to the unusual configuration of the cardiac chambers after surgery. Complications like trans-baffle punctures could be avoided by using remote magnetic navigation system to ablate the tachycardia circuits which without the use of this technology could have been difficult to approach.

Disclosures

No disclosures relevant to this article were made by the authors.

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