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Very long-term outcome of catheter ablation of post-incisional atrial tachycardia: Role of incisional and non-incisional scar

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ABSTRACT

Background: The arrhythmogenicity of right atrial (RA) incisional scar after cardiac surgery could result in atrial tachycardia (AT). Radiofrequency catheter ablation is effective in the treatment of such tachycardia. However, data regarding long-term outcomes are limited.
Methods and results: A total of 105 patients with prior RA incision who underwent radiofrequency catheter ablation of AT were included. In the first procedure, electroanatomic mapping (EAM) revealed a total of 139 ATs in 105 patients, including 88 cavotricuspid isthmus dependent atrial flutters (IDAFs), 5 mitral annulus reentrant tachycardias (MARTs), 44 intra-atrial reentrant tachycardias (IARTs) and 2 focal ATs (FATs). AT was successfully eliminated in 101 (96.1%) patients. During a mean follow-up period of 90 ± 36 months, recurrent AT was observed in 23 patients and 21 underwent a second ablation. A total of 23 ATs were identified in redo procedures including 4 IDAFs, 2 MARTs, 12 IARTs and 5 FATs. The time to recurrence was significantly different among various AT types. Acute success was achieved in 20 of 23 redo procedures. Taking a total of 21 patients presenting atrial fibrillation during follow-up into account, 85 patients (81.9%) were in sinus rhythm. No complications except for a case of RA compartmentation occurred.
Conclusion: RA incisional scar played an essential role in promoting both IDAF and IART, while non-incisional scar contributed to a substantial rate of late recurrent AT in forms of both macroreentry and small reentry. Catheter ablation using EAM system resulted in a high success rate during long-term follow-up.

1. Introduction

For most cardiac surgeries, the right atrial (RA) incision is frequently required to achieve access to heart chambers. Patients with simple congenital heart diseases (CHD) or acquired heart diseases (AHD) frequently exhibit atrial tachycardias (ATs) late after atriotomy, which are mostly associated with the arrhythmogenicity of incisional scars, along with prosthetic materials, atrial dilation and fibrosis [1–6]. Post-incisional ATs with fast ventricular response are usually responsible for hemodynamic deterioration, increased risk of thromboembolism and may lead to cardiac death [7–8]. The effectiveness of antiarrhythmic drugs (AADs) is very limited [1–2,9]. Catheter ablation is considered as a curative treatment for this set of arrhythmias. Advancements including irrigated radiofrequency catheter with 3-D electroanatomic mapping (EAM) techniques further facilitate this therapy, which is reported in numerous publications with high acute success rate [6,10–13]. However, data regarding long-term outcomes are very limited [14–19]. There is also a lack of information about recurrent atrial tachycardia and atrial fibrillation (AF) after very long-term follow-up in this set of patients.

The aim of this study is therefore to evaluate the long-term result of ablative therapy for post-incisional AT, and to investigate characteristics of AT recurrence and AF.

2. Methods

2.1. Study population

Among 137 consecutive patients with prior cardiac surgery who underwent catheter ablation for drug-refractory AT from 2002 to 2012, 17 patients had prior ablation procedure in other centers, 3 patients had more than one surgical procedures, 3 patients had complex surgical correction of CHD (1 Fontan procedure, 1 Mustard procedure and 1 Glenn procedure), 9 patients had coronary artery bypass grafting and the rest 105 patients with prior cardiac surgery involving a single right atrial incision consisted the study cohort.

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Surgical history was obtained in all patients. Clinical evaluation with electrocardiogram (ECG), echocardiography and lab tests was conducted for each patient. Patients with persistent AT underwent transesophageal echocardiography to exclude the presence of atrial thrombus.

2.2. Electrophysiological study and electroanatomic mapping

Class I and III AADs were withheld for at least five half-lives prior to the procedure. The procedure was approved by institutional review committee on human research at Fuwai Hospital and written informed consents were obtained from each patient. Electroanatomical mapping (EAM) was performed using the CARTO system (Biosense Webster Inc., Diamond Bar, CA, USA) for all patients. For each patient, a decapolar catheter was inserted into coronary sinus (CS) with whose stable bipolar electrograms served as a temporal reference, and a deflectable duodecapolar mapping catheter (Halo™, Biosense Webster Inc.) was always placed along the tricuspid annular (TA) with the distal poles positioned at 7 o'clock of TA in left anterior oblique view. A 3.5 mm irrigated-tip Thermocool Navistar catheter (Biosense Webster Inc.) was used for mapping and ablation. If AT was not present at the beginning of the procedure, programmed atrial pacing and burst atrial pacing, with intravenous isoproterenol when necessary, was applied to induce clinical AT. Activation map was constructed to define the nature of AT with surgical scar, which represented a line with fractionated signals and double potentials and low amplitude tagged on it (Fig. 1). Local activation time was determined with the combination of unipolar and bipolar electrogram. Scar tissue was identified when atrial potential signal presented amplitude <0.1 mV [20]. The location of incision was identified by a line of double potentials indicative of conduction block. Entrainment mapping at multiple sites was then performed to confirm the mechanism and to demonstrate the critical isthmus of AT, with methods previously described [21–22].

2.3. Classification of AT

Four different types of AT were distinguished according to activation mapping and entrainment mapping: (1) cavotricuspid isthmus (CTI) dependent atrial flutter (IDAF): a counterclockwise or clockwise CTI-dependent macro-reentrant tachycardia or lower loop reentry, (2) mitral annulus reentrant tachycardia (MART): a counter clockwise or clockwise macro-reentrant circuit along the mitral annulus (MA), (3) intra-atrial reentrant atrial tachycardia (IART): a macro-reentrant tachycardia involving incisions, prosthetic materials or non-incisional scar tissue, (4) focal AT or small reentry tachycardia (FAT): electric activation originating from a small region with centrifugal activation pattern shown on activation map. If tachycardia was amenable to entrainment, repeatedly induced by programmed pacing and exhibited fragmented potentials spanning over 40% of tachycardia cycle length (TCL), it would be classified as small reentry, otherwise non-reentrant FAT. Dual-loop reentry was identified when 2 loops, each meeting the requirement of reentrant circuit, were simultaneously documented, or ablation at one circuit resulted in sudden transformation to another circuit, which shared a common isthmus with the previous one [23].

2.4. Ablation

A Thermocool Navistar catheter was applied to deliver radiofrequency energy with temperature limited to 43–45 °C, power to 30–40 W and saline flow of 17–20 mL/min. For FAT or small reentry, the site of earliest atrial activation or fragmented potential with longest duration was targeted for ablation. In the presence of IART, a linear lesion connecting the scar to an anatomical barrier was created to eliminate critical isthmuses. For MART, an anterolateral line or posterior line, as described by previous report, was created [24]. If endocardial ablation failed, epicardial ablation was performed in the CS with power limited to 20 W to completely block the MA isthmus line. IDAF ablation was performed with an ablation line connecting TA with inferior vena cava (IVC). CTI linear ablation was also performed in case of an incisional scar to IVC line was created, despite the absence of clinical documentation or inducibility of IDAF.

The conduction block of CTI and MA isthmus ablation lines was validated with pacing manoeuvers as previously described [25–26]. The completeness of other ablation lines was evaluated with differential pacing.

The endpoints were as follows: (1) termination of AT during radiofrequency energy delivering, (2) absence of inducibility of any atrial arrhythmia at the end of procedure and (3) demonstration of onduction block of each ablation line.

If termination of tachycardia could not be achieved during procedure, direct current cardioversion was performed. And

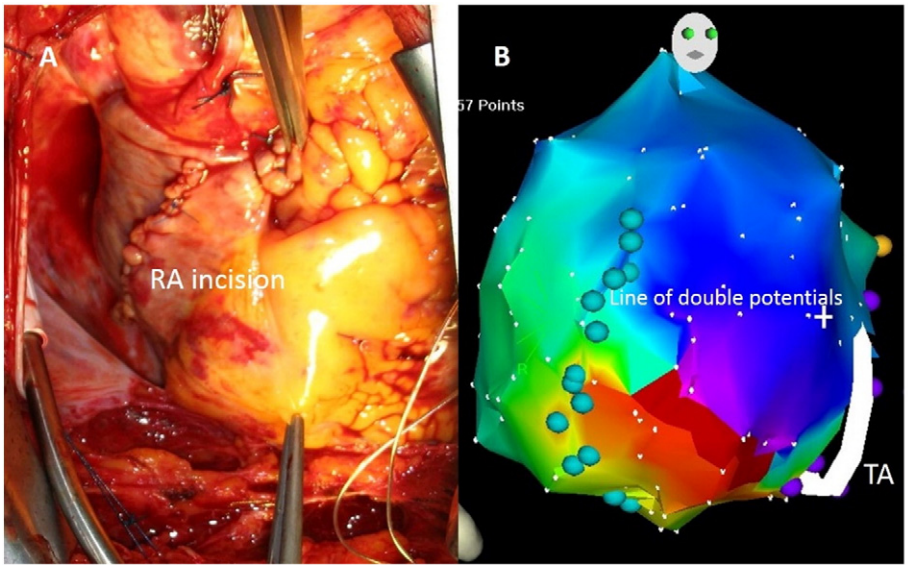

Fig. 1. A: RA incision extending from the posterior aspect of right atrial appendage down towards the inferior vena cava parallel to the atrioventricular groove sewed after surgical closure of ASD. B: Line of double potentials tagged by blue dots indicating conduction block across the incisional scar in a patient with counterclockwise atrial flutter. RA = right atrium; ASD = atrial septal defect; TA = tricuspid annulus.