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Original Article

# Elongated ascending aorta predicts a short distance between his-bundle potential recording site and coronary sinus ostium ☆

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STRUCTURED ABSTRACT

*Background:* When performing catheter ablation of atrioventricular nodal reentrant tachycardia (AVNRT), it can be difficult to maintain a safe distance from the His recording site to avoid AV block in patients with a short distance between this recording site to the coronary sinus (CS) ostium (small triangle of Koch [TOK]). In this study, we sought to identify parameters predicting small TOK and test these parameters in patients undergoing AVNRT catheter ablation.

*Methods:* Twenty-eight patients who underwent catheter ablation of atrial fibrillation using a three-dimensional (3D) electroanatomical mapping system (EAM) with computed tomography (CT) merge (23 males; mean age, 65.8 ± 12.1 years) were included. The shortest distance between the CS ostium and His recording sites (His-CSd) was measured on the EAM. Aortic (Ao) unfolding in chest X-ray scan, Ao angle to the LV, Ao length, Ao to the right ventricular distance, size of the Valsalva in the CT scan, and parameters of echocardiogram were evaluated. The identified parameters were subsequently tested as predictors for small TOK in patients undergoing AVNRT ablation.

*Results:* The size of TOK was associated with Ao length ($r = -0.70$, $p < 0.01$), left ventricular end-systolic dimension (LVDs) ($r = -0.51$, $p < 0.01$), and Ao unfolding. In patients with AVNRT, only Ao unfolding predicted a smaller TOK.

*Conclusions:* Small TOK was associated with longer Ao, larger LVDs, and Ao unfolding. Of these, Ao unfolding was associated with smaller TOK in patients with AVNRT.



## 1. Introduction

Catheter ablation of atrioventricular nodal reentrant tachycardia (AVNRT) is a highly successful treatment based on targeting the slow pathway [1,2]. To reduce the risk of AV block, radiofrequency applications are usually made below the level of the coronary sinus (CS) roof. The AV node is located at the base of the right atrial septum, at the apex of Koch's triangle (TOK). TOK is bordered anteriorly by the insertion of the septal leaflet of the tricuspid valve and posteriorly by the fibrous tendon of Todaro. In the pediatric population, TOK dimensions are best predicted by body surface area [3,4] or age [5], but these parameters are not useful in adults [6]. A short distance from the His recording site to the ostium of CS (His-CSd) is often encountered in elderly patients. Therefore, we sought to identify variables associated with small TOK using echocardiogram, chest X-ray scanning, and chest computed tomography (CT), and subsequently validate these variables in patients undergoing catheter ablation of AVNRT.

## 2. Materials and methods

### 2.1. Step 1: Identification of parameters

Consecutive patients who underwent catheter ablation of atrial fibrillation or structural heart-related ventricular tachycardia using a three-dimensional (3D) electroanatomical mapping system (EAM) with a pre-procedure cardiac CT for image integration and transthoracic echocardiography from December 2013 to April 2014

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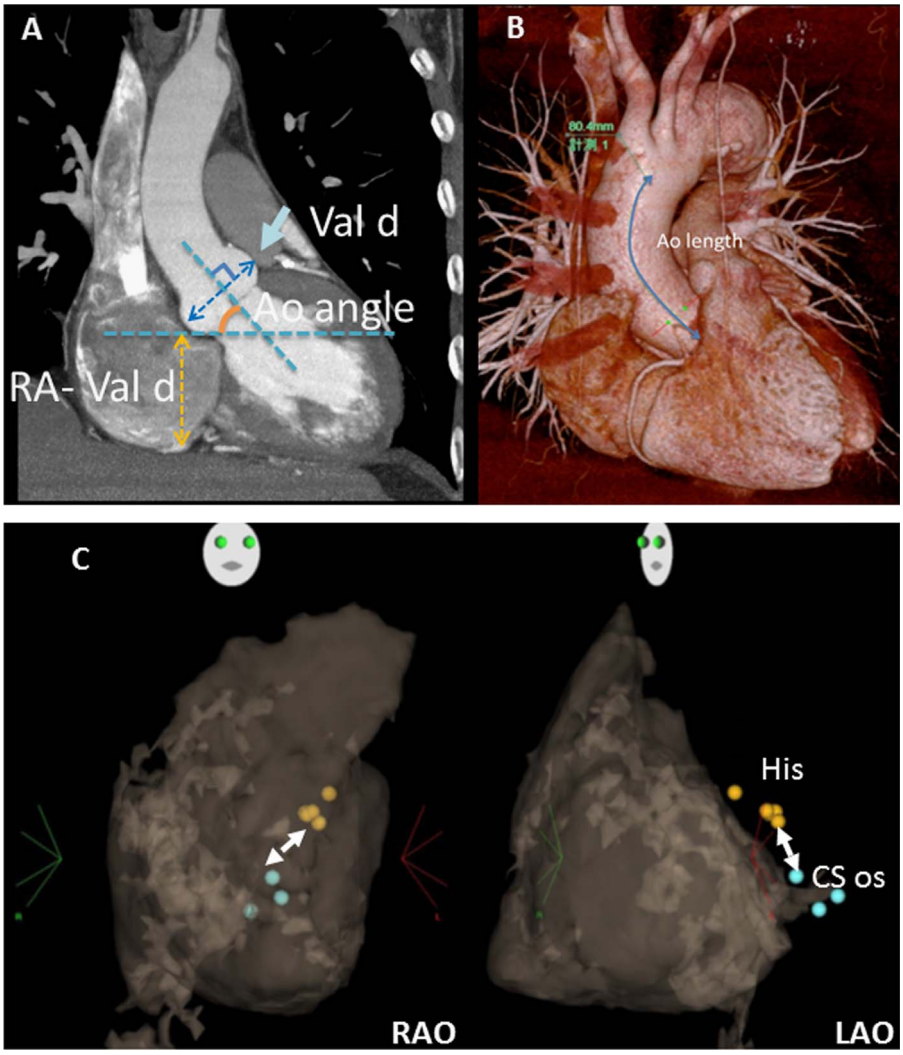


**Fig. 1.** Computed tomography measurements and measurements on the electroanatomical mapping system. (A) The Ao angle is the ascending aorta angle to the horizontal line. RA-Val d is the distance of the lowest point of the sinus of Valsalva to the floor of the right atrium. (B) The Ao length is defined as the length of the ascending aorta from the sinotubular junction to the right carotid artery. (C) The distance between the His recording site (yellow tags) and coronary sinus ostium (blue tags) was measured.

were included in this study. All patients had a chest X-ray scans performed on admission, as is routine in our clinical practice.

*2.1.1. Echocardiography*

On M-mode echocardiogram, the left ventricular dimension at end-diastole (LVDd), end-systole (LVDs), and maximal left atrial diameter (LAD) were measured. LV end-diastolic (EDV) and end-systolic volumes (ESV) were calculated from the apical two- and four-chamber views using a modified Simpson's method, and the LV ejection fraction was calculated as follows: $(EDV - ESV)/EDV \times 100$. The mitral inflow patterns were evaluated by peak early diastolic velocity (E), peak atrial systolic velocity (A), E/A ratio, and deceleration time (DcT). In addition, the mitral annular velocities on tissue Doppler (E/e′) were evaluated.

*2.1.2. CT measurements*

We measured the tilt angle of the aorta to the horizontal line (Ao angle), the distance between the bottom of the right atrium and sinus of Valsalva (RA-Val d), and the diameter of the sinus of Valsalva (Val d) (Fig. 1, panel A). The length of the ascending Ao from the sinotubular junction to the right carotid artery as measured at the center of the ascending Ao was defined as the Ao length (Fig. 1, panel B).

*2.1.3. Chest X-ray scanning*

With advancing age, the thoracic aorta loses its elasticity and expands both in cross-sectional area and in length. Therefore, the ascending aorta dilates and displaces from the central position towards a more lateral position, and the curvature of the aortic arch decreases. In this study, obtained chest X-ray images were read by two physicians and judged if these findings were present.

*2.1.4. Measurements on the electroanatomical mapping system*

The locations of the His recording site were tagged using the EAM (Carto system, Johnson & Johnson, Diamond Bar, USA), and merged with a pre-acquired CT image. The CS ostium was identified on the CT image, and the shortest distance between the His recording site to the CS ostium (His-CSd) was measured (Fig. 1, panel C).

*2.2. Step 2: Validation of identified parameters in patients with AVNRT*

In a subsequent group of patients, we evaluated the parameters associated with small TOK size in consecutive patients who underwent AVNRT ablation from January 2014 to December 2015.

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