Prevalence of Left Atrial Diverticula and Accessory Appendages and Origins of the Sinoatrial Nodal Artery in Patients with Atrial Fibrillation

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Abstract

Background: Considering the importance of knowledge about anatomical variations in the left atrium (LA) and its nearby structures for clinical decision-making and the lack of pertinent studies on Iranian patients, this study was conducted to determine the prevalence of LA diverticula and accessory appendages and the origins of the sinoatrial (SA) nodal artery in patients with atrial fibrillation.

Methods: In this observational cross-sectional study, 45 consecutive patients with atrial fibrillation undergoing preprocedural computed tomography angiography were enrolled. The prevalence rates of LA diverticula and accessory appendages and the origins of the SA nodal artery were determined and compared according to the patients’ age and gender.

Results: The origin of the SA nodal artery was R1 (medial to right auricle) in 30 patients (66.7%), L1 (medial to left auricle) in 11 patients (24.4%), and both R1 and L1 in 1 patient. The origin in the remaining 3 subjects was L2 (posterior to auricle), L3 (posterior to left atrium), and R2 (posterior to right atrium). The prevalence rates of LA diverticula and accessory appendages were 48.9% and 17.8%, respectively. Diverticula were seen in 34.8% and 63.6% of the patients younger and older than 50 years, respectively (P = 0.050). Also, accessory appendages were present in 30.4% and 4.5% of the patients younger and older than 50 years, respectively (P = 0.047). There was no significant association for age (P > 0.05).

Conclusions: The findings of the present study show that the main supplying artery of the SA nodal artery was R1 from the right coronary artery. The prevalence rates of LA diverticula and accessory appendages were higher than those reported previously.

Keywords: Anatomical Variation, Left Atrium, Diverticulum, Accessory Appendage, Prevalence

1. Background

Atrial fibrillation (AF) is the most common cardiac arrhythmia. The lifetime risk to develop AF has been reported to be 1% in individuals below the age of 60 years and 8% in those over the age of 80 years (1). Atrial fibrillation is characterized by irregular supraventricular tachyarrhythmias, leading to disordered atrial function (2), with the replacement of a normal uniform P wave with fluctuating fibrillatory waves and variable R-R intervals (3). The ventricular response is rapid, ranging from 90 to 170 minutes (4). Atrial fibrillation is associated with a high risk of mortality and morbidity due to cardiac dysfunction and increased risk of stroke and heart failure (5, 6).

The presence of anatomical variations in the left atrium (LA), such as accessory appendages, diverticula, and arterial supplies of the sinoatrial (SA) node, is occasionally observed in association with AF, which may be a risk factor and prove important in clinical decision-making (7, 8). Left atrial accessory appendages and diverticula are observed in 10% - 27% of the general population (9-12). These may result in increased rates of supraventricular tachyarrhythmias due to an increased atrial surface (13, 14). Electrical dissociation may be detected in cases with a minor LA auricle (15). Also, ectopic activities may arise from these structures despite pulmonary vein ablation (16). Nowadays, the use of multidetector computerized tomography scanners has conferred high-quality assessment of anatomical variations (17).

The SA nodal artery usually originates from the right or left coronary artery or its branches but may have an unusual origin in 1% of the subjects from the coronary sinus, descending aorta, or distal right coronary artery (18). Also, it may be S-shaped and originate from the proximal left circumflex artery, predisposing to injury during AF treatments such as catheter ablation and surgical procedures (19). On the basis of the position of the SA nodal artery in relation to the superior vena cava, it may be divided into precaval, retrocaval, and pericaval types. Among
them, the retrocaval type is more prone to trauma injuries during surgery (20, 21). The presence of vascular structures around the LA might result in diverticulum formation in this chamber (22). Given the significance of knowledge about these anatomical variations, especially for clinical decision-making, and also the current dearth of relevant data on Iranian subjects, we sought to determine the prevalence of LA diverticula and accessory appendages and the origins of the nodal artery in patients with AF.

2. Methods

In this observational cross-sectional study, 45 consecutive patients with AF undergoing preprocedural computed tomography (CT) angiography were enrolled. Patients with a congenital valvular disease were excluded.

The CT scan device was dual-source SOMATOM® Definition Flash (2 × 128, Siemens Company). The protocol employed was dual-source CT spiral with retrospective ECG gating for coronary artery assessment. The other characteristics included tube voltage of 120 kV, tube current of 320 mAs/rot, rotation time of .28 second, slice collimation of 6.0 × 128 mm, and reconstruction increment of 0.3 mm.

The frequency rates of LA diverticula and accessory appendages and the origins of the SA nodal artery were determined and compared according to the patients’ age and gender.

Data analysis was performed using the SPSS software version 21.0 (SPSS, Inc, Chicago, Illinois, USA). Fisher’s exact test, chi-square test, independent-sample t-test, Mann-Whitney U, and Pearson and Spearman regression tests were used. P values less than 0.05 were considered statistically significant. For multivariate analysis, multivariate logistic regression analysis was carried out and the results were reported as OR and 95% CI.

3. Results

In this study, 31 patients (68.9%) were males. The mean age of the patients was 50.98 ± 13.25, ranging from 21 to 72 years. The origin of the SA nodal artery was Rt (medial to right auricle) in 30 patients (66.7%), L1 (medial to left auricle) in 11 patients (24.4%), and both Rt and L1 in 1 patient. The origin in the remaining 3 subjects was L2 (posterior to auricle), L3 (posterior to atrium), and R2 (posterior to atrium). In 7 patients (15.6%), the SA nodal artery terminated in a diverticulum (n = 3) or an LA accessory appendage (n = 4). The branching in these 7 patients was from Rt in 5 patients and L1 in 2. An S-shaped branch from the left circumflex artery was seen in 1 patient.

The termination of the SA nodal artery was precaval, retrocaval, and pericaval in 13.3%, 48.9%, and 37.8%, respectively. There was no statistically significant association between the origin and termination of the SA nodal artery (P = 0.541). The dominancy of the SA nodal artery was left in 68.9% and right in 31.1%.

The prevalence rates of LA diverticula and accessory appendages were 48.9% and 17.8%, respectively. The main location was the upper anterior part of the atrium for the diverticula (45.5%) and the anterior right position (50%) for the accessory appendages. Three patients (6.7%) had 2 diverticula, and 1 (3.4%) patient had both diverticulum and accessory appendage.

The presence of diverticula was not related to the origin of the SA nodal artery (P = 0.710). Also, separately for the diverticula (P = 0.795) or the accessory appendages (P = 0.999), there was no significant association with the dominancy of the origin of the SA nodal artery. Gender had no association with the status of the origin of the SA nodal artery (P = 0.583). Furthermore, termination status (P = 0.463) and dominancy (P = 0.346) did not differ between men and women. The presence of diverticula (P = 0.235) and accessory appendages (P = 0.681) was not related to gender.

Diverticula were seen in 34.8% and 63.6% of the patients younger and older than 50 years, respectively (P = 0.050), and accessory appendages were present in 30.4% and 4.5% of the patients younger and older than 50 years, respectively (P = 0.047). No significant difference was observed in termination status (P = 0.128) and dominancy (P = 0.586) between the patients younger and older than 50 years (Figures 1 - 3).
4. Discussion

For all the various studies having been conducted worldwide on the origins of the SA nodal artery and the prevalence of LA diverticula and accessory appendages, the current literature is devoid of data on these issues among the Iranian population. However, some similarities in findings in the current study with other previous reports show same variants in different populations. On the other hand, the presence of some differences in findings demonstrates genetic variations between populations. Knowledge of anatomical variants in each population would be beneficial in early clinical decision-making vis-a-vis patients with AF, especially for cardiac resynchronization therapy or surgical methods.

In the current study, the main origin of the SA nodal artery was R1 and the main termination pattern was retrocaval. There were prevalence rates of 48.9% and 17.8% for diverticula and accessory appendages in the LA. A study by Song et al. (23) in the Korean population reported R1 as the origin of the SA nodal artery in 53.4%, which is lower than the rate in our study. Also, whereas the authors reported double-branching in 3.6% of their patients, we detected it in 2.2% with a close interval in our study population.

The study by Ozturk et al. (22) reported double-branching in 4% of their study population, which is higher than the rate in our study. R1 was the origin in 55.4% in their study, which is lower than the rate in our report. Another interesting point is the presence of S-shaped arteries in 20.3% of their patients versus 2.2% in our study. Also, they reported a prevalence rate of 42% for diverticula, which is lower than that in our study. Termination of the SA nodal artery in an LA diverticulum was seen in 69.7% of the subjects in their study versus 15.7% in our report. The investigators reported a significant association between the origin pattern of the SA nodal artery and the LA auricle, which does not chime in with the results of our study and other similar investigations. Saremi et al. (19) reported right dominancy in the origin of the SA nodal artery in 70.5% and double-branching in 6.3% of their study population; both rates are higher than those in our study. Also, they reported the presence of S-shaped arteries in 18%, which is again higher than the figure in our study. Nevertheless, chiming in with our findings, retrocaval termination was the most common pattern in their investigation. Yildirim et al. (24) reported right dominancy in 91%, which is significantly higher than the rate in our study. The retrocaval pattern of termination for the SA nodal artery was seen in 21% of their patients versus 50% in ours. Busquet et al. (25) reported retrocaval and precaval termination patterns in 36% and 6%, respectively, both of which are lower than the rates in our study. Abbara et al. (11) in the United States reported the prevalence of diverticula and accessory appendages to be 23% in patients with AF, which is lower than the rate in our study. Patel et al. (26) reported a 30.4% rate, which is again lower than that in our study. Lazoura et al. (27) reported a prevalence rate of 23.5% in patients with AF versus 20.5% in patients with sinus rhythm; both of these figures are lower than those in our study. Troupis et al. (28) reported the prevalence rate of diverticula and accessory appendages among 47 patients with AF to be 44.7% versus 51.1% in patients with sinus rhythm; the rate is significantly different from that in our study. Killeen et al. (29) reported a prevalence rate of 23% for LA accessory appendages. Incedayi et al. (30) in Turkey assessed 454 patients with AF and reported that 41% had diverticula mainly in the superoanterior portion; their findings are concordant with ours as well as those reported by Abbara et al. (11). In our study, the prevalence rate of both diverticula and acces-
sory appendages in the patients with right dominancy was 61.2% versus 50% in the patients with left dominancy. Previous studies have not assessed differences in terms of dominancy. Generally, the dissimilarities between the prevalence rates of anatomical variations in different populations demonstrate the role of genetic diversity in the development of the SA nodal artery and the LA tissue.

Totally, our results demonstrated that the main supplying artery for the SA nodal artery was R1 from the right coronary artery insofar as it accounted for two-thirds of the cases, followed mainly by L1 from the left coronary artery. The prevalence rates of LA diverticula and accessory appendages were 48.9% and 17.8%, respectively, with a total rate of 66.7%, which is higher than the rates reported in the vast majority of previous studies. Also, our results showed no significant relationship between the pattern of the origin of the SA nodal artery and the presence of diverticula and accessory appendages in the LA.

First and foremost among the limitations in our study is its low sample size under coronary CT angiography. Also, differentiation between accessory appendages and diverticula in imaging was difficult and some anatomical variations had characteristics of both diverticula and accessory appendages. Another drawback of note in the present study is the absence of pathological evaluation of the patients.

References


