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Intra-Atrial Right Coronary Artery and its Ablation Implications

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ABSTRACT

OBJECTIVES The study examined the frequency in which a right coronary artery (RCA) anomaly resulting in intra-atrialization of the vessel might increase risk of RCA damage during routine radiofrequency ablation in the right atrium even with low power or temperature.

BACKGROUND Right coronary artery (RCA) injury with endocardial RF ablation of the right atrium is a rare complication.

METHODS This prospective observational study comprised an analysis of coronary artery anatomies in 331 patients who underwent autopsies at our institution from 2005 to 2014. The presence of intra-atrial RCA including the number and length of intra-atrial RCA segments with accompanying atherosclerosis and coronary anomalies were evaluated.

RESULTS The authors report a case series of 6 of 331 (1.8%) patients in whom autopsies showed evidence of an intra-atrial RCA. The patients were all men (average 69 ± 12 years of age). They observed 3 variations of the intra-atrial RCA course. In 2 similar variations, the RCA entered the anterolateral aspect of the right atrium, returning to its normal distribution to supply the distal RCA (case 4 of 6) and the atrioventricular nodal artery (case 1 of 6). In the sixth case, the atrialized artery was an anterior branch of the RCA, in which the artery similarly coursed across the pectinate muscles, extending to the region of the anterior crista terminalis, before diving into the muscle.

CONCLUSIONS The prevalence and variants of the intra-atrial RCA have not been reported before. In the presence of an intra-atrial artery, RCA damage may occur due to direct injury rather than collateral injury due to transmural extension of an ablation lesion. (J Am Coll Cardiol EP 2017;3:1037–45)

Radiofrequency (RF) catheter ablation of accessory pathways requires the application of energy to the endocardial surface of the atrioventricular groove adjacent to the major epicardial coronary arteries. During this procedure, the coronary artery may be damaged.

Coronary artery injury occurring in association with catheter ablation procedures has primarily occurred during ablation of accessory atrioventricular pathways and has been almost exclusively confined to the left coronary artery (1). However, although rare, the right coronary artery (RCA) may also be injured. Similarly, RCA injury rarely occurs as a resultant of cavotricuspid isthmus (CTI) ablation (2,3). In particular, a few clinical case studies have shown that RCA occlusion during RF ablation of typical atrial flutter (4–7). Similarly RCA injury has also been shown during cryoablation of CTI atrial flutter (8). The risk of injury is thought to be due to transmural proximity to the coronary artery.

The purpose of this study was to evaluate the anatomic relationship of the RCA to the right atrium and ventricle, to determine the frequency with which anomalies exist that may increase risk of direct injury to the coronary vessel during ablation within the right atrium.

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ABBREVIATION AND ACRONYMS

CTI = cavotricuspid isthmus

IARCA = intra-atrialized right coronary artery

RCA = right coronary artery

RF = radiofrequency

VA = Veterans Administration

METHODS

We conducted a prospective observational study comprising consecutive subjects who had an autopsy performed at the Minneapolis Veterans Administration (VA) Health Care System (Minneapolis, Minnesota) between January 2005 and December 2014.

The study protocol was reviewed and approved by the institutional review board. Informed consent from the family of the deceased patients for autopsy was obtained in all cases.

Since 2000, 945 patients underwent autopsy at the Minneapolis VA with detailed heart dissection as part of the standard assessment. The first case of an atrialized RCA was observed in 2005. Since 2005, for subsequent autopsies (n = 331) a special protocol has been adopted for all heart specimens to undergo careful dissection by stripping the epicardium to display the major coronary and the atrial arteries. Each of the major coronary epicardial vessels had a complete description of the course of the coronary arteries relevant to the clinical series. Then the coronary arteries were individually transected along their course at 2-mm slices to display the vascular wall, intima, and lumen.

ANATOMIC DISSECTION PROTOCOL FOR CORONARY VESSELS. Following postmortem examination, the heart is routinely fixed in formalin for 24 h. Thereafter, the entire length of the coronary arteries is dissected out of the epicardium, leaving a generous amount of surrounding adipose tissue. Then they are placed in decalcifying solution for approximately 12 h. Following decalcification, the coronary arteries are transected at 2-mm intervals and sequentially positioned on a glass panel superimposed on a coronary artery anatomy drawing (Figure 1A). Under a magnifying glass, each segment is then grossly examined for pathology. Specifically, the percent luminal stenosis is estimated with detailed description of eccentric and circumferential lesions of the vessel walls. These lesions are subsequently depicted on a hand-drawn 2-dimensional coronary artery anatomy diagram, producing an overall representation of the coronary artery pathology (Figure 1B). Subsequently, gross digital photographs are taken for further mathematical computation and pathologic documentation. Representative sections of lesions and normal coronary artery segments are then submitted for histological examination. This technique was developed by Mr. Richard Dykoski, who is specialized in assessing coronary anatomy in cardiac dissections, which we have termed the Dykoski method.

ANATOMIC DEFINITIONS. The intra-atrial coronary artery is the segment of the RCA that is intracavitary in the right atrium without any myocardial interface between the blood pool and the vessel adventitia.

The atrialized coronary artery is a segment of the RCA that traverses the epicardial surface of the heart, displaced superiorly from the usual position within the atrioventricular groove to a more atrialized location on the atrial aspect of the atrioventricular groove. This is an uncommon position for the right coronary vessel.

Myocardial bridging is a band of myocardial fibers overlaying a segment of coronary artery along some part of their subepicardial; fibers of ventricular origin are known as myocardial bridges, whereas those of atrial origin are referred to as myocardial loops.

Intramyocardial vessels are vessels surrounded by myocardial fibers and usually considered deep myocardial bridged vessels, whereas myocardial fibers that cross the tunneled coronary artery perpendicularly or at an acute angle are considered superficial.

RESULTS

We report a case series of 6 patients with an intra-atrial course of the RCA within the right atrial chamber. These cases were identified among 331 autopsies in which a standard protocol for examination of the coronary arteries was followed (1.8%).

INDEX CASE REPORT. A 68-year-old man with past medical history of diabetes mellitus, nonischemic cardiomyopathy with left ventricular ejection fraction of 45% to 50%, chronic obstructive pulmonary disease, and hypertension with atrial flutter. He underwent a CTI-dependent atrial flutter ablation. An 8-mm-tip catheter was used. Temperature was limited to 60°C, powered to 50 W. The procedure was successful, with no ischemic electrocardiographic signs or symptoms noted during ablation or afterward while monitored on cardiac telemetry. Twenty-four hours after the procedure, he expired due to pulseless electrical activity. Postmortem examination revealed extensive bilateral pleural effusions and diffuse alveolar damage. The heart showed cardiomegaly with biventricular hypertrophy, coronary atherosclerosis, and focal myocardial necrosis in the posterior wall of the left ventricle. The right atrium revealed several areas of recent hemorrhage on the lateral edge of the eustachian ridge, lateral pectinate muscles, and the tricuspid valve (Figure 2). The sectioned coronary artery showed severe atherosclerosis at the site of hemorrhagic necrosis due to the