Septal summit: A narrow epicardial region above the left ventricular summit. Implications for electrophysiological procedures

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INTRODUCTION

Systematic advancements in electrophysiological procedures outpace established anatomical definitions [1]. Therefore, there is a need to identify new heart regions dependent on clinical and procedural aspects [2]. An example of this was identifying accurately the left ventricular summit (LVS) due to the difficulty in eliminating ventricular arrhythmias from this area (Figure 1B) [3, 4]. A recent publication describing arrhythmias originating from non-epicardial LVS regions redefined a septal structure as the superior intraseptal site. This intraseptal structure between the endocardial outflow tract and epicardial LVS was penetrated through the perforating arteries and the anterior vein branches of the heart [5]. While the anatomical boundaries of the left ventricular summit have been accurately described (Figure 1, white dotted line), the epicardial region located outside the septal margin, toward the right ventricular outflow tract is described as the septal summit (Figure 1, yellow asterisk) [4].

Specific "ventricular outflow tract" morphology visible in electrocardiography (ECG) with V3 abrupt transition may indicate its localization in the septal summit region (Figure 1C) [1, 3, 6].

This article aims to illustrate the anatomical description and significance of the septal summit region, its content, and surrounding structures.

The septal summit as an anatomical term was proposed in 2021; nevertheless, in the literature, it is primarily described as the septal margin of the left ventricular summit [4, 5]. According to the septal summit definition, these few millimeters (2–5 mm) are beyond the top of the left ventricle on the right side below the trunk of the left coronary artery. The question is whether these few millimeters matter? Yes, they matter. These milliseconds and millimeters are decisive in electrophysiological procedures, as the ranges of the lesion formation created by an electrode reach up to 5–6 mm [1, 6].

METHODS

We examined dissected human hearts of cadaveric individuals who died of noncardiac causes. Hearts were acquired from the Department of Anatomy of the Jagiellonian University. The septal summit region was cleared from epicardial adipose tissue, and the pulmonary trunk at the aorta was cut right above valves (Figure 1A). The right ventricular outflow tract was removed during investigatory sections to uncover the septal summit and muscular region of the superior intraseptal site (Figure 1B). The anatomic sections were combined with 3D maps from the CARTO system (Biosense Webster, Diamond Bar, CA, US) after ablation of arrhythmias with particular ECG morphology (Figure 1C and D).

Statistical analysis was not performed since this was an observational study. Nev-

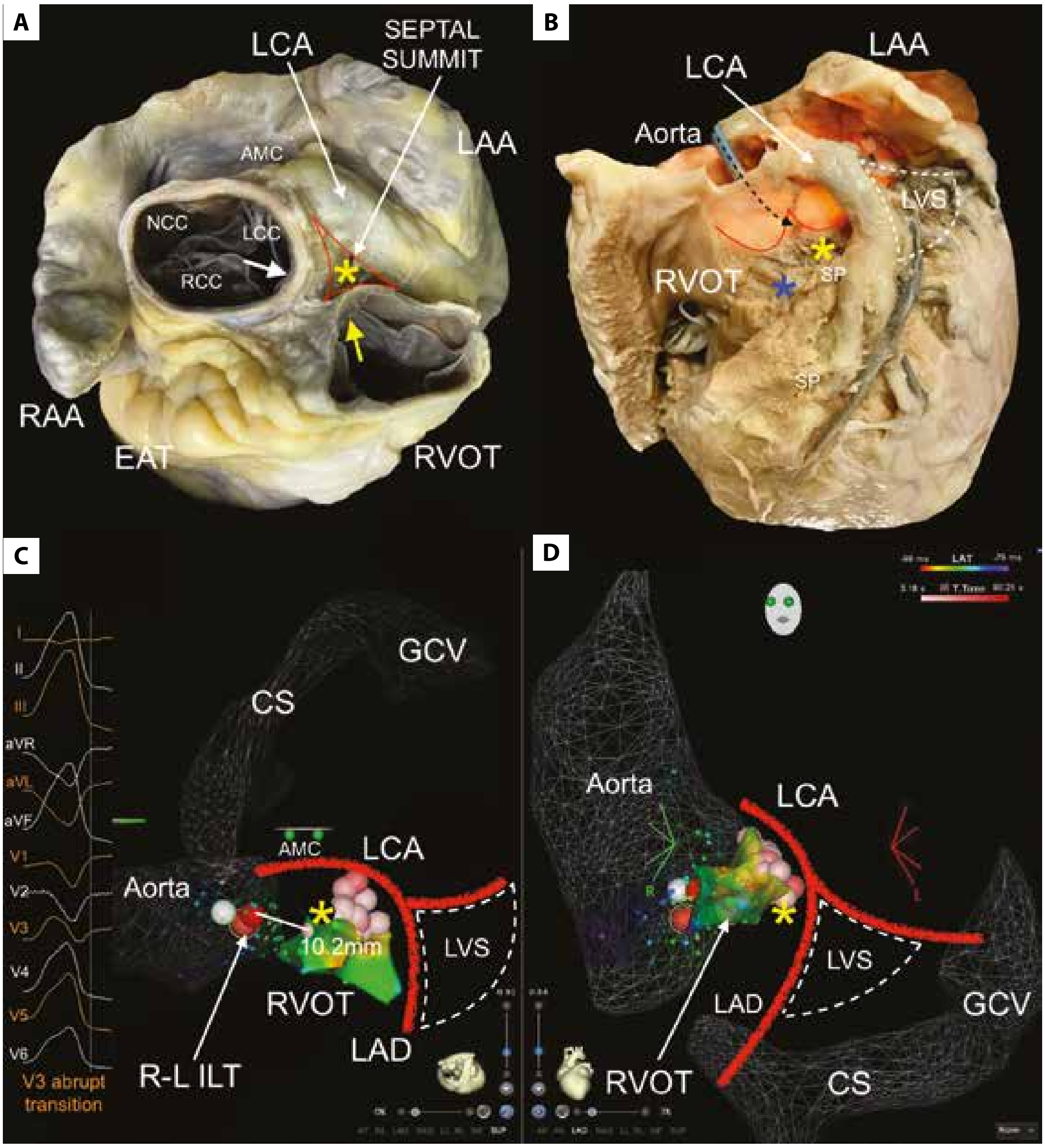

Figure 1. Anatomical specimen of the septal summit region. **A.** View from the aortic root, inside the red area — septal summit; small white arrow — right-left interleaflet trigon; small yellow arrow — left Valsalva sinus of the pulmonary trunk. **B.** Cleared from epicardial adipose tissue and with RVOT medial wall removal; blue asterisk — basal superior intraseptal region (endocardial), yellow asterisk — septal summit (epicardial), red lines indicate aortic sinuses of Valsalva, white — red line of the LVS indicates septal summit, black dotted line — ablation electrode located in the right-left interleaflet trigon. **C, D**. 3D maps form the CARTO System presenting the same heart aspects during the procedure from the septal summit

Abbreviations: AMC, aortic-mitral continuity; CS, coronary sinus; GCV, great cardiac vein; EAT, epicardial adipose tissue; LAA, left atrial appendage; LCA, left coronary artery; LCC, left coronary cusp; LVS, left ventricular summit; NCC, non-coronary cusp; RAA, right atrial appendage; RCC, right coronary cusp; R-L ILT, right left interleaflet trigon; RVOT, right ventricular outflow tract; SP, septal perforators

ertheless, this area and surrounding tissues are carefully examined, and the results will also be published.

Anatomy

The septal summit is the most superior part of the interventricular septum, located epicardially near the LVS septal margin, approaching the pulmonary trunk. It extends from the ventriculo-aortic junction down to the first septal perforator. The structures neighboring the septal summit from the top are the right-left interleaflet trigon (Figure 1A, white arrow), the left pulmonary sinus from the right aspect (Figure 1A, yellow arrow), and the anterior interventricular groove's content from the left side. Above the apex of the LVS (under the left coronary artery), the septal summit corresponds with aortic-mitral continuity.

Content of the septal summit

The contents within this region include arteries, veins, and epicardial fibers of the intrinsic cardiac autonomic plexus [7]. All are covered by various amounts of epicardial adipose tissue [8]. Arteries are represented by small septal perforating arteries exiting from the left main trunk or proximal aspect of the left anterior descending artery [4]. The veins leaving the superior septal and communicating veins, also known as the Vieussens veins, are combined with the conus vein. The venous drainage is directed into the right atrium directly or via the coronary venous system into the great cardiac vein [9].

Surrounding structures

This narrow structure (yellow asterisk) is surrounded by the left sinus of Valsalva superiorly, aorto-mitral continuity and septal margin on the left border, and pulmonary trunk and left pulmonary sinus on the right border [10, 11]. The distance between right and left interleaflet trigon (the white arrow on Figure 1A) to the left Valsalva sinus of the pulmonary trunk (yellow arrow on Figure 1B) ranges from approximately 1 to 2 cm (Figure 1C). The inferior aspect of the septal summit reaches the first dominant septal perforator [12]. Going deeper, the septal summit amalgamates with the superior intraseptal site (blue asterisk) [5].

A picture of the septal summit and surrounding structures is shown in Figure 1C and D.

Anatomical access

The epicardial location of the septal summit is found above the inaccessible part of the left ventricular summit, resulting in an externally unapproachable site. The region can only be ablated transmurally from adjacent structures: the aorta or pulmonary trunk [13] (precisely, from the right-left interleaflet trigon) the aortic approach and the left sinus of Valsalva in the right ventricular outflow tract. Access to this region from the venous system is clinically hazardous because of its close relation to the left coronary artery [14]. Under favorable conditions, the septal summit can be reached from the left atrial appendage [15].

RESULTS AND DISCUSSION

Ventricular arrhythmias originating from the septal summit region are characterized on the ECG with an abrupt R-wave transition in the V3 lead (Figure 1C) [6], unlike the V2 pattern break mainly visualized by the left ventricular summit [4]. This is also unlike the positive or pattern break in V1 — which point toward the left Valsalva sinus. Nevertheless, in some cases, a superficial ECG may be misleading. Therefore, precise mapping of the arrhythmia is always crucial for a successful ablation. The mapping should start from the right ventricular outflow tract, and in addition, should include mapping from the aorta and left ventricular outflow tract [10]. In the presented CARTO maps (Figure 1C, D) the successful ablation site was in the right-left interleaflet trigon in the aorta, while the earliest activation time was recorded on the posterior wall of the right ventricular outflow tract. The distance between these two sites was 10.2 mm.

As an important observation, the septal summit is covered with a disproportionate amount of epicardial adipose tissue. This superficial fat may compress the heart's epicardium and structures inside the septal summit by weight and volume and potentially induce ventricular arrhythmias [8].

Article information

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Other declarations: Anatomical specimens ware conducted at the Department of Anatomy of the Jagiellonian University Medical College and was approved by the Bioethical Committee of the Jagiellonian University in Cracow, Poland (1072.6120.131.2018). The study protocol conformed to the ethical guidelines of the 1975 Declaration of Helsinki. The methods were carried out in accordance with the approved guidelines.

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