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The valve of the superior vena cava — the supernumerary structure of the precaval segment of the crista terminalis

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The primitive right sinuatrial valve persists in humans as the crista terminalis, the valve of the inferior vena cava and the valve of the coronary sinus, while according to the known data the primitive left sinuatrial valve is supposed to have no derivatives. Ten human right atria were opened with intercaval incisions and the precaval segment of each crista terminalis was studied macroscopically. Three specimens did not present any peculiarities at this level, but the other 7 had sagittal muscle bundles and supernumerary valves in individual arrangements. Supernumerary valves were present in 2 specimens, one complete and the second fenestrated; these valves were located immediately below the superior vena cava orifice and covered the medial end of the crista terminalis. The supernumerary valves at the superior vena cava orifice may be termed, mirroring that of the inferior vena cava, "valves of the superior vena cava". Their exact frequency of occurrence and their embryonic precursors must be further established. The presence of such valves in the right atrium may interfere with the flow to the right side of the heart, may represent conditions for thrombotic changes and may disturb a central venous catheter placement. If present, the valve of the superior vena cava will also interfere with the catheter ablation procedures used for supraventricular tachycardia.

Key words: right atrium, sagittal muscle bundle, septum spurium, Chiari net

INTRODUCTION

It has traditionally been considered that the trabeculated portions of the atria are derived from the primitive atria, while the smooth-walled posterior portion of the atria originates from incorporation of venous blood vessels [6].

New techniques show that, rather than developing in the form of a segmented tube, the heart is built up by the addition of material to both its arterial and venous poles. Areas that, at first sight, seem destined to become the systemic venous tributaries and that are usually recognised as the embryonic sinus venosus become incorporated at the caudal end of the primary cardiac tube as the primordium of the atrial component of the heart [1].

The right venous sinus horn opens into the right atrium; the orifice is guarded by the right and left sinuatrial (venous) valves. These 2 valves meet cranially and become continuous with the embryonic septum spurium [9]. The right sinuatrial valve persists in humans as the crista terminalis, the valve of the inferior vena cava and the valve of the coronary sinus [8, 9]. The right sinuatrial valve, but not the left, is homologous throughout the vertebrate phylogeny [4]. The left sinuatrial valve fuses with the atrial septum and usually no remnant of it can be seen in the adult [6, 9].

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The crista terminalis of His is a significant structure in several forms of atrial tachyarrhythmias and, occasionally, the target for radiofrequency catheter procedures. In the precaval segment the crista terminalis gives rise to the anterior pectinate muscles; in 82% one of these anterior pectinate muscles is particularly prominent, tracking along the superior part of the right appendage and spreading out in an irregular pattern across the body of the appendage; this is described as the "sagittal muscle bundle" [7].

The origin of the crista terminalis at the interatrial groove is confluent with the origin of Bachmann's bundle [7]. Also described is the junctional point between the apex of the crista terminalis, the origin of the sagittal muscle bundle and the interatrial band [5]. The anterior interatrial band ("Bachmann's bundle") extends from the junction of the superior vena cava and the right atrial appendage transversely to the anterior wall of the left atrium, ending at the base of the left atrial appendage [2].

Chiari anomalies (Chiari networks) in the human right atrium are rarely encountered and are typically referred to perforations or tissue strands related to the inferior vena cava valve and possibly the coronary sinus valve. The terms "right atrial net" or "Chiari net" have been proposed for anomalies involving valves of the inferior vena cava and coronary sinus and strands within the right atrium connecting these valves with the crista terminalis, right atrial wall or interatrial septum [3].

No reference is currently available on any valvular structure, compact or fenestrated, located immediately below the superior vena cava orifice in the right atrium of the human heart.

MATERIAL AND METHODS

The present study was determined by a routine dissection of a human right atrium when a supernumerary valve was found located on the precaval segment of the crista terminalis. Another 9 specimens of human right atria were dissected to observe the individual morphologies of the crista terminalis in the precaval segment. All the hearts that were used were from cadavers without any known cardiac pathology; there were 6 adult male and 4 adult female hearts, aged from 44 to 71 years (mean 56 ± 8.74 SD). All the right atria that were used were opened by intercaval incisions of their lateral walls. The approval of the ethics committee of the University was obtained for this study.

RESULTS

Of the right atria studied, 3 presented no peculiarities of the precaval segment of the crista terminalis such as valves or sagittal muscle bundles; the smooth segment of the crista terminalis ended medially, at the junction of the superior vena cava and the right atrium. The other 7 specimens used for this study presented at the level of the precaval segment of the crista terminalis sagittal muscle bundles and supernumerary valves in individual dispositions (Fig. 1, 2). All the observed specimens exhibited complete well defined valves, Thebesian and Eustachian.

Five specimens without supernumerary valves (Fig. 1A, B, C, D, F) presented distinctive sagittal muscle

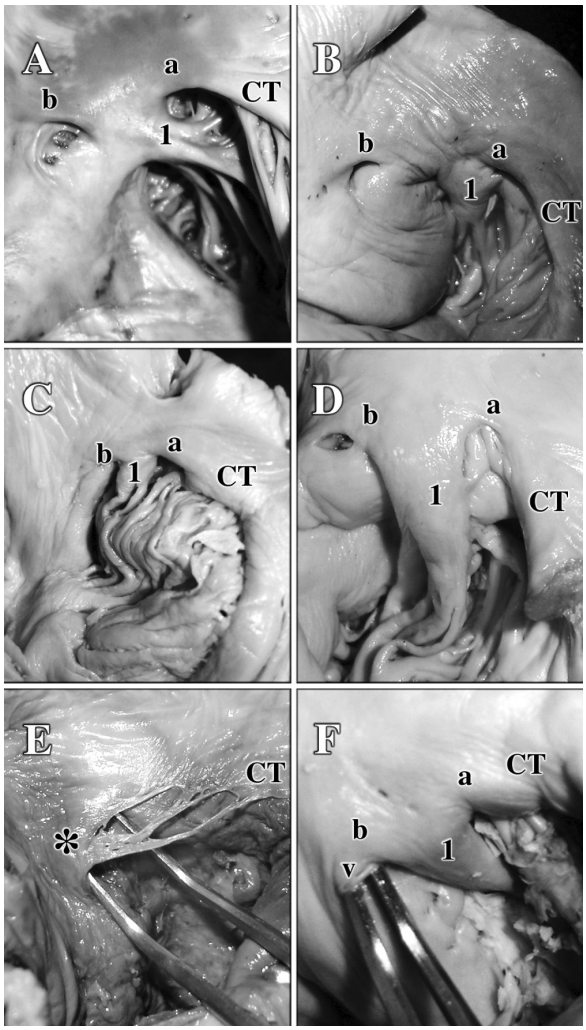

Figure 1. Posterolateral views of the precaval segment of the crista terminalis in 6 specimens (**A–F**). The precaval segment of the crista terminalis (CT) is divided into anterior (a) and medial (b) parts by the origin of the sagittal muscle bundle (1). There are specimens in which a small pit can be distinguished below the medial part of precaval segment of crista terminalis (**A**, **B**, **D**, **F**). In specimen **F** an endocardial valvule is attached to the medial part of the precaval segment of the crista terminalis and covers that pit. One specimen (**E**) presented a supernumerary fenestrated valve (*) attached at the CT and the atrial septum; the sagittal muscle bundle was lacking in that specimen.

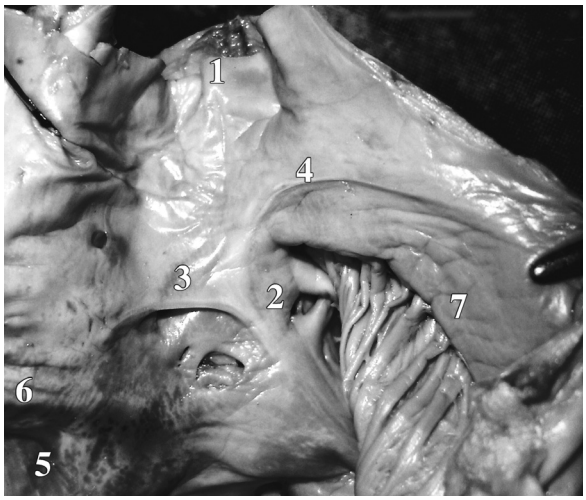

Figure 2. Posterolateral view of the precaval segment of crista terminalis: 1 — superior vena cava; 2 — sagittal muscle bundle; 3 — supernumerary complete valve covering the medial part of the precaval segment of the crista terminalis and a large trabeculated pit below this part; 4 — endothelial ridge on the anterior part of the precaval segment of the crista terminalis; 5 — fossa ovalis; 6 — limbus fossae ovalis; 7 — crista terminalis.

bundles, dividing the precaval segment of the crista terminalis into 2 parts, anterior and medial. Thus the medial part of the precaval segment of the crista terminalis is the terminal part of the crista terminalis in hearts with sagittal muscle bundles. While the anterior part of the precaval segment of the crista terminalis bordered the right appendage, the medial part individually bordered superiorly a small pit, smooth-walled (Fig. 1B, F) or trabeculated (Fig. 1A, D). In one specimen at the medial part of the precaval segment of the crista terminalis a distinctive endocardial valvule could be distinguished (Fig. 1F). In another specimen both the medial and the anterior parts of the precaval segment of the crista terminalis bordered the right appendage (Fig. 1C).

In two specimens (20%) supernumerary valves were detected below the superior vena cava orifice (Fig. 1E, Fig. 2).

One specimen (Fig. 1E) had no sagittal muscle bundle but presented a supernumerary valve attached to the precaval segment of the crista terminalis and the atrial septum. Fenestrations were present in the anterior part of this valve, while medially, towards the atrial septum, the valve was complete, hiding the tip of the crista terminalis.

A further specimen (Fig. 2) presented both a sagittal muscle bundle and a supernumerary valve. The sagittal muscle bundle appeared extremely large, separating the precaval segment of the crista terminalis into anterior and medial segments. The pit below the medial segment of the precaval segment of the crista terminalis was the largest of all the specimens. This specimen's valve was attached by its medial and posterior horns, respectively, to the sagittal muscle bundle and the atrial septum, and it was complete.

DISCUSSION

The study of the precaval segment of the crista terminalis correlates with the frequency of occurrence at this level of the sagittal muscle bundles, but the alternative term "septum spurium", used for this muscular bundle [7] may lead to confusions with the embryonic septum spurium.

Individual morphological structures that may be found medial to the sagittal muscle bundles are:

— a supernumerary valve;
— a distinctive medial part of the precaval segment of the crista terminalis where the endocardium may occasionally configure a small valvule;
— a pit, smooth-walled or trabeculated, below the medial part of the precaval segment of the crista terminalis.

It thus seems that the sagittal muscle bundles, if present, determine a series of individual morphological features that are absent when the sagittal muscle bundle is absent.

Several points are known to be chosen as the site of ablation [7], and these correspond to the origin of the sagittal muscle bundle from the crista terminalis and the two demonstrated parts of the precaval segment of crista terminalis. For catheter ablation techniques therefore the morphological patterns at this level are useful if known. Moreover, the presence of a supernumerary valve hiding the medial part of the precaval segment of the crista terminalis may interfere in and be detrimental to ablations at this level. Nevertheless, such a supernumerary valve, if fenestrated, must be taken into account when considering the Chiari networks of the right atrium and the risks for thrombotic events.

The supernumerary valves located immediately below the superior vena cava orifice and linked to the atrial septum and crista terminalis may be termed, mirroring the inferior vena cava valve, "valves of the superior vena cava". In this study 2 of 10 specimens presented such valves, one complete and the other fenestrated.

Nevertheless, the structure described here as the valve of the superior vena cava could equally

well be considered the persisting superior portion of the left venous valve, as it extends from the sagittal band to the superior interatrial fold, although for the present this must be regarded as speculation.

Further statistical studies are needed to establish the exact percentage of occurrence of such valves of the superior vena cava. Embryonic studies are also required to demonstrate their origin; for the present it would be purely speculative to link these valves with any of the primitive sinuatrial valves, even though the left one is supposed to have no derivatives [6, 9].

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