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Morphological classification of the septomarginal trabecula in humans

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Although the septomarginal trabecula is a well-known anatomical structure, there continue to be different ways of studying it. In this study, we dissected the muscle bundles that form it, and this has enabled us to present a new classification based on the origin, path, and termination of these bundles. This study was conducted on 99 hearts removed from the cadavers of adult humans aged 18 to 82 years, of which 72 were male and 27 were female. The septomarginal trabecula presents two components in its composition: one septal and the other septal-papillary, i.e. extending from the septum to the anterior papillary muscle. The septal component may be visible macroscopically, forming a fleshy third-order column, or may only be visible by means of dissection. The septal-papillary component is always visible and is a fleshy column of either second-order or third--order type. Another parameter takes into consideration the papillary-parietal connection, i.e. the junction of the septomarginal trabecula with the anterior papillary muscle, which may be single or present ramifications to the anterior wall and/or apex. Taking these criteria as references, we have classified the septomarginal trabecula into eight types. (Folia Morphol 2011; 70, 4: 300–304)

Key words: heart, anatomy, morphology, fleshy beams, ventricle

INTRODUCTION

The septomarginal trabecula is a fleshy trabecula of the right ventricle that has been known for a long time and for which there are many citations [5–9, 13, 19].

Nevertheless, recent mentions correlating this structure to cardiac disorders such as double-chambered right ventricle [1, 12, 16, 17, 20] and arrhythmias [10, 11, 18] have made it important to add new contributions towards the anatomical knowledge of this structure. One aspect of the septomarginal trabecula that has been of interest to some authors is its classification [3, 9, 14, 21, 22]. Their interest in this topic was probably to make descriptions of this structure more objective and directed towards the function that it performs.

Although contributing towards studies on the trabecula that were more objective, most of these classifications did not faithfully portray the laboratory findings. Therefore, we considered that it would be opportune to update our previous contribution [21] through increasing the same size, performing dissections, and carrying out a systematic study, thereby seeking criteria of sufficient objectivity to lead to results that are more compatible with reality.

MATERIAL AND METHODS

This study was conducted on 99 hearts that were removed from adult humans aged 18 to 82 years, of which 72 were male and 27 were female. The causes of death among these individuals were unrelated to conditions that could directly compromise the

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Table 1. Distribution of septopapillary component in relation to presence of prominent septal portion

	3rd order		2nd order		Total	
Septal component	N	%	N	%	N	%
With prominent portion	32	62.7	19	37.3	51	51.5
Without prominent portion	35	72.9	13	27.1	48	48.5
Total	67	67.7	32	32.3	99	100.0
			χ^2 Test			
	χ^2 calculated = 1.17			χ^2 critical = 3.84		

heart. This material came from the anatomy laboratories of the Biological and Health Sciences Centre of Campina Grande, Federal University of Paraíba and Federal University of São Paulo. The hearts were fixed and kept in a 10% formalin solution until dissection.

We sectioned the sternocostal face of the heart by means of three incisions: one parallel to the anterior interventricular sulcus, extending from the pulmonary trunk to the right margin close to the apex of the heart; another incision parallel to the coronary sulcus, extending from the pulmonary trunk to the right margin; and a third incision along the right margin, joining the other two incisions. By removing the triangular fragment formed by these three incisions, the septomarginal trabecula was exposed for its morphological characteristics to be observed. With the aim of investigating the path followed by the muscle bundle, we then dissected the septum and its prolongations.

We defined the septal component of the septomarginal trabecula as the prominent fleshy third-order column (crest) that was visible macroscopically along the septum. This was indissociable from the portion that, close to the apex, headed for the anterior papillary muscle and/or the anterior wall (moderating band), which we called the septal-papillary component.

Septal connection is the place where the trabecula separates from the interventricular septum. The papillary-parietal connection is the place where the trabecula is in contact with the anterior papillary muscle or the anterior wall of the RV.

Twenty trabeculae were dissected to confirm that the septal component and the septopapillar component are continuous and inseparable. Measurements of the length and the width were done with a Mitsutoyo digital paquimeter. The length is the distance between the connections of the septal- and papillary-parietal. The large was measured in the medium point between these connections. Statistical analyses were done by χ^2 test and Pearson's correlations.

RESULTS

We present a classification based on the following aspects of the septomarginal trabecula: composition of the muscle bundle, type of bundle, and connection to the anterior papillary muscle and/or anterior wall (papillary-parietal).

The septomarginal trabecula presented two components in its composition: one septal component along the interventricular septum, and another septal-papillary component extending from the septum to the anterior papillary muscle.

The septal component could be seen macroscopically forming a third-order fleshy column (51.5%) (with a prominent septal portion) or was visible only by means of dissection (48.5%) (without a prominent septal portion) (Table 1).

The septal-papillary component was always visible macroscopically and could be either a second-order fleshy column or bridge (67.7%), or a third-order fleshy column or crest (32.3%).

We took the papillary-parietal connection to be the junction between the septomarginal trabecula and the anterior papillary muscle. This could be single (32.3%) when it occurred only with the anterior papillary muscle, or complex (67.7%) when the connection occurred with ramifications from the anterior papillary muscle to the anterior wall and/or apex (Table 2).

Using these criteria, we classified the septomarginal trabecula into eight groups (Figs. 1, 2):

— Group 1 — septomarginal trabecula with prominent septal portion, septal-papillary portion consisting of a second-order fleshy column, and single connection to the anterior papillary muscle (8.1%).

Table 2. Distribution of the origin papillary/parietal of the septomarginal trabecula in presence of prominent septal portion

	Simple		Complex		Total	
Septal component	N	%	N	%	N	%
With prominent portion	13	25.5	38	74.5	51	51.5
Without prominent portion	19	39.6	29	60.4	48	48.5
Total	32	32.3	67	67.7	99	100.0
			χ^2 Test			
	χ^2 calculated=1.17		χ^2 critical=3.84			

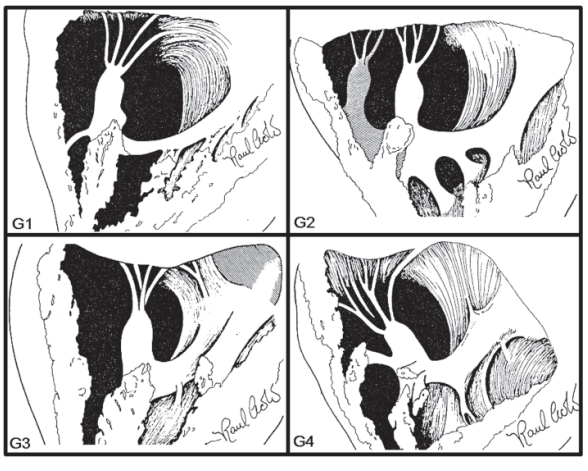

Figure 1. Examples of septomarginal trabecula groups 1 to 4.

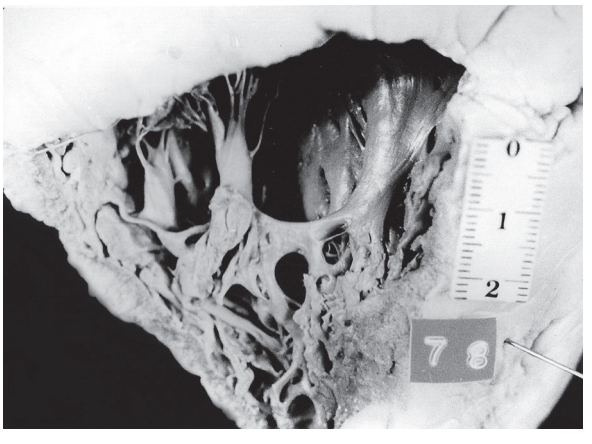

Figure 3. Example of septomarginal trabecula group 2.

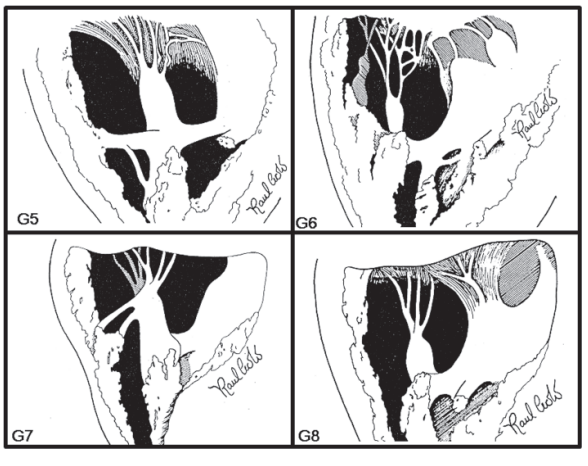

Figure 2. Examples of septomarginal trabecula groups 5 to 8.

— Group 2 — septomarginal trabecula with prominent septal portion, septal-papillary portion consisting of a second-order fleshy column, and complex connection to the anterior papillary muscle (24.2%) (Fig. 3).
— Group 3 — septomarginal trabecula with prominent septal portion, septal-papillary portion consisting of a third-order fleshy column, and single connection to the anterior papillary muscle (5.0%).
— Group 4 — septomarginal trabecula with prominent septal portion, septal-papillary portion consisting of a third-order fleshy column, and complex connection to the anterior papillary muscle (14.1%).
— Group 5 — septomarginal trabecula without prominent septal portion, septal-papillary portion consisting of a second-order fleshy column, and single connection to the anterior papillary muscle (13.1%).
— Group 6 — septomarginal trabecula without prominent septal portion, septal-papillary portion consisting of a second-order fleshy column, and complex connection to the anterior papillary muscle (21.2%) (Fig. 4).

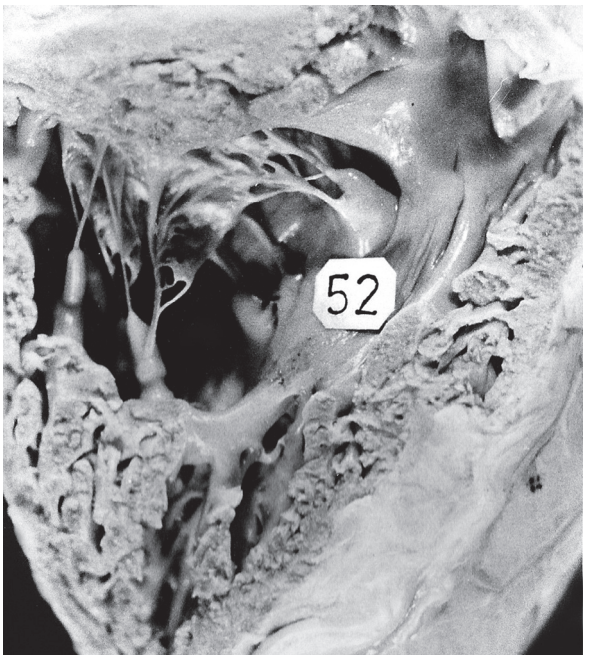

Figure 4. Example of septomarginal trabecula group 6.

— Group 7 — septomarginal trabecula without prominent septal portion, septal-papillary portion consisting of a third-order fleshy column, and single connection to the anterior papillary muscle (6.1%).
— Group 8 — septomarginal trabecula without prominent septal portion, septal-papillary portion consisting of a third-order fleshy column, and complex connection to the anterior papillary muscle (8.1%).

According to Pearson's correlation there was no statistical significance between the length and width of septomarginal trabecula X thickness of the right ventricle anterior wall ($r > 0.05$).

DISCUSSION

From reviewing the literature it can be seen that several authors have sought to classify the septomarginal trabecula by considering only the anatomical characteristics of the component located in the cavity close to the apex, connecting the septum to the anterior papillary muscle or to the anterior wall.

Thus, Horand [9] examined 120 human hearts and put forward a classification based on the type of adhesion between the convex lower margin of the septomarginal trabecula and the ventricular wall. He concluded that three types were present: a) freely arched fascicle, which was considered rare (4%), in which the septomarginal trabecula extended from the septum to the base of the anterior papillary muscle or to the anterior wall; b) semi-free, mentioned as very frequent; and c) complete adhesion, which was the most frequent type.

Weinberg [22] took into account not only the type of adhesion of the lower margin but also the number and thickness of the connections, thus classifying the septomarginal trabecula into three types: I) single, with adhesion to the wall and connections to the anterior wall and anterior papillary muscle; II) several filaments, among which the true septomarginal trabecula would be the largest of them, located on the right side and not always connected to the anterior wall; and III) bridge type, connected directly to the anterior papillary muscle without ramifications.

Bagalá [3] analyzed the posterior face of the septomarginal trabecula in 150 human hearts and distinguished four types: 1) free path in the ventricular cavity; 2) semi-free path, with ramifications to the anterior wall or to the septum; 3) midpoint of the posterior face of the trabecula connecting to the anterior papillary muscle; and 4) adhesion, similar to a third-order fleshy column.

Kocyanic and Mrvaljevic [14] studied 100 hearts and used measurements and statistical data to classify the septomarginal trabecula into several types, for example: in 6% of the hearts, the trabecula that is usually described was absent; in 20%, the trabecula was robust, with adhesion along its lower margin to the internal face of the ventricular wall, presenting two to five ramifications, of which one terminated at the anterior papillary muscle and the others at the anterior wall, but sometimes with two to four ramifications from its upper face; and in 39%, they found an arched septomarginal trabecula, jumping from the interventricular septum to the anterior papillary muscle, in accordance with the classical description.

Depreux et al. [6] investigated 100 hearts from several mammals and, based on observations and measurements, classified three types of trabecula: I — muscular and thick, II — fibrous and thin, and III — fibromuscular.

Although we are of the opinion that classification of the septomarginal trabecula is important for better anatomical and functional knowledge of this structure, we recognise the difficulties in establishing clear and objective criteria for grounding the suggested systems. The classifications cited above, which were based solely on the septal-papillary portion, omitted an indissociable component of the trabecula: its septal portion. The latter also shows continuity with the supraventricular crest [2, 15]. The participation of the

septal band as a component of the septomarginal trabecula has also been confirmed by several other authors: Anderson et al. [2], in an embryological study, cited the continuation of the septal bundle as a moderating band; Becker et al. [4] defined the septomarginal trabecula as an extensive septal trabecula going from close to the valve of the pulmonary trunk to the apex and to the ventricular wall; and Kosinski et al. [15] stated that the supraventricular crest and septomarginal trabecula were common and continuous elements. From Wafae et al. [21] we used the first of these classifications and also took the septal component into account. In this earlier study by our group, the septomarginal trabecula was divided into three groups. Group I presented a septal portion and a long free portion, and included three subgroups (72%); group II showed only the free portion, of short length, and also included three subgroups (16%); and group III was intermediate, with characteristics common to the two other groups (10%).

We therefore propose to classify the septomarginal trabecula in the present study by the following criteria: situation of the septal component visible or not; type of fleshy column of septal-papillary component; and shape of connection with the papillary anterior muscle, and that, based on these criteria we observed 8 different types of septomarginal trabecula.

The importance of this research was based in dissections and measurements of septomarginal trabecula, and it establishes objective criteria and anatomical evidence for classification.

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