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Anatomy of the septomarginal trabecula in goat hearts

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Summary

Our aim in this study was to examine the right septomarginal trabecula of goats regarding the frequency, origin course of the septal and free component, attachment to the papillaris magnus muscle and size . The material used consisted in 32 hearts from non-pedigree goats of both sexes, preserved in 10% formalin. The right septomarginal trabecula was present in all hearts. It could also present a prominence in the form of a cord in the septum before detaching and going towards the wall or the papillary muscle. We called this a septal component and found it in 69% of all hearts studied. In the remaining specimens, the exit of the septomarginal trabecula was abrupt, without presenting a septal component. It could be attached solely to the papillaris magnus muscle or to the papillary muscle and the ventricle wall, originated in the cranial third of the septum, and was attached to the middle third of the papillary muscle or its caudal third. Its free part, from the septum to the papillaris magnus muscle, ranged in length from 1.3 cm to 2.6 cm. The mean value was 1.7 cm, and the most frequent values were 1.9 and 1.5 cm. In conclusion, in goats, the septomarginal trabecula is a constant and invariable structure.

Key words

Anatomy; morphology, trabecula septomarginalis

Introduction

The septomarginal trabecula is a structure in the right ventricle that was already represented in the drawings of Leonardo da Vinci. For this reason, it is also called Leonardo's cord. King (1837) attributed to septomarginal trabecula the important function of a moderating band, since it would avoid excessive distension of the right ventricle. However, it was left to Tandler (1913) to give it the present name of "septomarginal trabecula".

Though a structure commonly cited, it has anatomical features that are still not entirely clear. Among these, the following can be cited: its formation from the interventricular septum; the levels of its origin from the septum and of its attachment to the papillaris magnus muscle; the shape of the trabecula; the relationship with the right branch of the stimulating complex; and its variability in different mammalian species. Horand (1908), Argaud (1912) and Garinei (1936) performed comparative studies on the septomarginal trabecula in different mammals but did not present any results relating to goats; only Lorenz & Guski (1990) described peculiarities in

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the wall structure of the arteries in the trabecula septomarginalis of swine and pigmy goats interpreted as adaptive processes of the vascular wall to the extraordinary stress on those vessels. Bagalà (1940) performed an excellent study on the trabecula in several animal species but did not investigate it in goats. Depreux et al. (1976) developed a study that compared the morphology between different animals including goats, but the aim of their study did not consist of in-depth analysis of the morphology in each animal species. In the present study, our aim was to examine the septomarginal trabecula in goat hearts, with regard to the frequency, origin from the septum, course along the septum and in the free part to the papillaris magnus muscle, attachment to the papillaris magnus muscle, and size, because the function of septomarginal trabecula is unclear and details of its anatomy may help clarify this functions in mammals.

Material and methods

Materials

The material used in this study consisted of 32 goat hearts weighing between 76.5 and 107.7 g that were fixed and conserved in 10% formalin. The goats were of both sexes, without pedigree. The hearts were obtained from a cold storage unit and, after we removed the heart from the animal thorax, we washed it to remove coagulum from the cavities.

Methods

The right ventricle was opened by means of an incision that started at the central part of the pulmonary trunk and continued through the arterial cone to the right margin, parallel to the paraconal interventricular groove. In some specimens to facilitate the dissection, we opened a window in the right ventricle wall in order to better expose the septomarginal trabecula. The interventricular septum, apex and atrioventricular valves were fully preserved. To identify the exit point of septomarginal trabecula from the interventricular septum, the septum was divided into thirds (cranial, medial and caudal), considering the distance from the atrioventricular ring to the apex. To measure the trabecula, a metal wire was placed along the free part of the septomarginal trabecula, going from septum to the magnus papillary muscle, and then this wire was measured using a universal mechanical caliper rule.

Results

Frequency

The septomarginal trabecula was present in all the hearts. Conceptually, since the septomarginal trabecula should contain a muscle bundle and the right branch of the stimulating complex, we deduced that in goats these two structures are joined together, as is seen in human hearts. We did not observe any dissociation macroscopically.

Morphology

The septomarginal trabecula in goats was seen to present two very evident components. Firstly, there was a component attached to the septum, consisting of a third-order fleshy trabecula that was present in 22 specimens, or 69%., In continuation of this bundle there was a second-order fleshy trabecula inside the ventricle, close to the apex that was present in all specimens (100%).

The septal component (Fig 1) presented the form of a flattened muscle cord that was attached to the interventricular septum until the point at which it detached to go towards the wall of the papillary muscle. In 10 hearts (31%), this could not be seen and the detachment of the septomarginal trabecula from the septum was abrupt.

The free component was a cylindrical muscle cord that could be either solely attached to the papillaris magnus muscle, a situation that we called a simple septomarginal trabecula and observed in 30 cases (93.7%), or attached by means of two muscle bundles, one of them to the papillaris magnus muscle and the other to the ventricle wall. We called the latter situation a bifurcated septomarginal trabecula (Fig 2) and observed it in two specimens (6.3%).

Fig. 1 – Septal component of the septomarginal trabecula attached to the interventricular septum.

The free part of the septomarginal trabecula may present a false tendinous cord connecting its lower margin to the septum. We observed this in six specimens or 18.7%. There may also be a tendinous cord that goes out from the upper margin of the trabecula and heads towards the septal cusp of the tricuspid valve. We found the latter situation in 20 trabeculae (62.5%).

Origin in the septum

The septomarginal trabecula originated in the cranial third of the septum in 31 specimens (96.8%) (Fig. 3) and in the middle third in one case (3.2%).

Attachment to the papillaris magnus muscle

The septomarginal trabecula was attached to the middle third of the papillaris magnus muscle in 16 hearts (50%) or to the caudal third of the papillaris magnus muscle in 16 hearts (50%).

Morphometry of the free part of the trabecula from the septum to the papillaris magnus muscle

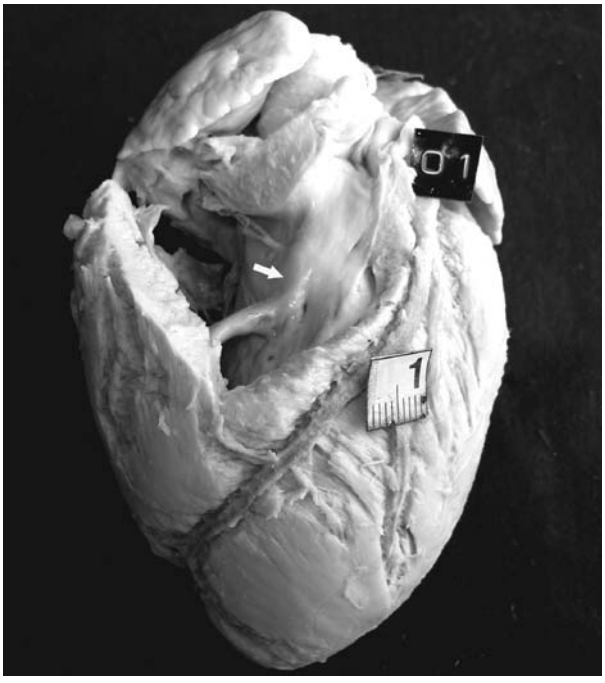

Fig. 3 – Septomarginal trabecula with origin in the cranial third to the interventricular septum

Fig. 2 – Bifurcated septomarginal trabecula.

The length of the free part of the septomarginal trabecula going from the septum to the papillaris magnus muscle ranged from 1.3 cm to 2.6 cm. The mean value found was 1.7 cm and the most frequent values were 1.9 and 1.5 cm (34.4%). The width at the midpoint of this free part was greater than or equal to 0.5 cm in 87.5% and less than 0.5 cm in 12.5%.

Discussion

The septomarginal trabecula is an important muscle bundle that connects the lower part of the septum to the anterior wall and to the base of the papillaris magnus muscle of the right ventricle. It is so resistant that, according to some authors (King, 1873), it would avoid excessive distension of the ventricle wall. For this reason, it is also known as the moderator band.

In humans, the septomarginal trabecula is a second-order trabecula that is fleshy, muscular and resistant. Its upper part carries the direct branch of the stimulating complex (Depreux et al., 1976). In goats, some authors (Depreux et al, 1976) reported that the septomarginal trabecula was a second-order fleshy trabecula or bridge that extends from the septum to the anterior wall. It was classified as having a fibromuscular constitution, with a width of 1 to 3 mm. It could present 1 to 3 false tendinous cords that join the trabecula to the lower part of the septum.

Our results indicate that the septomarginal trabecula presents two segments. The first was not a constant feature (occurring in 69%) and consisted of a third-order fleshy trabecula or crest located in the interventricular septum. The second was a second-order fleshy trabecula or bridge that extended from the septum to the papillaris magnus muscle. In most cases (87.5%), its width was greater than or equal to 5 mm. The presence of false tendinous cords to the septum was infrequent (18.7%), whereas tendinous cords to the septal cusp of the tricuspid valve were frequently observed (68.7%). The width and fleshy consistency, and the observation in some specimens of a clear band on the upper margin of the free part of the septomarginal trabecula, make us believe that, in goats, the right branch of the stimulating complex is joined to the muscle bundle that forms the trabecula. Some authors (Depreux et al, 1976) only accepted an union between the muscle and the branch of the stimulating complex in septomarginal trabeculae of muscular type, i.e. not the type seen in goats (fibromuscular). They placed the septal origin of the trabecula at the level of the subarterial papillary muscle, which we can consider to be equivalent to our indication of the cranial third of the septum (96.8%). According to some authors, the septal insertion occurred at the center of the papillaris magnus muscle (Depreux et al 1976), whereas our results indicated that 50% were in the middle third and 50% in the caudal third of the papillaris magnus muscle.

In conclusion, in goats, the septomarginal trabecula is a constant and invariable structure. The septomarginal trabecula of goats presents anatomical similarities with the septomarginal trabecula of humans. Since this search is only morphological we have no elements for functional conclusions, but the strong muscular component of the septomarginal trabecula in goats, similar to the same structure in humans and different from other mammalian species, let us argue that its function is mechanical besides giving path to the right branch of stimulant complex.

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