Presence of cartilaginous foci in the left atrioventricular opening of the chinchilla’s heart

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Summary

There are several publications in veterinary medicine reporting the presence of cartilage tissue in the heart of different classes of animals, including reptiles, birds, and mammals. Among mammalian species this phenomenon has been documented in rodents, lagomorphs, carnivores, proboscideans, perissodactyls, and artiodactyls. The aim of this study was to document foci of cartilaginous tissue in the left atrioventricular ostium and the left atrioventricular valve. These foci were located in the areas of leaflet attachment to the fibrous rings, as well as in both the parietal and septal cusps.

Keywords: cartilage, heart, left atrioventricular opening, left atrioventricular valve, chinchilla

Material and methods

The study was carried out on the hearts of 30 adult chinchillas of both sexes (16 males, 14 females), all aged 9 months, with the individuals weighing an average of 0.55 kg. Chinchillas were provided by a commercial reproductive farm (No. W-07 Warszawa-Dobre), where they were killed for fur by qualified personnel according to the Polish law and under the control of the Veterinary Inspectorate (16). According to the Polish law, tests on tissues obtained post mortem do not require an approval from the Ethics Committee. The terminology used in the manuscript is consistent with the prevailing veterinary nomenclature (18).

No pathology was noted in the gross anatomy of the thoracic cavity prior to heart excision. After isolation, the hearts were weighed. The tissues were then fixed in a 10% buffered formalin solution and immersed in paraffin (Pra-plast, Sigma). Transverse, longitudinal or sagittal paraffin block sections were cut serially with a rotation microtome into 3 μm sections. Theses samples were then stained by the routine hematoxylin and eosin (HE) method for a general assessment of the tissue structure. Additional histochemical staining was performed in order to locate cartilaginous foci.

PAS-Alcian staining was performed to show the areas of glycosaminoglycan (GAG) deposition in the extracellular matrix (ECM). The collagen fibers of connective tissue were...
stained by the van Gieson method, and orcein staining was performed on elastic fibers (1).

The histological samples were examined with a light microscope (Olympus BX 50).

Results and discussion

All hearts had a normal anatomy of the left atroventricular opening and left atroventricular valve. This left atroventricular valve apparatus was built of the septal cusp and the parietal cusp. The septal cusp was located along the interventricular septum and aortic orifice. The parietal cusp was directed along the left ventricular margin. Both leaflets originated from the periphery of the left atroventricular fibrous ring.

During the histological examination of all heart samples, cartilaginous foci were observed in the left atroventricular opening and the left atroventricular valve. These foci were located in the areas of leaflet attachment to the fibrous rings, as well as in both the parietal and septal cusps (Fig. 1).

The cartilaginous tissue in the left atroventricular opening had a semilunar shape with the convex portion directed towards the left ventricular lumen. It contained chondrocytes of typical morphology confined to small spaces (lacunae) within the matrix. Small clusters of chondrocytes, called isogenic groups (in the central portion of the semilunar shape) (Fig. 2), were frequently observed. Its ground substance was separable into pale and darkly stained areas, called interterritorial and territorial matrix, respectively. The extracellular matrix was made up of matrix composed of hyaluronic acid, proteoglycans (Fig. 3), and large quantities of collagen and elastin protein fibers (Fig. 4). According to reports, collagen makes up about 40% of the dry weight of cartilage and appears as collagen fibers immersed in the extracellular matrix, which are usually arranged irregularly in different directions. Oval or hexagonal chondrocytes were found in the central portions of the cartilage, whereas flattened chondrocytes were found in the marginal portions. Along the external margins...
of the territorial matrix of hyaline cartilage, there was a sheath known as the perichondrium that encapsulates this tissue and forms an interface between the surrounding connective tissue and the body of the cartilage.

The fibrous skeleton of the heart separates the atria from the ventricles. It is made up of fibrous rings that surround the four main orifices of the heart, as well as the right and left fibrous trigones, which connect the aortic fibrous ring with the left and right atrioventricular fibrous rings. The membranous interventricular septum also makes up part of the fibrous skeleton. The fibrous skeleton of the heart is composed of elements of fibrous cartilage, within which cartilaginous foci may form. Delicate strands of connective tissue reach all the way to the valvular leaflets. Osseous elements may appear in any of the mammalian species, but they are most often noted in the bovine (2, 4).

The observations regarding the formation of cartilage in the aortic valves of Syrian hamsters concur with the assumption that the chondrocyte precursors originate from the neural crest. Studies have show that cells from the neural crest may be precursors of chondrocytes in the pulmonary and aortic valves of hamsters (12). This hypothesis was proven because the occurrence of cartilaginous foci along the regions of the attachment of the aortic valves to their respective sinus regions is preceded by the presence of neuronal crest cells in prenatal life as well as postnatal life (7, 17).

It is believed that the presence of cartilaginous foci is not confined to the ventral wall of the valve and the dorsal aortic sinus, as previously reported (8, 13). Cartilaginous tissue can occur in any part of the sinus boundaries. There are portions of the valvular apparatus that are exposed to high tension generated by the motion of the valve during the heart cycle. This tension is distributed along each leaflet sinus, as if there was continuity between the leaflet and the valve (15). It is therefore believed that this mechanical factor plays a role in the induction of cartilaginous formation in the aortic valve. This theory is supported by studies performed by Hueper (6), Hollander (5), and Sans-Coma et al. (13). However, López et al. (12) have contradicted this theory by pointing out that mechanical forces cannot be the sole reason for cartilage formation, as their influence is too short in relation to the initial appearance of cartilaginous foci to be significant.

According to literature data, the presence of cartilaginous foci in the aortic valve of the Syrian hamster is a common occurrence. The tension mechanisms may play a significant role in their development. The occurrence and location of cartilage differ, however, between species and individuals. It has been shown that in birds and reptiles the presence of cartilaginous foci is not necessary for proper valve function. The occurrence of cartilage in the pulmonary valve is relatively infrequent, as demonstrated by López et al. (12), who found cartilaginous tissue in only 40 out of 351 Syrian hamsters (11.4%).

This is the first report of cartilaginous foci in the chinchilla’s heart. A continuation of this study is warranted in order to determine more precisely the location and function of this tissue, especially since the location in this species differs from previously reported locations in other species.

References

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