

Anatomical and Histological Description of the Right Atrioventricular Valve of the Canine Heart (*Canis lupus familiaris*)

Manuel Saldivia Paredes* and Esteban Schencke Martínez

Veterinary Anatomy Unit, Santo Tomás University, Puerto Montt, Chile

*Corresponding Author: Manuel Saldivia Paredes, Veterinary Anatomy Unit, Santo Tomás University, Puerto Montt, Chile.

Received: May 20, 2019; Published: June 27, 2019

Abstract

The atrioventricular valves are irregular cusps located in the atrioventricular orifice, separation between the atrium and ventricle. They allow the passage of blood from the atrium to the ventricle, preventing blood return. In the periphery, the cusps that are part of the atrioventricular valves are joined by a complex fibrous skeleton of dense non-patterned connective tissue that forms the fibrous rings. These fibrous rings separate the musculature of the atrium with that of the ventricle. When the ventricle contracts, the chordae tendons prevent the valves from being pushed into the atrium. These chordae tendineae are characterized by fine fibrous cords covered by endothelium, which are attached to the ventricular surface of the valves.

The objective of the present study was to anatomically and histologically describe the right atrioventricular valve, allowing to understand and clarify the atrioventricular structural morphology, considering only the right side of heart of the dog.

Keywords: Anatomical; Atrioventricular; Fibrous; Histological; Valve

Introduction

The heart is located in the thorax, between the walls of the mediastinal pleura and in canines it extends from the third rib to the caudal edge of the sixth rib. It has a cone shape and its arrangement is oblique, so that its base (basis cordis) looks towards the dorsal-cranial and its apex (apex cordis) is directed ventro-caudal and towards the left side [1].

The heart is almost completely inverted by the pericardium. This corresponds to a closed serous sac that is so deeply invaginated by the heart that it is reduced to a simple capillary cleft. The space contains serous fluid, usually sufficient in quantity to allow easy movement of the heart wall against its covering. The visceral and parietal layers of the pericardium continue with each other in a complicated reflection that runs through the atria and the roots of the great vessels. The visceral layer is so attached to the wall of the heart that it can be described as a component of the epicardium [2].

The left surface presents the atria, this region is called the auricular face (auricularis facies), the atria embrace the pulmonary trunk. Ventral to the coronary sulcus (sulcus coronarius), the ventricles are divided by the paraconal interventricular sulcus (sulcus interventricularis paraconalis). On the right surface it presents the atrial surface (atrialis facies), with the subsynchronous interventricular groove (sulcus interventricularis subsinuosus). The right ventricular margin (margo ventricularis dexter) is the convex cranial edge of the heart that comprises the right ventricle. The left ventricular margin (margo ventricularis sinister) is the caudal edge of the heart that faces the diaphragm and is composed of the left ventricle [1,3,4].

The heart is composed of three layers. The myocardium comprises the cardiac muscle. The endocardium covers the atrial and ventricular cavities. The epicardium is the outermost layer and covers the myocardium [5].

The heart is composed of three layers. The endocardium covers the atrial and ventricular cavities.

The myocardium comprises the cardiac muscle. The epicardium is the outermost layer and covers the myocardium.

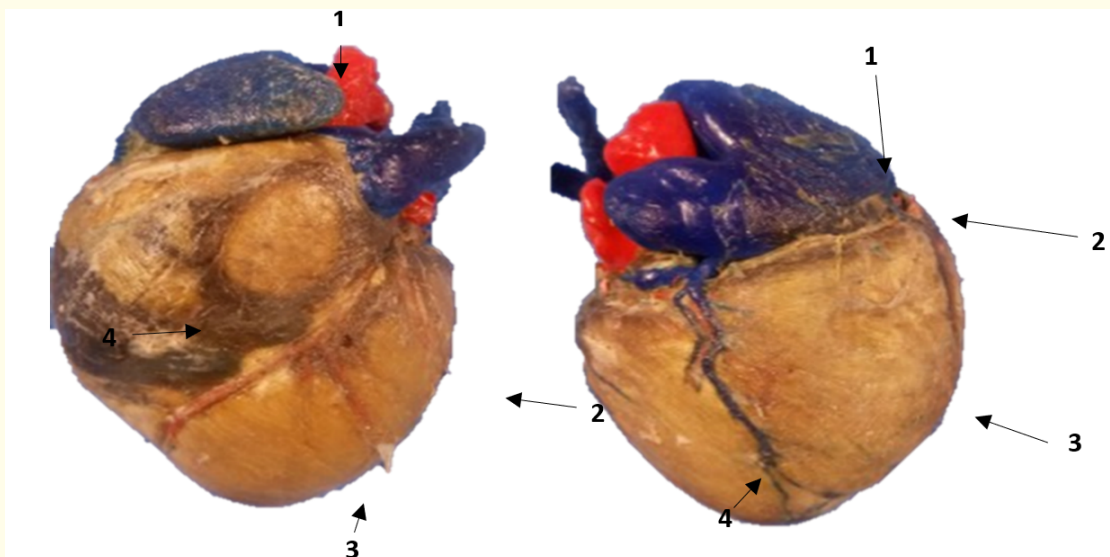


Figure 1: (A) Auricular face of the heart (Left), it is observed: 1-Left atrium, 2-Left ventricle, 3-Apex of the heart, 4-Right ventricle. (B) Atrial Face of the heart (Right), it is observed: 1-Right atrium, 2-Coronal furrow, 3-Right ventricle, 4-Left ventricle. Repletion of dog heart. Veterinary anatomy unit Santo Tomás. Montt port. Chile.

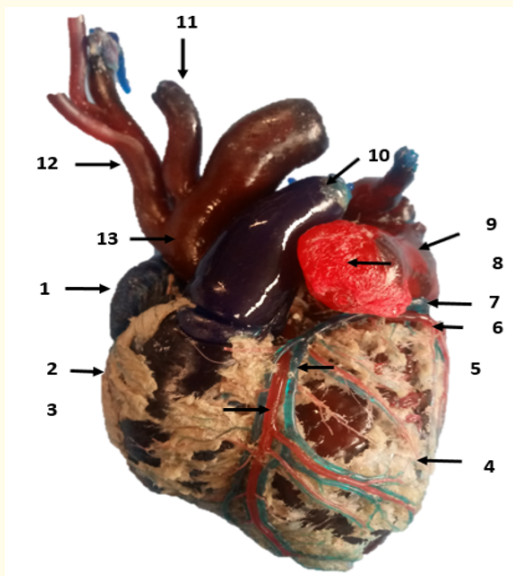


Figure 2: Observed: 1-Right atrium, 2-Right ventricle, 3-Anterior interventricular branch, 4-Right ventricle, 5-Magnetic cardiac vein, 6-Left circumflex branch, 7-Coronary venous sinus, 8-Left atrium, 9-Left atrium, 10- Pulmonary Art, 11-Art subclavian left, 12-Brachiocephalic Trunk. Repletion and corrosion of dog heart. Veterinary anatomy unit Santo Tomás. Montt port. Chile.

Right atrium

The right atrium (atrium dextrum) receives blood from the systemic veins and most of the blood, from the heart itself. It is located dorso-cranial to the right ventricle. It is divided into a main part, the sinus venarum cavarum and a blind part, which projects cranially, ventrally and to the left, is the right atrium (atrium dextrum). The main openings of the right atrium are four in all [1,6]. The coronary sinus (sinus coronarius) is the smallest of these and enters the atrium caudally from the left side. Dorsal is the caudal vena cava (vena cava caudalis), which enters the heart from caudal. The caudal vena cava returns blood from the abdominal viscera and the pelvic extremities. The cranial vena cava (vena cava cranialis) is approximately the same size as the caudal vena cava. It enters the heart from the dorsal-cranial. In the dog, the azygos vein usually enters the cranial vena cava dorsally at the base of the heart, although it occasionally enters directly into the atrium. The azygos vein drains the blood to the heart from the part of the lumbar region and three quarters of the chest wall [7]. The cranial vena cava returns blood to the heart from the head, neck, thoracic extremities, ventral chest wall and adjacent regions of the abdominal wall. The right atrioventricular orifice (ostium atrioventriculare dextrum) is the communication between the right atrium to the right ventricle [1].

Fibrous atrioventricular rings (atrioventricular anuli fibrosi) are thin rings of a tissue that is mostly collagen, which are joined by muscle fibers from the atrial and ventricular walls. The atrioventricular valves emanate from their endocardial borders. Although the proximal parts of the ventricular musculature adhere to their ventral surfaces, most of the fibers of this muscle at its origin are peripheral to the rings, since muscle tissue protrudes proximally after arising from them [1,8].

Right ventricle

The right ventricle, with a crescent shape, is located cranially to the left ventricle, although not reaching the tip of the heart [3,4]. The fourth intercostal space on the right side can be used to gain access to the main part of the right ventricle [2]. Its base is in contact with the right atrium, with which it communicates through the right atrioventricular orifice. Its left part projects to the dorsal and forms the cone of the arteries (conus arteriosus), from which the pulmonary trunk emerges. If we open the cavity it can be observed that the atrioventricular orifice and the cavity of the cone of the arteries are separated by a thickening, the supraventricular crest [6].

The right atrioventricular valve (valva atrioventricularis dextra) in humans is also known as the tricuspid valve. The cusp that joins the fibrous annulus adjacent to the ventral wall is the parietal cusp (cusps parietalis). The extremities of these two cusps become narrower and fuse or, in some specimens, small secondary cusps are formed at these sites. These are the angular cusps (cusps angularis). Peripherally, it adheres to the fibrous rings that separate the musculature of the atrium with that of the ventricle. When the ventricle contracts, the chordae tendons prevent the valve from pushing into the atrium. The chordae tendineae attach to the ventricular surface of the valve. The larger cords can be followed as ridges under the endocardium to their adjoining edges, while the finer cords go to the points of the ridges and disappear [1,9].

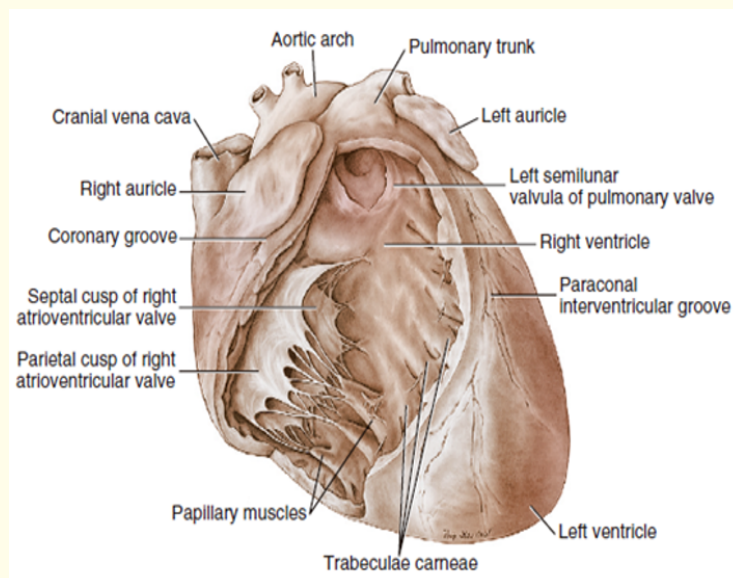


Figure 3: Interior of the right ventricle, ventral view, showing the right atrioventricular valve, with the septal cusp of the right atrioventricular valve and the parietal cusp of the right atrioventricular valve. Adapted [1].

The median strings go to the middle part of the ventricular surfaces of the valves before mixing with the proprio stratum [1]. From the parietal cusp, the chordae tendineae extend mainly to the greater papillary muscle (M. papillaris magnus), from the septal cusp mainly to the less noticeable minor papillary muscles (mm papillaris parvi) [8].

Some blood vessels have been described in the valves, adjacent to their adjoining edges, most of the nutrition of the valves is derived from the free blood in the heart. As well as the presence of a nervous network in the atrioventricular and semilunar valves of the dog that was concentrated near the junctions of the chordae tendineae. The nerves that make up the valvuloventricular plexus were derived from the atrial subendocardial network. In general, the right atrioventricular valve is better innervated than the left atrioventricular valve [1].

Atrioventricular histology

3 strata or layers are described, one fibrous, which forms the center of the valve and contains fibrous extensions of the dense non-molded connective tissue of the rings of the cardiac skeleton; Spongy, which is formed by loose connective tissue located on the atrial or vascular side of each valve. It consists of elastic fibers and lax disposable collagen infiltrates with a large number of proteoglycans. The sponge acts as a shock absorber since it reduces the vibrations associated with the closing of the valve. It also confers flexibility and plasticity to the cusps of the valve; Ventricular, which is contiguous to the ventricular surface of each valve and has an endothelial lining. It contains dense connective tissue with many layers of elastic fibers.

In AV valves, the ventricular layer is continued with the chordae tendineae, which are thin fibrous cords also lined by endothelium. They extend from the free edge of the AV valves to muscle projections of the wall of the ventricles called papillary muscles [10].

The leaflets of the tricuspid valve are composed of a fiber skeleton and an endocardial surface. The atrial layer of the endocardium shows a smooth surface is a monolayer of endothelium. These cells are interconnected in several ways. They show a straight edge interlaced with each other or show superimpositions similar to “tiles”. It has been speculated that this arrangement is important to maintain structural integrity in the maximum stretch. The endothelium is underlined by a basement membrane, composed of an osmophilous dense lamina and a rare osmophobic lamina. The spongy lamina is composed of a layer disposed of connective tissue. The fibrous sheet is composed of dense collagen fibers that form a solid plane. The sections of electron microscopy through the sheets reveal that the fibers are arranged parallel and vertical to the free margin of the sheets [11].



Figure 4: IA photomicrograph showing the myocardioocytes bundles (M), the purkinje fibers bundle (arrow head), blood vessels (long arrow) and lymph vessels (short arrow). Stain: Hand E Obj.x4: OC.x10. Adapted from (11).

Materials and Methods

The dissection of 3 dog hearts was carried out, which were kept in the veterinary anatomy laboratory of the Santo Tomás University, Puerto Montt. The patients were donated to the anatomy unit by the clients with prior authorization.

For the selection of the 3 patients with whom we worked, the following inclusion criteria were considered:

- Canine patients
- No race distinction
- No distinction of sex
- Range age greater than 2 years and less than 5 years
- Body situation between 3 to 3.5
- Cause of death due to acute polytraumatism
- Time of death no more than 7 days.

As an exclusion criterion, the following were considered:

- Non-canine patients
- Patients of less than 2 years or more 5 years
- Low body condition [1] or overweight [6]
- Facing by multi-systemic diseases (congestive heart failure (CHF), Acute renal failure (ARF), Chronic renal failure (CRF)).
- Time of death greater than 7 days

The hearts were extracted by dissecting the skin in the left ventrolateral region at the level of the chondral joint between the second and seventh thoracic ribs. The incised muscles were M. pectoral superficial, M. pectoral profunda, M. recto thoracic and part of M. rectus abdominis, in its most cranial portion. Then the chondral cost articulation was incised by separating it through a cut, from the second to the seventh rib. Allowing the ribs to be displaced cranially by means of the dissection of the thoracic rectus muscles, M. scaleno, M. serratus ventral thoracic portion, external intercostal M. and internal intercostal M. We proceeded to take the heart and extract it by cutting large vessels and ligaments that adhere to its position. Then the pericardial sac of the heart was separated. Posteriorly, a cut was made to the hearts in the right ventricle at the level of the interventricular septum and in the vicinity of the pulmonary valve, continuing ventrocaudally in proximity to the interventricular septum, in order to gain access to the right atrioventricular valve.

For histological sections, the complete right atrioventricular valve was dissected, first, by the parietal cusp and then the septal cup. For its later sending to the histology laboratory of the Santo Tomás University. The stains used were Hematoxylin and Eosin (H-E) and Van Gieson's elastic stain.

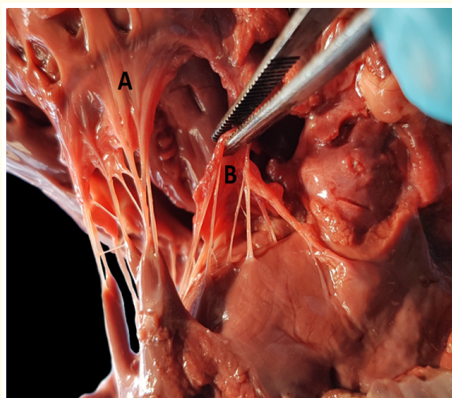


Figure 5: Dissection of the right atrioventricular valve, ventrocaudal view, is observed: (A) Parietal cusp; (B) Septal cusp. Veterinary anatomy laboratory, Santo Tomás University, Puerto Montt.

Results and Discussion

The morphological characteristics at the right atrioventricular valve level found in the dissected hearts are assimilated to that described by [1]. This allows to clarify that the terminology “tricuspid valve” is not correct in the canine species. Alignment and homogeneity were observed in the entire extension of the cusp from its base to the vertex. It was not possible to observe the presence of angular cusps. The tendinous cords presented a whitish coloration, elastic and strongly adhered to the papillary muscles, their elongation from the cusp to the papillary muscle at the endocardium level did not present differentiations.

The septal cusp was characterized by a greater thickness in relation to the parietal cusp, not to mention that the latter has a greater length, due to its relationship with the adjacent fibrous annulus that allows joining both anatomical structures.

Histologically it coincides with the description of [10], who state that there are 3 strata at the valvular level.

This could be corroborated when performing the histological observation of the atrioventricular valves, identifying a spongy, fibrous and ventricular layer.

To clarify his observation, Van Gieson’s elastic stain was used. I can easily differentiate between the layer and the ventricular layer, as it gives a brown to pink tone.

The ventricular stratum showed a smaller amount of collagen fibers and a brown tone of its cellular components was observed.

In the stratum or fibrous layer, due to its greater amount of collagen fibers, a homogenous pink shade was observed, very few elastic fibers were present in this segment.

Finally, the spongy layer is completely pink, except for the cell nuclei that stain brown equally.

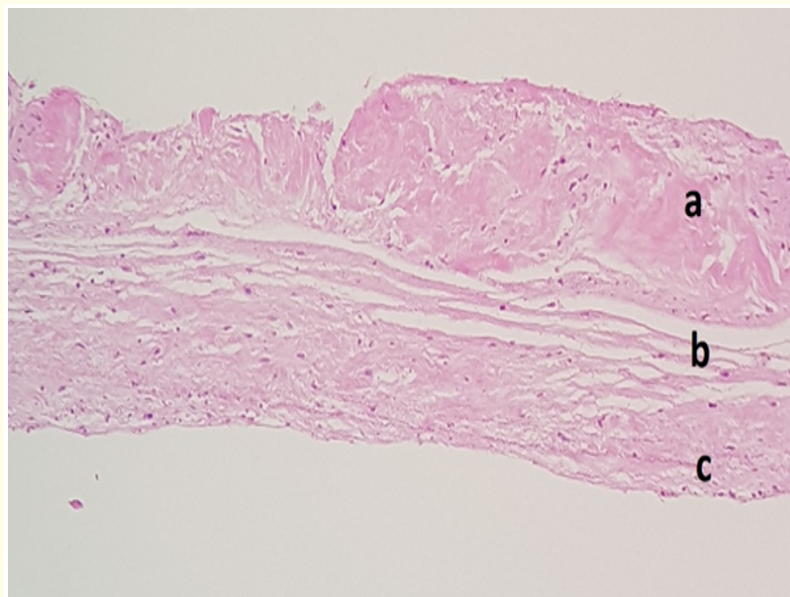


Figure 6: Septal cusp of the right atrioventricular valve, H & E (40x). (a) spongy layer, (b) fibrous layer, (c) ventricular layer.

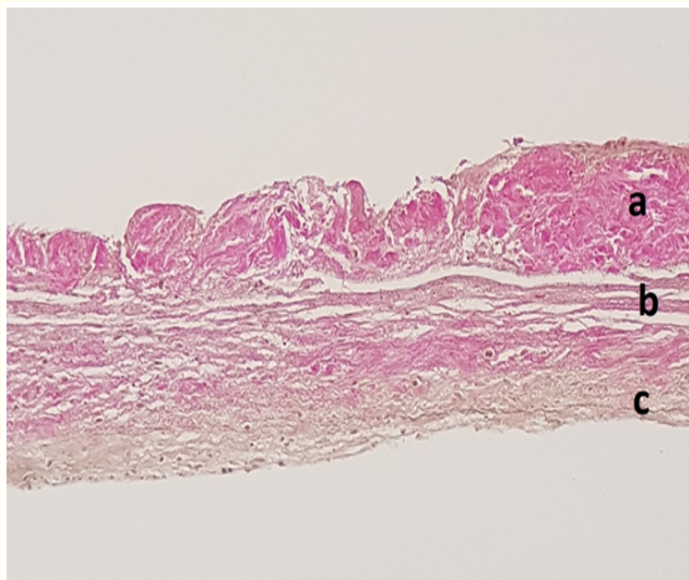


Figure 7: Septal cusp of the right atrioventricular valve, Van Gieson elastic stain (40x). (a) spongy layer, (b) fibrous layer, (c) ventricular layer.

The endothelial cells presented a uniform interlaced order, allowing to observe a straight edge.

Conclusion

Anatomically the heart of the dog is similar to that of many mammals, fulfilling a unique functionality as a pump. The structural arrangement of four chambers, two atria (right and left) and two ventricles (right and left) allow to grant a unique morphology.

It can be clarified through the dissection and corroboration of the literature that the anatomical terminology of the tricuspid valve is not correct in the anatomical descriptions of the dog.

The concept of atrio ventricular valve, in veterinary anatomy is the correct terminology due to the presence of two large cusps (Septal and parietal).

The tendinous cords and papillary muscles did not present differences being similar to what was proposed by different authors.

Histologically, there are not many changes in the descriptions made in humans, it can be extrapolated to the dog, referring to the strata, and the cellular ordering of the endothelium.

The importance of performing descriptive anatomical studies lies in the genetic variability that occurs in different species in veterinary medicine, many of them generating completely different adaptations proposed by the classic anatomical literature.

Volume 2 Issue 5 July 2019

© All rights reserved by Manuel Saldivia Paredes and Esteban Schencke Martínez.