

## Heart anatomy of *Giraffa camelopardalis rothschildi*: a case report

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**ABSTRACT:** In the present study the most outstanding anatomical findings of the heart of a giraffe are described. Two papillary muscles were found in the right ventricle, namely magnus and subarterial. There were no papillary parvi muscles. The supraventricular crest gave insertion to various tendinous chords. These chords fixed the angular cusp of the right atrioventricular valve. The pectinate muscles were better developed in the left auricle than in the right one. Within the left ventricle two big papillary muscles were found as well as a notorious septomarginal trabecula. The left coronary artery irrigated the majority of the heart's territory. It gave origin to the interventricular paraconal branch and to the circumflex branch. The latter gave off the branch of the left ventricular border and the interventricular subsinusal branch.

**Keywords:** animal anatomy; heart anatomy; wild animals; Giraffidae; coronary vessels

Several physiologic studies of the cardiovascular system of the giraffe were performed in the fifties (Goetz, 1955; Goetz and Budtz Olsen, 1955; Goetz and Keen, 1957; Smith, 1957, Goetz et al., 1960). These authors stated that the heart of the giraffe is very large, weighing up to 11.3 kg (Goetz, 1955). It was also reported that the heart of the giraffe is heavier in relation to body weight than in other large mammals and that the walls of the left and right ventricle measure 7.5 cm and 2.5 cm, respectively (Goetz, 1955; Goetz and Keen, 1957). In these studies only the weight of the heart and the thickness of its walls are determined, but there is no morphologic description of the giraffe's heart.

The objective of this article is to describe the most relevant anatomic features of the heart of a giraffe (*Giraffa camelopardalis rothschildi*).

### MATERIAL AND METHODS

The heart obtained from a necropsied animal at a local zoo was studied following fixation in a 10% formaldehyde solution. The body weight of

the animal was 1 800 kg. After studying the external conformation and the distribution of the blood vessels, both ventricles were cut open parallelly to the coronary and interventricular sulci, and both auricles were cut at their free border, with the aim of studying the internal conformation. The terminology of the NAV (2005) was employed.

### RESULTS

The heart of the animal that we studied weighed 4.3 kg. The circumference at the level of the coronary sulcus measured 60.0 cm. The distance between the pulmonary trunk and the apex measured along the auricular face was 25.0 cm. The distance from the coronary sulcus to the apex measured along the subsinusal sulcus of the atrial face was 28.0 cm. The interventricular paraconal sulcus crossed the ventricular border 9.0 cm away from the apex.

At the right atrium, the right auricle and its pectinate muscles were poorly developed. The right atrioventricular orifice was closed by means of the right atrioventricular valve. The latter was tricuspid.

Several tendinous chords ran from their insertion at the supraventricular crest to the angular cusp of the right atrioventricular valve. The septomarginal crest was attached to the septal wall at a site near the base of the supraventricular crest. It measured 7.5 cm in length. One tendinous chord was inserted directly to the septal wall at a site 0.5 cm away from the supraventricular crest.

Within the right heart two papillary muscles were found. The papillary muscle found on the septal wall, the subarterial papillary muscle, was bilobed. It received tendinous chords from both the septal and parietal cusp of the right atrioventricular valve. The papillary muscle arising from the marginal wall, magnus papillary muscle, was simple and gave insertion to the septomarginal trabecula. It also received the tendinous chords of the septal and angular cusp of the right atrioventricular valve. There were no papillary parvi muscles.

Almost the entire surface of the inner walls of the right ventricle was smooth, and the number of trabecula carneae was small. Most of them could be found in the marginal wall near the magnus papillary muscle.

The pectinate muscles of the left auricle were developed very well, much more than in the right auricle.

The thickness of the left ventricle wall was 4.0 cm. The widest part of the interventricular septum measured 4.5 cm. Within the left ventricle there were two large papillary muscles on the parietal wall. The septomarginal trabecula and tendinous chords of both cusps of the left atrioventricular valve were inserted on the subatrial papillary muscle. The thicker tendinous chords belonged to the septal cusp.

The subauricular papillary muscle also received the thicker tendinous chords from the septal cusp and thinner chords belonging to the other cusp.

The septomarginal trabecula proceeded from the expulsion route of the left ventricle and distally it ramified sending one branch to the subatrial papillary muscle and several branches to the parietal wall (Figure 1).

The left atrioventricular valve was bicuspid and the aortic valve had three cusps. When the cusps of the aortic valve were opened imitating their position during systole, the left semilunar cusp completely covered the orifice where the left coronary artery originates.

Within the cardiac skeleton there was a cardiac bone which occupied most of the right fibrous trigone. The left fibrous trigone had a tiny structure composed of hyaline cartilage.

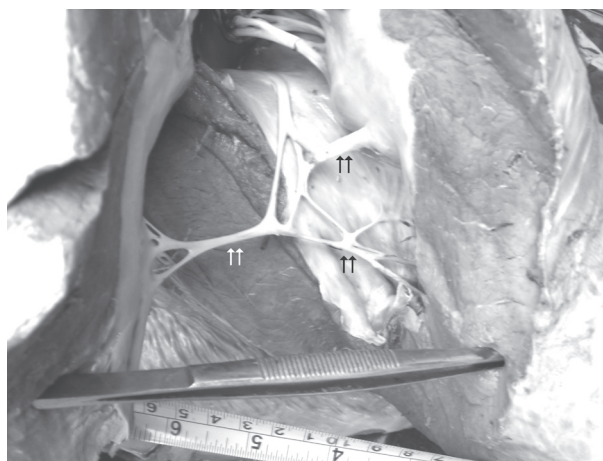


Figure 1. The interior of the left ventricle showing a left septomarginal trabecula (arrows)

The arterial irrigation of the heart proceeded from the two coronary arteries (Figure 2), and the left coronary artery irrigated the majority of the cardiac territory.

The left coronary artery emerged from a large orifice on the left sinus of the aorta. It divided into the interventricular paraconal and circumflex branches (Figure 2). The interventricular paraconal branch followed the sulcus of the same name along the

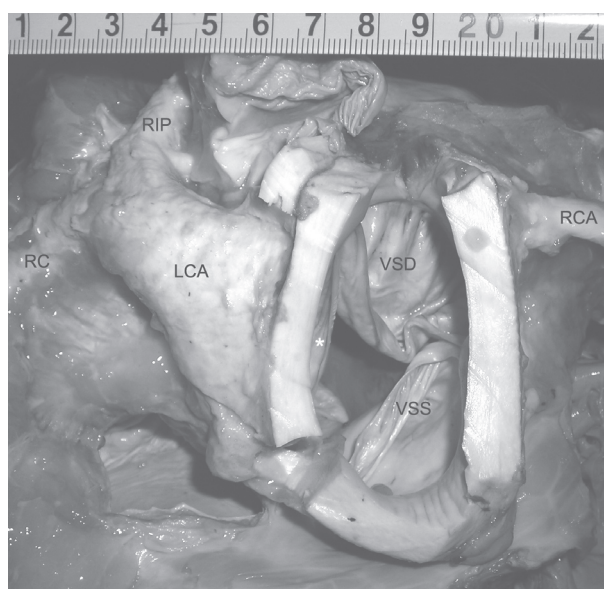


Figure 2. Dorsal view of the valva aorta and coronary arteries. LCA = left coronary artery; RCA = right coronary artery; RIP = ramus interventricularis paraconalis; RC = ramus circumflexus; VSD = valvula semilunaris dextra of valva aorta; VSS = valvula semilunaris septalis of valva aorta

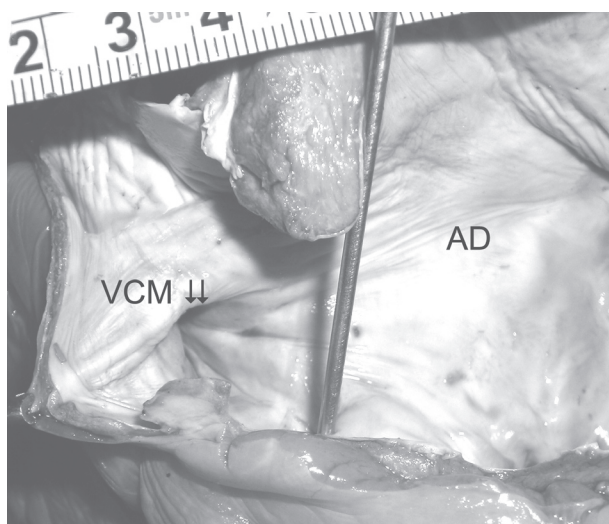


Figure 3. The right atrium (AD) with venous openings of vena cordis magna (VCM) and the vena cordis media (hook inside)

auricular face of the heart and gave branches for both ventricles. The circumflex branch followed the coronary sulcus and gave the branch of the left ventricular border, which it divided distally. Upon arriving at the subsinusal interventricular sulcus the circumflex branch runs along it as the subsinusal interventricular branch.

The right coronary artery had a very small diameter and travelled a shorter distance than the left one.

The venous system was composed mainly of the vena cordis magna and the vena cordis media, both of which opened as two separate orifices in the right atrium, at a site ventral to the orifice of the caudal vena cava (Figure 3).

## DISCUSSION

The studied heart of the giraffe was quite weightless compared with another report that found hearts weighing up to 25 lbs (Goetz, 1955). The studied heart came from an animal with restricted physical activity.

The most outstanding findings of the cardiac conformation belonged to the internal anatomy of the heart. In the right ventricle there were no papillary parvi muscles, in opposition with what is seen in domestic animals.

The septomarginal trabecula of the right ventricle was similar to that in domestic ungulates, where it has been studied in detail (Truex and Warshaw, 1942; Depreux et al., 1976).

A similar structure, although more complex because of its branching, was found in the left ventricle of the giraffe (Figure 1). These bands have been named trabeculae septomarginales sinistralae in the NAV (2005). Moderator bands were described in the left ventricle (Truex and Warshaw, 1942; Ghoshal, 1975; Gerlis et al., 1984). An excessive, abnormal number of these bands was associated with cardiac decompensation in cats (Liu et al., 1982). The bands usually extended from the papillary muscles to the interventricular septum in animal hearts (Ghoshal, 1975; Deniz et al., 2004). They were composed of muscle tissue in various proportions in human and dog hearts, and of connective and conductive tissue in sheep and goat hearts (Deniz et al., 2004). According to Truex and Warshaw (1942) they contain bundles of fibres derived from the left branch of the atrioventricular bundle.

The topographic disposition of the atrioventricular and arterial ostiums, as well as the constitution of the cardiac valves was similar to the descriptions done for the domestic ruminants (Barone, 1996; NAV, 2005). The fact that it is the left coronary artery that is blocked when imitating the systolic opening of the aortic valve and not the right coronary artery indicates that the latter one can receive blood during systole, but not so the left artery, this one receiving blood only during diastole.

Furthermore the disposition of the fibrous trigonum and cardiac bones was grossly the same as described for ovines and caprines, where the left bone is not present (Barone, 1996).

Since the left coronary artery predominates (Figure 2), this animal corresponds to the so-called left type. This is similar to what happens in ruminants and domestic carnivores (Barone, 1996).

Moreover the disposition of the venous orifices of the major and middle cardiac veins within the right atrium (Figure 3) is analogous to what was described in horse (Barone, 1996).

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