

Anatomical study on coronary arteries in dogs

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SUMMARY

Coronary arteries from dogs are often used in experiments on the action of drugs, for clinical observations and surgical applications. The objective here was to observe the frequency, morphometry, quantity and destination of coronary artery branches, and the endings of these branches. Methods: For this anatomical study on coronary arteries, thirty hearts from mongrel dogs of various ages and both sexes were used, fixed in 10% formalin. The coronary arteries and their branches were dissected as far as the ends of the macroscopically visible ramifications. Results: There was one left coronary artery ending in two (86.7%) or three (13.3%) branches. The paraconal interventricular branch, of length 5.6-8.7 cm, issued 5 to 14 branches, 49.5% to the right ventricle and 50.5% to the left ventricle. The circumflex branch, of length 3.3-6.7 cm, issued 3 to 12 branches to the left ventricle (59.4%) and 1 to 6 branches to the left atrium (40.6%). There was one right coronary artery, of length 1.0-7.2 cm, which issued 6 to 21 branches: 61.1% to the right ventricle and 2 to 9 branches to the right atrium. The subsinuosal interventricular branch, of length 1.0-6.2 cm, issued 1-8 branches: 59.6% to the right ventricle and 40.4% to the left ventricle. Conclusions: Comparison between the results obtained from the present study and the results found in the specialized literature indicates that the distribution of the coronary branches in dogs and humans not is similar.

Key words: Coronary arteries - Dog anatomy - Heart vascularization

INTRODUCTION

Over recent years, increasing numbers of studies on animal hearts have been conducted. Their aim has been to observe the application of animal hearts to experimental pharmacological studies, clinical practice and heart surgery. This large number of studies can clearly be seen in relation to evaluations on the coronary arteries. The literature shows that one hundred studies on the coronary arteries of dogs are conducted per year (Sukmawan et al., 2007; Del Rio et al., 2008; Han and Wei, 2008).

Despite the large number of studies using the coronary arteries of dogs, there are few references in the literature to detailed studies on the anatomy of these arteries (Bull and Boaro, 2002; Noestelthaller et al., 2005; Noestelthaller et al., 2007; Weaver et al., 1986; Dyce et al., 2004; Kelly et al., 2009). Taking the view that anatomical knowledge of the coronary arteries of dogs might assist in conducting studies like the ones cited above, we proposed to conduct an anatomical study on these arteries in dogs. The aim was to observe the frequency, morphometry, quantity and destination of coronary artery branches, and the endings of these branches.

MATERIAL AND METHODS

The material used in this study consisted of 30 hearts from mongrels: 19 males and 11 females. It included dogs ranging in age and weight from: 12 dogs between 8-13 kg; 11 dogs between 14-19 kg; 7 dogs between 20-25 kg. There were 7 dogs with 4 years or less; 8 dogs with 5 and 6 years, 5 dogs with 7 years or more and 10 dogs with unknown age. The hearts were fixed and conserved in 10% formalin. The hearts came from dogs that were used within the Discipline of Surgical Technique of the School of Medicine of UNIPLAC, in its regular classes for the medical course.

After removing the heart from the animal's thorax, we washed it to remove coagulum from the cavities and from inside the coronary arteries. The cavities were filled with cotton wool to maintain the shape. The coronary arteries were identified and dissected. In some specimens, to expose the arteries and their branches better, we introduced a plastic cannula into the arteries to inject red-colored neoprene latex. Next, we dissected the arterial branches as far as their macroscopically visible terminations.

Morphometry was performed using a metal wire extended along the artery and its branches. These lengths were then measured using a pachymeter. The reference point of the *Crux cordis* was used in this study, and was defined as the location where the interatrial, subsinuosal interventricular (posterior interventricular) and coronary sulci crossed.

RESULTS

Left coronary artery. The left coronary artery present in all the hearts was single (100.0%). Its length ranged from 0.5 to 1.2 cm, with a mean of 0.7. It terminated by forming the paraconal interventricular and circumflex branches (86.7%) or the paraconal, circumflex and diagonal interventricular branches (13.3%) (Fig. 1).

Paraconal interventricular branch. The paraconal interventricular branch was located in the sulcus of the same name. It was present in all of the hearts and was single (100.0%). Its length ranged from 5.6 to 8.7 cm, with a mean of 6.9 cm. It issued 5-14 branches, with a mean of 9.9 branches, of which 49.5% went to the right ventricle and 50.5% to the left ventricle.



Fig. 1. Dog heart, auricular surface showing the paraconal interventricular branch (PIB), and the left coronary artery (LC).

This artery could terminate before reaching the apex of the heart (10.0%), at the apex (56.7%) or beyond the apex, continuing onwards to terminate at the subsinuosal interventricular sulcus (33.3%).

Circumflex branch. The circumflex branch was located in the coronary sulcus. It was present in all of the hearts and was single (100.0%). Its length ranged from 3.3 to 6.7 cm, with a mean of 4.7. It issued 3-12 branches (mean of 6 branches) to the left ventricle (59.4%), and 1-6 branches (mean of 4.1 branches) to the left atrium (40.6%). This artery could terminate before reaching the *Crux cordis* (3.3%), at the *Crux cordis* (40%) or beyond the *Crux cordis* (56.7%). Its left ventricular marginal branch was always present (100.0%) and this could terminate before reaching the apex (53.3%) or at the apex (46.7%) (Fig. 2).

Right coronary artery. This artery was located in the coronary sulcus. It was present in all of the hearts and was single (100.0%). Its length ranged from 1.0 to 7.2 cm, with a mean of 3.8 cm. It issued 6-21 branches (mean of 6.5 branches) to the right ventricle (61.1%), and 2-9 branches (mean of 4.2 branches) to the right atrium (38.9%). Its right marginal branch was present in 93.3% of the hearts.

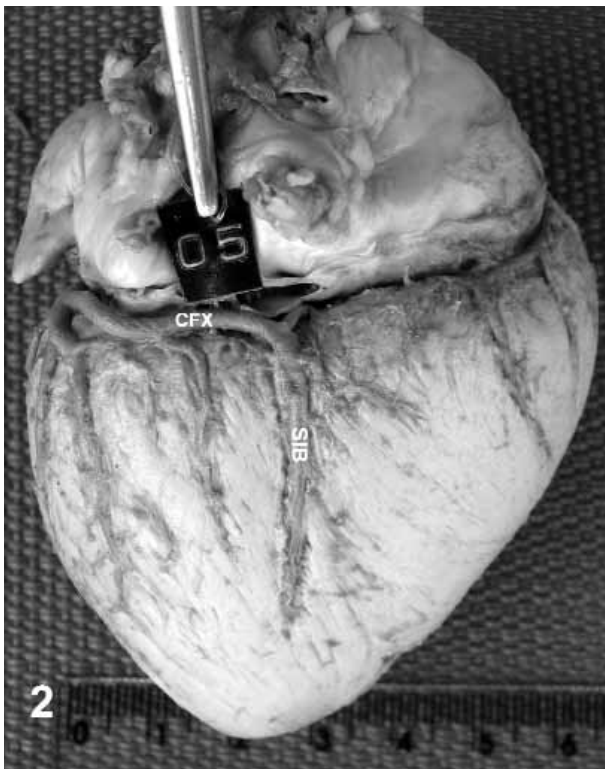


Fig. 2. Dog heart, atrial surface showing the subsinoasal interventricular branch (SIB) and circumflex branch (CFX) of the left coronary artery.

Subsinoasal interventricular branch.

This branch was located in the sulcus of the same name (corresponding to the posterior interventricular sulcus in humans). It was present in all of the hearts and was single (100.0%). Its length ranged from 1.1 to 6.2 cm, with a mean of 3.4 cm. It issued 1 to 8 branches (mean of 4.1 branches), and 59.6% of them were to the right ventricle and 40.4% to the left ventricle (Fig. 2).

This artery could terminate before reaching the apex of the heart (70%), at the apex (20%) or beyond the apex, continuing onwards to terminate at the paraconal interventricular sulcus (10%).

DISCUSSION

Dog hearts are greatly used in experiments aimed at applications in human hearts. We believed that it would be opportune to investigate whether similarities exist between dog and human hearts, starting with the distribution of the coronary arteries.

The diagonal branch has been found to be present in 13.3% of dog hearts, while this is found in human hearts: 45.3% (Baptista et al., 1991), 35% (Lujinovic et al., 2005), 14% (Kiliç et al., 2007) and 25% (Loukas et al., 2009).

In dogs, the paraconal interventricular branch (anterior interventricular branch in humans) was found to issue a mean of 9.9 branches, of which 49.5% were to the right ventricle and 50.5% to the left ventricle. According to Hamby (1979) the medium number is 15 branches, 60% for the left ventricle and 40% for the right ventricle, for Baptista et al. (1989), this artery in humans may have 16 branches, of which 25% go to the right ventricle and 75% to the left ventricle. Three diagonal branches were founded by Loukas et al. (2009).

The circumflex artery issues up to 10 branches to the left ventricle in humans and terminates before the *Crux cordis* in 86.1% (Baptista et al., 1990). The circumflex artery reaches the *Crux Cordis* in human hearts in 10% (Loukas et al., 2009). Our study showed that there were up to 10 branches going to this destination, and that the artery terminated at or beyond the *Crux cordis* in 96.7% of the dogs. The left ventricular marginal branch (left marginal branch in humans) was found in 100% of the dog hearts, while Baptista et al. (1990) found this in 96.2% of the human hearts.

According to Baptista et al. (1988), the anterior interventricular branch reached the apex in 95% and the left marginal branch reached it in 19.7% of the human hearts. For Hamby (1979) in 17% to 36% of cases the artery terminates at the apex and in 60% the human hearts it usually crossed the apex. Our study demonstrated that the paraconal interventricular branch (corresponding to the anterior interventricular branch in humans) reached the apex in 90% and the left ventricular marginal branch (corresponding to the left marginal branch in humans) reached it in 43.3%.

The left coronary artery is short and terminates with the formation of two branches: the paraconal and circumflex interventricular branches. At lower frequency (13.3%), it may also issue the diagonal branch. The paraconal interventricular branch, which is the longest branch, issues equal numbers of branches to each of the ventricles and terminates at the apex or the subsinoasal interventricular sulcus. The circumflex branch issues branches to the left ventricle and atrium and terminates at the *Crux cordis* or goes beyond it. The subsinoasal interventricular branch, which is the terminal branch of the circumflex branch of the left coronary artery, issues equal numbers of

branches to both ventricles and terminates before or at the apex of the heart.

Comparison between the results from this study and the results from humans reported in the specialized literature indicate marked differences in the distribution of coronary arteries between dogs and humans.

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