

Architecture of Buffalo's (*Bubalus bubalis*) Coronary Arteries

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Abstract: The buffalo have belonging to ruminant family. Causality the buffalo has many physiological and anatomical variations with other ruminants. Many different organs of buffalo were studied by different scientists. Some of buffalo organs had distinctive variation and some of it had not variation with another ruminant. The heart is important organ from circulatory system. It has two blood supplies, nutritional and functional. Nutritional blood supply pattern of the heart has variation in different animals. They are mono and bicorony type. The heart of ruminants has monocorony type circulation pattern and heart of the horse and human has bicorony type circulation pattern. In this survey, biometrical characterizes and anatomical structure of buffalo coronary arteries and its branching were studied. Twenty healthy buffalo hearts were collected from Tabriz slaughterhouses and slaughterhouses of another city around Tabriz. Buffalo hearts are used for biometrical studies and studying architecture of coronary arteries. Anatomical structure of buffalo coronary arteries are detected by injection contrast media such as barium sulphate and maglumin and injected by gelatin and latex for determination derivatives branches. Obtained results of this survey are showed that buffalo heart has two coronary arteries. They were right and left coronary artery. Right coronary arteries originated from right coronary sinus and lied in right coronary groove. It was named circumflex branch in this region Then, it was entered in subsinusal groove and extended till apex of the heart. Right coronary artery was named subsinusal interventricular artery in this groove. Circumflex branch and subsinusal interventricular branches had many collateral branches which they supplied the wall of right atrium and right ventricle subsinusal interventricular branch had three large and important collateral branches which they were named ventricular edge, proximal left collateral and distal left collateral branches. Left coronary artery originated from left aortic sinus and passed a short distance and arose 2 branches. They had many collateral branches but two collateral branches were instant and important which they named left proximal and distal collateral branch. Present study results were appeared which buffalo heart was imitating from bicorony pattern circulation. It was not similar to another ruminant and was similar to horse.

Key words: Anatomy, buffalo, heart, ruminant, coronary vein

INTRODUCTION

The buffalo is special species in ruminant, which they are indaian and domestic animals in Asia. Buffalo have high production rate when they are feeding by low quality food materials and also, they are resistance against local diseases. Therefore, buffalo is a suitable farm animal in Asia (Ayazi, 1992). Anatomical structures and physiological properties of buffalo are not explained completely yet. Therefore, buffalo is an unknown animal.

Anatomical structures and physiological properties characteristics are important factors for diagnosis of body disorders or disease. Different studies are performing on buffalo anatomical structures, physiological properties and nutritional necessary in recent years by Asian researcher chiefly. The heart is important organ in circulatory system which has conical shape and occupes greater parts of middle mediastinal space (Rao *et al.*, 1984). It has four chamber, 2 atria and 2 ventricles and is attached at its base by the large vessels (Getty, 1975a).

The heart has 2 blood supply or circulation, nutritional and functional circulation. Nutritional circulation supplied heart cell nutrition and gas necessities. Nutritional blood supply pattern of the heart has important variation in different animals. They are monocorony type and bicorony type. The heart of ruminants has monocorony type circulation pattern and the heart of the horse and human has bicorony type circulation pattern (Getty, 1975a, b; Miller *et al.*, 1964; Nickle *et al.*, 1986; Williams *et al.*, 1989). The heart of the buffalo is an organ that is not sufficient information about it in the scientific references and reports. In this research, morphometric characteristics and the architecture of nutritional blood supply pattern of buffalo's heart were studied by *in vitro* angiographic method and latex injection dissection method.

MATERIALS AND METHODS

Twenty healthy buffalo's hearts were collected from Tabriz slaughterhouses and another city around the Tabriz slaughterhouses. The hearts immersed in heparin and normal saline solution (1/500000) immediately after slaughter in slaughterhouse. This solution can be prevented from clot formation in the heart vessels and therefore, the clot is not forming in objected vessels (Ahmed *et al.*, 1978; Jian and Dhingra, 1992; Rao *et al.*, 1984). The heart biometry performed in 2 directions by wet silk surgical thread and metal rule. Then the coronary arteries were cannulated and injected and then radiographs were prepared. Heart angiography was performed *in vitro* method by Shimatsu radiographic apparatus (1500 mL amp), in condition 16-18 mL amp per second radiation, in Tabriz Imam Khomeini hospital. Barium sulphate solution and maglum in ampoule was using as contrast media (Ahmed *et al.*, 1978; Singh *et al.*, 1984). Angiographs were prepared in two heart aspects. They are atricular and auricular surfaces. Then coronary arteries were injected by red colored latex in right and left aortic sinus and then injected hearts dissected for observation of manner of to arise coronary arteries and other derivatives arteries from coronary arteries.

RESULTS

Biometrical results are showed in Table 1. This information is appeared which buffalo's heart shape is flattened cone, which it was depressed from base to apex.

Angiographic results of coronaries arteries: Angiographs were appeared which 2 coronary artery of buffalo have following architecture:

Table 1: Biometrical results of the buffalo's heart

Average of diameter	Average of half of diameter	Average length from base till apex	
		Atricular surface	Auricular surface
34.11±5.7	17.34±2.42	20.69±1.88	21.53±3.26

Left coronary artery: This artery was originated from left aortic sinus and 2 principle arteries arose from it. These arteries were interventricular paraconal artery and left circumflex coronary artery (Fig. 1).

Interventricular paraconal artery: This study results was appeared which this artery had commune origin with circumflex coronary artery in 70% cases and was originated individually from left aortic sinus in 30% cases. It was leaving coronary sinus between pulmonary trunk and the left auricle and proceeded to apex of the heart in interventricular paraconal groove. It was derivate many small and large branches in this groove. It changed to 2 distal branches similar handlebar mustache in near apex. Two branches were large and distinct. They were left proximal and distal collateral branches. Left proximal branch arose proximal. It supplied the most regions in wall of left ventricle. Left distal collateral branches arose in caudal border of interventricular paraconal artery in 1/3 distal and supplied most distal area in wall of left ventricle (Fig. 1 and 2).

Left circumflex coronary artery: It originated from left aortic sinus. In 70% cases, it had commune origin with interventricular paraconal artery but in 30% studied cases it originated individually from left aortic sinus in behind origin interventricular paraconal artery. It run to caudal in near apex left auricle and proceeded to atricular surface in left coronary groove and terminated before to reach to interventricular subsinusal groove. It was covered by much fat tissue in coronary groove. Left circumflex coronary artery derived many collateral branches from dorsal border and ventral borders. They were dorsal and ventral branches. Dorsal branches supplied the wall of left atrium and left auricle and ventral branches supplied wall of left ventricle chiefly. It had many anastomotic branches for right coronary artery (Fig. 1 and 2).

Right coronary artery: It was originated from right aortic sinus and run into right coronary groove. Right coronary artery was named right circumflex coronary artery in this region. It was proceeded to interventricular subsinusal groove and continued in this groove and was named interventricular subsinusal artery (Fig. 3 and 4).

Right circumflex coronary artery: This artery was proceeded to ward right coronary groove and covered by

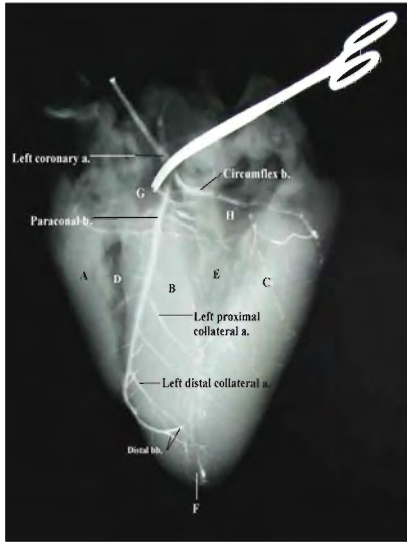


Fig. 1: Buffalo's heart radiograph in auricular surface. A: Right ventricle wall. B: Interventricular septum. C: Left ventricle wall. D: Right ventricle. E: Left ventricle. F: Apex of the heart. G: Right atrium. H: Left atrium

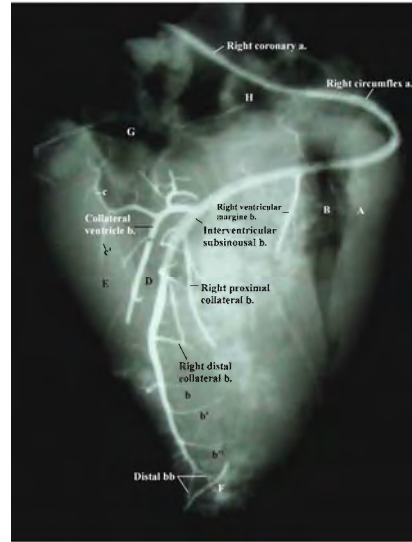


Fig. 3: Buffalo's heart radiograph in atrial surface. A: Right atrium wall. B: Right ventricle. C: Interventricular septum. D: Left ventricle. E: Left atrium. G: Right atrium b, b', b'', c, c', Small collateral branches

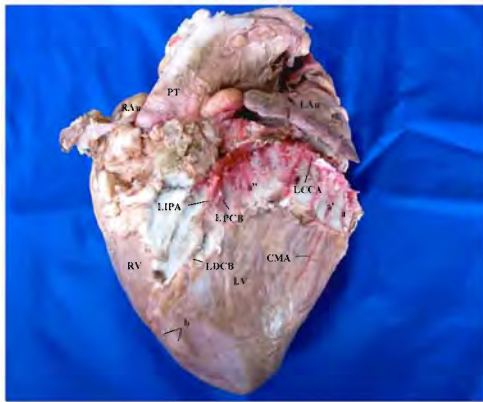


Fig. 2: Buffalo's heart auricular surface after latex injection and dissection. LAu: Left auricle. RAu: Right auricle. RV: Right ventricle. LA: Left ventricle. PT: Pulmonary trunk LCCA, Left Circumflex branch. LIPA: Interventricular paraconal artery. PCB: Proximal left collateral branch. DCB: Distal left collateral branch a, a', a'', Small collateral branches b, Terminal branches



Fig. 4: Buffalo's heart atricular surface after latex injection and dissection. RAu: Right auricle. LAu: Left auricle. LV: Left ventricle. RV: Right ventricle. RCCA: Right circumflex branch SICA, Subsinosual interventricular artery, b, Distal branches

fat tissue completely. It had many collateral branches such as dorsal and ventral collateral branches. Dorsal collateral branches were supplied right atrium and right auricle. Ventral collateral branches were supplied right ventricle and interventricular septum chiefly. Two collateral branches were larger and distinct than other

collateral branches. Right ventricular margin artery arose ventral border of it and supplied wall of right ventricle. Another, one was collateral ventricle artery. It was largest branches which arose from distal part of right circumflex coronary artery and passed toward left ventricle. Collateral ventricle artery is last large branch which arose left border of right circumflex coronary artery and supplied the wall of the left ventricle wall and interventricular septum chiefly (Fig. 3).

Interventricular subsinusal artery: This artery was continued right circumflex coronary artery in interventricular subsinusal groove. It was preceded to apex of the heart and had 10-12 collateral branches. Two collateral branches were larger and distinct than other collateral branches. Two another large branches were right proximal and right distal collateral branches. Right proximal collateral branches arose from right border of initial part of interventricular subsinusal artery after collateral ventricle artery and supplied wall of the right atrium and right ventricle by many small branches. Right distal collateral branches arose from right border of interventricular subsinusal artery after right proximal collateral branches and they supplied wall of right ventricle. Other small branches supplied wall of right ventricle, wall of left ventricle and interventricular septum. They originated from right and left border of interventricular subsinusal artery chiefly (Fig. 3 and 4).

Study of dissected of the hearts after injection latex was appeared the results similar to angiographic results.

These study results (angiographic and dissection study) appeared which buffalo's heart had bicoronary functional circulation.

DISCUSSION

The heart is muscular central organ of the blood-vascular system which, by its rhythmic contraction, act like a double suction pressure pump and thus maintains of the blood through the closed system of tubes, the blood vessels. It located within thoracic cavity in middle mediastinal space. Although, somewhat variable from species to species, its shape resembles that of a more or less pointed and bilaterally flattened cone and its base located in proximal and its apex located in distal (Junqueira *et al.*, 1992; Nickle *et al.*, 1986). Nickel *et al.* (1986) reported that ox heart is distended by longitudinal axis and compressed from front to behind but the heart of the horse compressed from base to apex and it is cubical approximately (Getty, 1975a).

Biometrical study on buffalo's heart was appeared which its wide is approximately equal its length and therefore, it was similar to the horse heart approximately.

The heart has two type circulation and they are functional and nutritional circulation. Functional circulation is performed by aorta and pulmonary trunk and nutritional circulation is performed by right and left coronary artery. The origin of right and left coronary artery is right and left coronary sinus. They have a series variation in branching in different animals. Two pattern functional circulations were founded in mammals. They are monocoronary and bicoronary type circulation pattern (Getty, 1975a, 1975b; Miller *et al.*, 1964; Nickle *et al.* 1986; Williams *et al.*, 1989).

In monocoronary type, left coronary artery supplied the heart chiefly. It was 3 important branches. They are interventricular paraconal artery, left circumflex coronary artery and interventricular subsinusal artery (Nickle *et al.*, 1986).

In bicoronary type, left and right coronary artery have similar role in heart nutritional circulation approximately. Left coronary artery have 2 principle branches that they are intherventricular paraconal artery and left circumflex coronary artery. Also, right coronary has 2 principle branches; they are right circumflex coronary artery and interventricular subsinusal artery (Nickle *et al.*, 1986).

Obtained results appeared which the heart of buffalo is bicoronary type. Left coronary artery divided 2 principles branches after to arise from left aortic sinus. They were interventricular subsinusal artery and left circumflex coronary artery. They had commune origin in 70% of cases and arose individually in 30% cases. Interventricular paraconal artery proceeded in interventricular paraconal groove under distal part of left auricle. It had many collateral branches which supplied wall of left atrium and left ventricle. Two branches were large distinctly. They were left proximal and left distal collateral branches. These branches arose from caudal border of interventricular paraconal artery and supplied the more part of wall of the left ventricle and interventricular septum. This artery was reported almost similar buffalo in ox and other domestic animals (Getty, 1975a, b; Miller *et al.*, 1964; Nickle *et al.*, 1986).

Left circumflex coronary artery was preceded in left coronary groove and covered by fat tissue. This artery terminated in origin of subsinusal interventricular groove and did not proceed in this groove. Radiographs and dissection study was appeared, which it had many collateral branches. Collateral branches arose from dorsal and ventral border of this artery. Dorsal branches supplied wall of left and right atrium and ventral branches supplied the wall of left ventricle and interventricular septum chiefly. Intermediate interventricular artery was one of these collateral branches that it was large significantly. It proceeded in ventricular border and it did not reach to base of the heart. It was accompanied by similar name vein in this region. Nickel *et al.* (1986) was reported similar architecture for left circumflex coronary artery in the horse and human but they did not reported intermediate interventricular artery in these mammals (Nickle *et al.*, 1986; Williams *et al.*, 1989). This artery reported only in ruminant (Nickle *et al.*, 1986). This research results were showed that left circumflex coronary artery architecture and branching of buffalo's heart was like the horse and human chiefly.

Also, this research results showed that right coronary artery was originated from right aortic sinus and run to right side of the heart and preceded in right coronary groove immediately. It covered by fat tissue in this groove. Radiographs and dissection study appeared which it has many collateral branches. They originated from dorsal and ventral border of this artery and supplied wall of right atrium, right auricle and right and left ventricle. Two collateral branches were distinctly large. One arose from ventral border of right circumflex coronary artery in border of right ventricle and was named right ventricular margin artery and another one arose from distal part of it in origin interventricular subsinusal groove. Right ventricular margin supplied wall of right ventricle and collateral ventricular artery supplied wall of left ventricle and left atrium. Right circumflex coronary artery run into subsinusal interventricular groove and terminated before to reach apex of the heart. This artery was named subsinusal interventricular artery in this region. Radiographs and dissection study showed which it had many collateral branches. They supplied wall of right and left ventricle. Two collateral branches were significantly large. They were named right proximal and right distal collateral branches.

Nickel *et al.* (1986) was reported this artery similar of buffalo in the horse and human. Also, Nickel *et al.* (1986) was reported which this artery is terminating in origin of subsinusal interventricular groove and it did not proceeded in interventricular subsinusal groove and interventricular subsinusal artery is continuous of left circumflex coronary artery in ruminant. Therefore, this research results appeared which buffalo right circumflex coronary artery architecture and its branching was similar to the horse and human. In generally, in the base on this research results, the buffalo's heart have bicorony type circulation pattern similar to the horse and human chiefly and it is not similar another ruminant heart circulation pattern.

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