Sudan Journal of Science and Technology (2015) 16(2): 1-8

Sudan Journal of Science and Technology
Journal homepage: http://jst.sustech.edu/

Histology of the Myocardial Bridges and the Related Arteries of the adult dromedary Camel *(Camelus dromedarius)*

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ARTICLE INFO

Article history
Received:18.5.2015
Accepted: 30.5.2015
Available online:01.10.2015

Keywords:
dromedary Camel,
Histology,
myocardial bridges,
branches of coronary arteries

ABSTRACT

The aim of this study was to investigate the histology of the myocardial bridges of the dromedary camel. Ten adult she-camels were used for this study. The samples were collected from Al-Salam and Al-Buga´a slaughter houses, Sudan. Specimens were taken from regions showing myocardial bridges. They were then processed for routine histological techniques. The regions of the myocardial bridges were obviously covered by large amount of adipose tissue. This adipose tissue infiltrated the cardiac muscles of the bridge. The lumina and the tunics of the interventricular branches lying unearth the bridges were obviously compressed giving the lumina oval shapes. The cardiac muscles distal to the bridges showed no signs of myocardial infarctions. It was therefore concluded that the presence of the myocardial bridges is a normal feature in the heart of the dromedary camel.

INTRODUCTION

The myocardial bridges are an anomaly characterized by intramyocardial paths of an epicardial coronary arteries or their branches segments. They are found during autopsies in the year 1737 and were described angiographically in 1960 (Darius, 2014). The cardiac muscle is located primarily in the walls and septa of the heart and in the walls of large vessels attached to the heart. The cardiac muscles exhibit distinct cross striations due to actin and myosin filaments arrangement (Eroschenko, 2008). The endocardium is the inner most layer of the heart; it consists of the endothelial lining and its supporting tissue. The endothelium is a single layer of flattened epithelial cells continuing with the endothelium of the vessels entering and leaving the heart. The endothelium is supported by a delicate layer

of collagenous tissue (Young and Heath, 2000). The heart of the camel is not unlike that of other domesticated animals. It presented the usual three layers, the epicardium, the myocardium, and the endocardium. The myocardium presents cross striations, but with somewhat larger fibers and single nuclei (Hegazi, 1954). The amount of myocardium and the diameter of muscle fibers in the chambers of the heart vary according to the workload of the chamber. The left ventricle has the thickest myocardium with the largest diameter muscle fibers, the left and right atria have thin walls composed of cells of small diameter. The right ventricle has a moderately thick muscle layer composed of fibers intermediate in diameter between atrial and left ventricular muscle cells (Stevens and Lowe, 1997). Microscopic examination has been restricted to two characteristics: the thickness of the muscular layer and the relation of the overbridged artery to the commitant veins (van Nie and Vincent, 1989).

Eurell and Frappier (2006) stated that the striated myocytes of cardiac muscle branch and anastomose at the end-to-end junction of adjacent cells, dense intercalated discs are present. Cardiac myocytes are approximately 15 nm in diameter and 85 nm to 100 nm in length. The single nuclei of cardiac muscle cells are located in the center of the cell and the cytoplasm is acidophilic.

The aim of the current study was to investigate the histological structure of myocardial bridges and myocardium proximal and distal to the bridge.

MATERIALS and METHODS

Ten camel hearts were used for this study. Samples of tissues of 1 cm^3 thick were taken from the following structures: myocardial bridges, ventricular myocardium proximal to the bridge, ventricular myocardium distal to the bridge, the segment of the artery immediately underneath the bridge, the segment of the artery proximal to the bridge, and the segment of the artery distal to the bridge. Tissues were fixed in 10% formalin, dehydrated in ascending grades of ethanol (70%-90%-100%) 2 hours of each change, cleared overnight in chloroform, embedded in three changes of paraffin wax 55-60ºC (one hour for each change), and finally blocked in paraffin wax.

Sections about 4-7 µm thick were cut using a rotary microtome, picked up on clean slides. Routine and special stains were employed for staining the paraffin sections. These included:

1- Haematoxylene and Eosin (H and E) for general histological observation (Drury and Wallington, 1980).

2- Van Gieson's Technique for the demonstration of collagen fibers (Bancroft and Stevan, 1990).

3- Aldehyde fuchsin stain for illustration of elastic fibers (Bancroft and Stevan, 1990).

4- Gordon and Sweet for determination of reticular fibers (Bancroft and Stevan, 1990).

RESULTS

Myocardial bridges and the proximal and distal ventricular myocardium

The histological structure of the cardiac muscle whether from the bridge or from the ventricle proximal or distal to the bridge showed no variations. We found that the cardiac muscle cells were joined end to end and each cell was usually branched (Figure 1). However, the only difference which was noticed, the presence of large amount of adipose tissue in the bridge, but was absent in the ventricular myocardium proximal or distal to the bridge (Figures 2 and 3). Collagen fibers and reticular fibers were present between the cardiac muscle fibers (Figure 4).

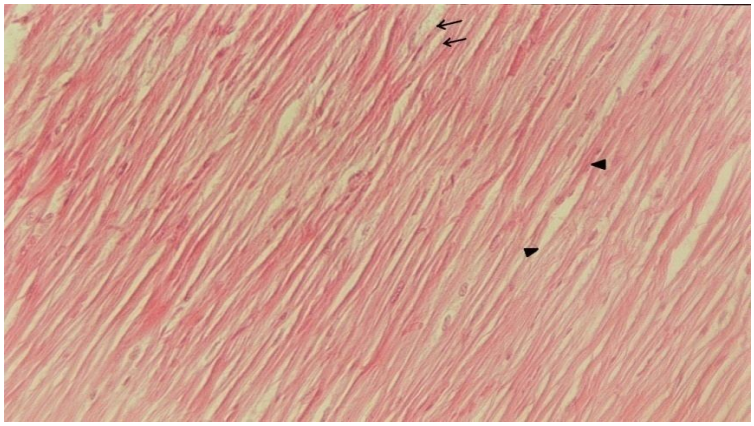

Figure 1: Photomicrograph of the myocardium proximal to the bridge. Note the branching of the cardiac muscle cells (arrows) and their ends binding to each other (arrowheads). H and E (X40).

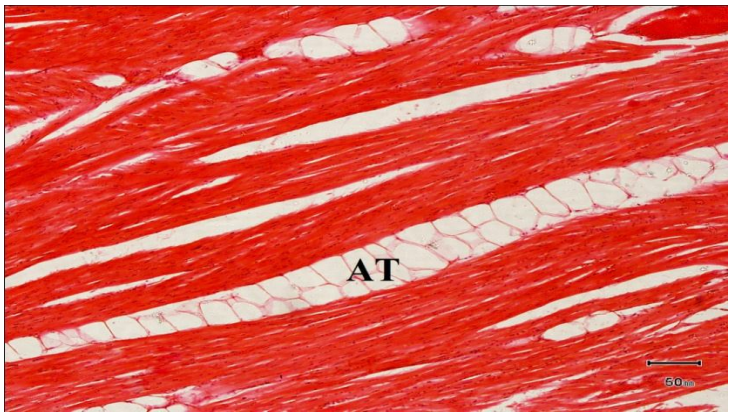

Figure 2: Photomicrograph of the myocardial bridge revealing the presence of small amounts of adipose tissue (AT). H and E (X10).

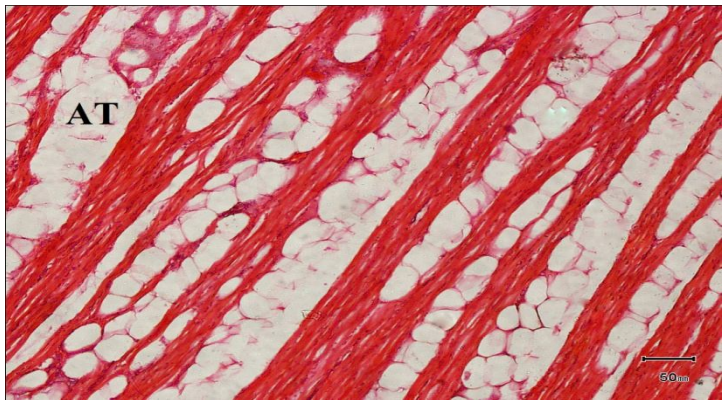

Figure 3: Photomicrograph of the myocardial bridge displaying large amounts of adipose tissue (AT). H and E (X10).

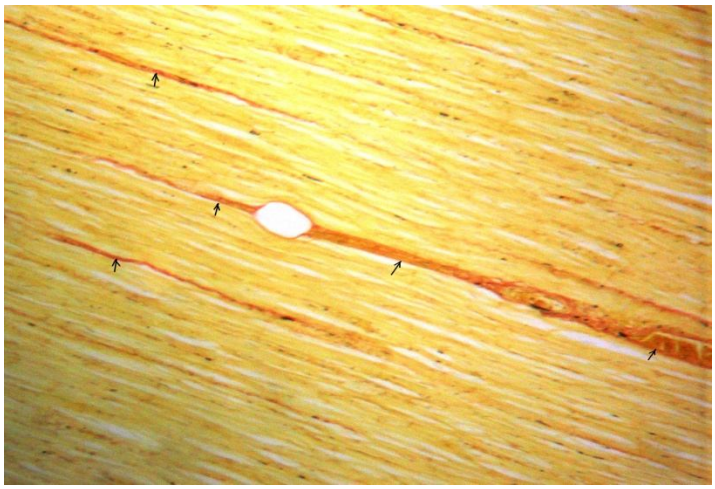

Figure 4: Photomicrograph of the myocardial bridge showing the collagen fibers (arrow) between the cardiac muscle cells, Van Gieson's (X10).

The interventricular branch of the coronary artery proximal and distal to the myocardial bridges

The histological structure of the interventricular coronary arteries proximal and distal to the myocardial bridges was similar but looked different from that of the coronary arteries. These arteries showed a thick tunica media which was made mainly of collagenous fibers (Figure5) rather than the elastic fibers which characterized the tunica media of the coronary arteries. Likewise the tunica adventitia of the interventricular arteries showed large amounts of elastic fibers (Figure 6) which characterized the tunica media of the coronary arteries. Fair amounts of reticular fibers were found in the tunica media and the tunica adventitia (Figure 7). A thin layer of fat is mostly found between the overbridging coronary artery and the myocardial bridges.

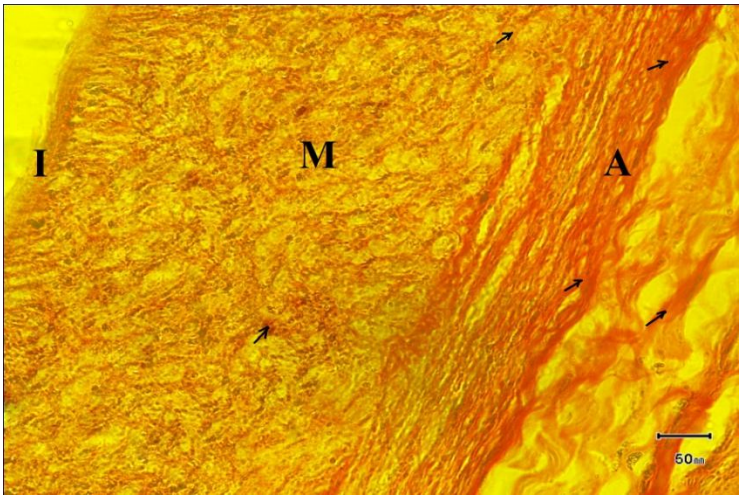

Figure 5: Photomicrograph of the interventricular branch of the coronary artery proximal to the myocardial bridge presenting large amounts of collagen fibres (arrow) in the tunica media (M) and tunica adventitia (A) in different directions. I; tunica intima, Van Gieson's (X40).

Figure 6: Photomicrograph of the interventricular branch of the coronary artery proximal to the myocardial bridge showing large amounts of elastic fibres (arrows) in the tunica adventitia (A). Note that there are some elastic fibres (arrows) in the tunica intima and tunica media (M). Gomori's Aldehyde fuchsin (X10).

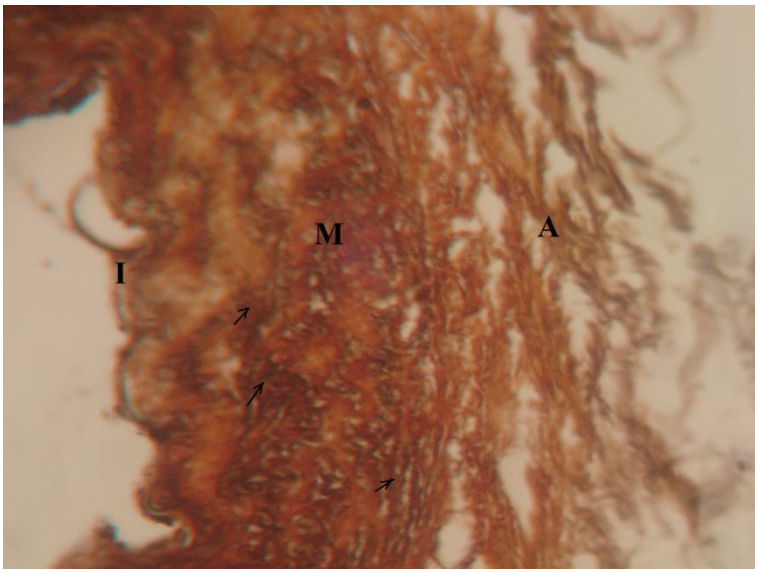

Figure 7: Photomicrograph of the interventricular branch of the coronary artery proximal to the myocardial bridge showing the large amounts of reticular fibers (arrows) in the tunica media (M). A; Tunica adventitia, I; Tunica intema. Gordon and Sween (X40).

The segment of the interventricular branch of the coronary artery immediately underneath the bridge

The lumen of the artery in this site was oval in shape because the artery was compressed by the myocardial bridges in the outer part of the tunica adventitia, large amounts of collagen and adipose tissue were present separating the artery from the myocardial bridge (Figure 8).

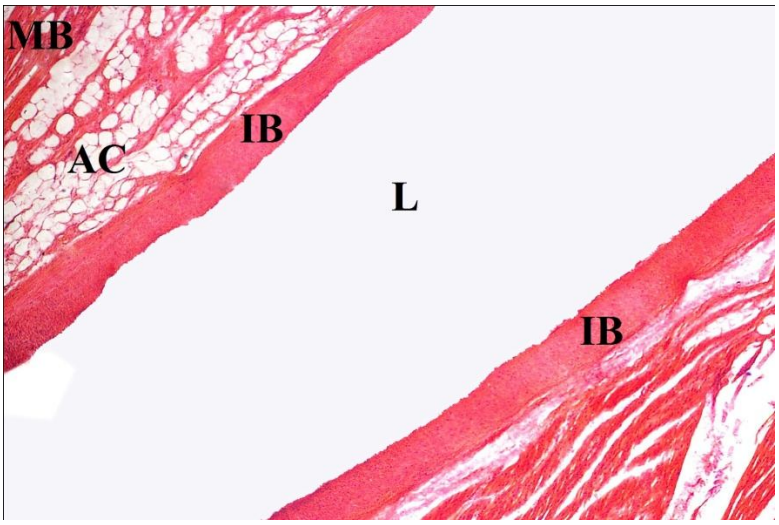

Figure 8: Photomicrograph of the interventricular branch of the coronary artery immediately underneath the bridge. Note that there are large number of adipocytes (AC) in between the artery (IB) and the myocardial bridge (MB). L; lumen. H&E (X4).

DISCUSSION

Review of the literature revealed that the histology of cardiac muscle was studied from many authors but very few reports were studied histology of myocardial bridges. Leeson, *et al.*(1985); Bloom and Fawcett (1986); Eurell and Frappier (2006); Samuelson (2007) who studied the cardiac muscle fiber by light microscopy have shown that it is a linear unit composed of several cardiac muscle cells joined end to end by specialized junctional zones called intercalated discs. It is often divided partially into two or more branches at its ends and these branches meet with adjacent cells, or part of them, at intercalated discs. Between the fibers, but not extending into the intercalated discs, is fine connective tissue, the endomysium containing small blood vessels and lymphocytes. Nuclei are elongated and situated centrally in the fiber between the dividing myofibrils. We found fair amount of collagen fibers and reticular fibers between the cardiac muscle fibers in myocardium.

van Nie and Vincent (1989) have described the thickness of the muscular layer and the relation of the overbridged artery to the comitant veins. The thickness of the muscular layer is expressed by the number of muscle fibers and accordingly is divided into three groups: 1. 1-10 fibers; 2. 11-50 fibers and 3.> 50 fibers. Yamaguchi *et al.,* (1996) have compared the structure of myocardial bridges muscle with that of tissue from the subepicardial myocardium in dogs. They found that the heart is characterized by a distinctive special arrangement with individual fibers separated by substantial elements of inner cellular connective tissue in cross-section. Longitudinally, the long slender fibers are aligned continuously with intermediation of intercalated disks lying perpendicular to the long axis of the fibers. Our investigation showed no variations from previous accounts in the histological structure of the cardiac muscle whether from the bridge or from the ventricle proximal or distal to the bridge. However, the only variation which was noticed was the presence of large

amount of adipose tissue in the myocardium of the bridge, but not in the myocardium of the ventricle proximal or distal to the bridge.

The present investigation revealed that the histological structure of the interventricular arteries proximal and distal to the myocardial bridges was similar but looked different from that of the coronary arteries. These arteries showed a broad tunica media which was made mainly of collagenous fibers rather than the elastic fibers which characterized the tunica media of the coronary artery. Likewise the tunica adventitia of the interventricular arteries showed large amounts of elastic fibers which characterized the media of the coronary artery. Fair amounts of reticular fibers were found in the tunica media and the tunica adventitia. A thin layer of fat is mostly to be found between the overbridging coronary artery and the myocardial bridges. The present study agrees with Stolte, *et al.* (1977) who stated that a thin layer of fat is mostly to be found between the overbridging coronary artery and the myocardial bridges. They added that there is a significantly more atherosclerosis of the coronary proximal to the myocardial bridges than there is under and distal to the bridge. There is a significantly lower incidence of atherosclerosis in heart with myocardial bridges of left anterior descending coronary artery. The reason for the protective effect of coronary muscle bridge is still not clear.

In the present study it was observed that the vessel wall underneath the myocardial bridges is usually thin and free from degenerative atherosclerosis changes. The lumen of the artery is oval in shape because the artery is compressed by the myocardial bridge. On the other hand, the tunica adventitia displayed large amounts of collagen and adipose tissue thus separating the artery for the myocardial bridge. This finding supports the finding of Dottori, *et al.* (1993).

ACKNOWLEDGEMENTS

The authors wish to thank the International Centre for Faith Researches- Khartoum for Financial support.

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