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Original Research

Left Atrium of the Mature Dromedary Camel Heart (*Camelus dromedaries*): Microanatomy

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Abstract

The current work was carried out on the left atrium of ten healthy mature camels. The specimens were collected and examined histologically after being fixed in 10% Neutral Buffered Formalin. The atrium was processed till paraffin sections obtained and stained. Microscopically, the left atrium is consisted of three major tunics; the internal endocardium, the middle myocardium, and the external epicardium. The endocardium is the inner layer of the atrial wall and consisting of the endothelial layer of simple squamous epithelium that lining the atrium, subendothelial layer of loose connective tissue supporting the endothelium and the subendocardial layer that connecting the endocardium with the myocardium. Myocardium is the middle layer of the atrium, forming the main mass of the atrial wall. It is sandwiched between an outer epicardium, that covers the atrium, and an inner endocardium, that lines the atrial chamber. It is mainly formed from bundles of the contractile cardiac myocytes; myocardiocytes that arranged in strands or branching columns. The left atrium is externally covered with the epicardium that is relatively thin in comparison with the myocardium and consisting of a subepicardial layer of highly vascularized loose connective tissue and the mesothelium of simple squamous epithelium.

Keywords: Camel heart; Cardiomyocytes; Atrium; Endocardium; Myocardium; Epicardium

Introduction

The heart is a muscular organ that contracts rhythmically, pumping the blood through the circulatory system (Mescher, 2010). It is also responsible for producing a hormone called atrial natriuretic factor. This potent polypeptide has a critical role in cardiovascular homeostasis, blood pressure regulation, and fluid-electrolyte balance. It promotes natriuresis; sodium excretion and diuresis; excretion of urine (Needleman *et al*., 1985).

The thick wall of the heart is mainly composed of the cardiac muscle cells capable of spontaneous rhythmic contraction, which pumps the blood into the vascular system. The inner layer of the heart is referred to as endocardium and is continuous with the tunica intima of the large blood vessels leaving and entering the heart. The contractile middle muscular layer is called the myocardium and is considered the thickest layer of the heart. The outermost layer is the epicardium (Dellmann and Eurell, 1998, Eurell, 2004 and Bacha and Bacha, 2012).

The endocardium consists of a single layer of squamous endothelial cells on a thin subendothelial layer of loose connective tissue containing elastic and collagen fibers. Connecting this subendothelial layer to the myocardium, is additional connective tissue (often called the subendocardial layer) with variable thickness containing veins, nerves, and branches of the impulse-conducting system of the heart (Junqueira *et al*., 2007 and Mescher, 2010).

The myocardium is the thickest of the tunics and consists of cardiac muscle cells arranged in

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layers that surround the heart chambers in a complex spiral. The myocardium is much thicker in the ventricles than in the atria. The arrangement of these muscle cells is extremely varied, so that in sections cells are oriented in many directions (Mescher, 2010). Although the cardiac muscle fibers are striated, they are involuntary, constitutes the muscular walls of the heart. Some cardiac muscle is also present in the walls of the pulmonary veins and superior vena cava. A histological feature of cardiac muscle fibers that they branch and anastomose. Furthermore, the nuclei lie centrally in the fibers where, most cardiac muscle cells have a single nucleus, but a few of them contain two, occupying a central position in the muscle cell. The nucleus is relatively large and pale-staining (Cormack, 2001; Kuehnel, 2003).

The sarcoplasm shows its characteristic striations of alternating dark and light bands. The dark band is called anisotropic or A band because it is doubly refractive to polarized light and appear dark in fresh state. The light band is called isotropic or I band because it is singly refractive to polarized light and appear pale in fresh state (Ghallab, 2000). A clear zone of perinuclear sarcoplasm, free of myofibrils, may be seen in some of the sections (Di Fiore, 1976).

Cardiac muscle fibers are basically branching chains of cardiac muscle cells joined end to end by intercalated disks. In longitudinal sections, intercalated disks appear as darkly stained irregular lines, some of which extend across the fibers in a step-like pattern. These irregular transverse structures indicate the positions of apposed borders of contiguous muscle cells (Cormack, 2001). A unique and distinguishing characteristic of cardiac muscle is the presence of dark-staining transverse lines that cross the chains of cardiac cells at irregular intervals. These intercalated discs represent the interface between adjacent muscle cells where many junctional complexes are present (Mescher, 2010).

The epicardium is consisting of a broad layer of adipose connective tissue that connects epicardium to myocardium, a thin layer of fibro elastic connective tissue that housing many blood vessels, lymph vessels and nerve fibers. The free surface of epicardium is covered by simple squamous epithelium; a mesothelial membrane of the visceral pericardium (Samuelson, 2007).

The aim of our investigation is to study the morphological features of the left atrium in the camels (*Camelus dromedarius*).

Materials and methods

Hearts of ten apparently healthy mature camels were collected from Zagazig slaughter house in Sharkia province for histological studies. For light microscopy; the left atria were immediately fixed in 10% Neutral Buffered Formalin and Bouin's fluid. The fixed specimens were processed using the usual histological techniques; dehydrated in ascending grades of ethanol series, cleared in benzene and embedded in paraffin. 5-7μm thick sections were prepared and mounted on glass slides. These are dewaxed in xylene, hydrated in descending grades of ethanol series and stained with Harris's hematoxylin and eosin (H andE) for routine histological studies, green masson's trichrome for demonstration of collagen fibers and muscle cells cytoplasm, periodic acid schiff technique (PAS) for detection of neutral mucopolysaccharides. The micrographs were taken using a digital Dsc-W 130 super steadycyper shot camera connected to an Olympus BX 21 light microscope.

Results

Histologically, the left atrium is consisted of three major layers; the internal endocardium, the middle myocardium, and the external epicardium.

The endocardium, is the inner most layer and is also consisting of three layers; the endothelial layer, the subendothelial layer and the subendocardial layer. The endothelium is composed of single layer of simple squamous epithelium and sometime simple cuboidal epithelium (Figs. 1, 2, 3, 5).

The subendothelial layer, is the second layer of the endocardium and consists of narrow zone of loose connective tissue (Figs. 2, 3) that is mainly composed of fine collagen fibers (Fig. 4). The endothelial and subendothelial layers showed strongly PAS positive reaction. Moreover, no clear cut border could be seen separating the endothelial and subendothelial layers (Fig. 5).

The subendocardial layer, is the deep layer of the endocardium which is composed of loose connective tissue that is appeared having the two types of modified cardiac muscle cells; the first one, is round or ovoid with perinuclear clear zone, with single, central, large nucleus with distinct nucleoli

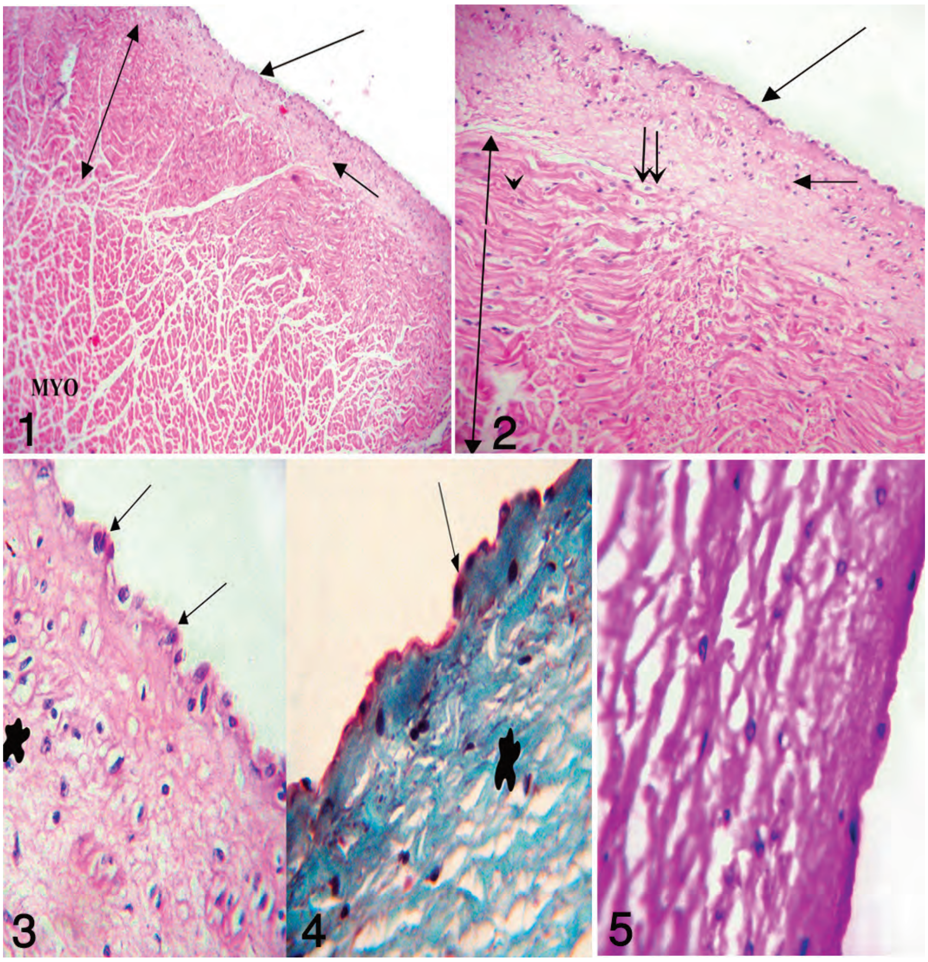

Fig. 1. A micrograph of mature camel left atrium showing the endothelium(long arrow), the subendothelium (short arrow), the subendocardium (double head arrow), and the myocardium (MYO). Stain: H and E X40.

Fig. 2. Higher magnification of Fig. 1, showing the endothelium (long arrow), the subendothelium (short arrow), the subendocardium (double head arrow), P. cells (double arrow) and T. cells (arrow head). Stain: H and E X 100.

Figs. 3, 4. Higher magnification of Fig. 2. Fig. 3. showing the endothelium (arrow), the subendothelium (star). Fig. 4. Showing the endothelium (arrow), the collagen fibers (star). Stain: 3) H and E X400. 4) Green Masson's Trichrome X400.

Fig. 5. Showing strongly PAS positive reaction of the endothelium and the subendothelium. Stain: PAS stain X400.

and smaller in size than working cardiomyocytes in the cross sections. Meanwhile, in longitudinal sections, it is appeared elongated with wide, expanded central region and narrow, slender peripheral region of these cells. These cells are named perinuclear clear zone cells ("P" cells). Meanwhile, the second cells, transitional cells are also observed round or ovoid but smaller in size than the perinuclear clear zone cells, without perinuclear clear zone, with single, central, large nucleus with distinct nucleoli in the cross sections. Meanwhile, in longitudinal sections, it is appeared more elongated, slender and narrower in diameter than the perinuclear clear zone cells and the working cardiomyocytes and also, is observed without wide, expanded central region. These cells are arranged longitudinally into fibers and make contacts between themselves, and also with working cardiomyocytes. No clear cut border could be seen separating the endothelial and subendothelial together with the subendocardial layer (Fig. 2).

The myocardium, is the middle and thickest layer of the left atrial wall, containing the working cardiac myocytes throughout most of the heart. This layer is consisting of the cardiac muscle cells that arranged in strands or branching columns (Figs. 1, 6).

The myocardium consists of cardiac muscle cells arranged in layers that surround the heart chambers in a complex spiral. The arrangement of these muscle cells is extremely varied, so that in sections, cells are seen to be oriented in many di-

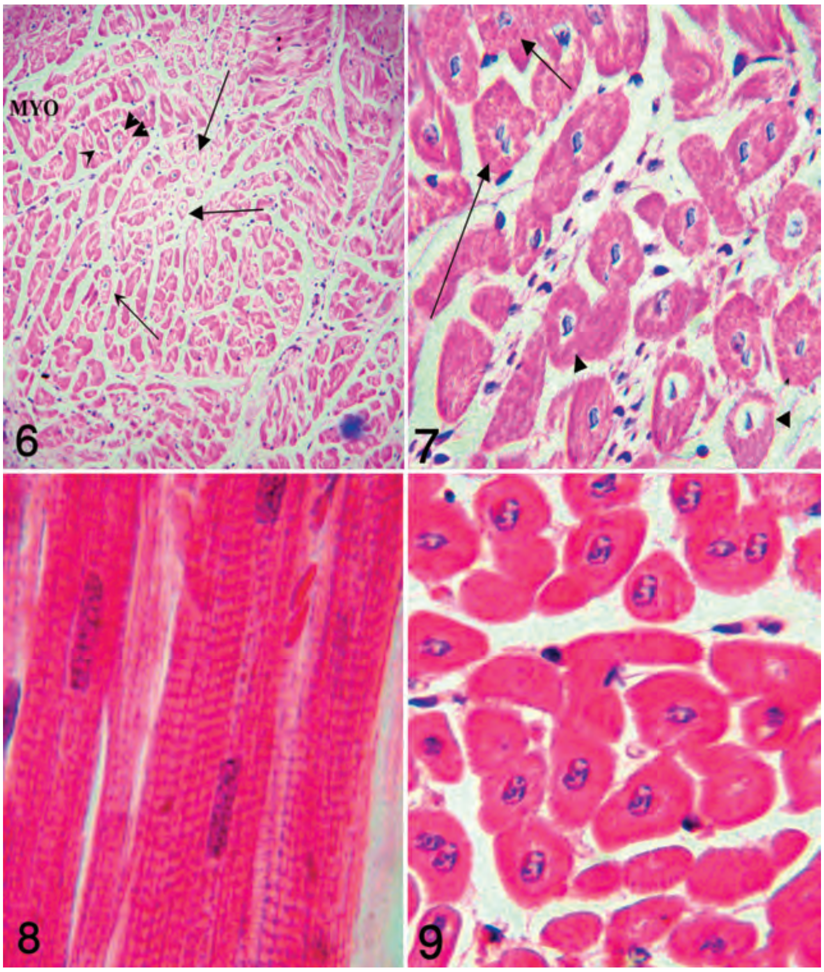

Fig. 6. A micrograph showing the left atrium myocardium (MYO), bundle of P. cells (arrow), the myocardiocytes (arrow head) and binucleated myocardiocytes (double arrow head) Stain: H and E X40.
Fig. 7. Higher magnification of Fig. 6, showing P. cells (arrow head), the myocardiocytes (short arrow) and binucleated myocardiocytes (long arrow) Stain: H and E X400.
Fig. 8. A micrograph showing the longitudinal section of the cardiac myocytes (striation), Stain: H and E X1000.
Fig. 9 A micrograph showing the cross section of the cardiac myocytes. Stain: H and E X400.

rections (Figs. 1, 6).

Most of the cardiac muscle cells possess only a single, relatively large, oval, ovoid pale-staining, more euchromatic and centrally placed nucleus, however, some binucleated cells are occasionally observed, occupying a central position in the muscle cell and some of them showed prominent nucleoli. The nuclear chromatin is dispersed and in most cases tended to be condensed peripherally (Fig. 7).

The cardiac muscle cells in longitudinal sections are appeared short, striated, branched and anastomosed, forming network and joined end to end and side to side at specialized sites known as intercalated disks, forming the myocardial fibers. These disks appear as thin, typically dark-staining lines that run transversely in a step-wise manner across the fibers where, it runs perpendicular to the direction of muscle fibers (Fig.11).

In cross sections, the cardiac muscle fibers appear irregular polygonal cells of various sizes with a large, round, pale-staining, euchromatic, centrally placed, single nucleus and also sometimes, binucleated cells (Fig. 7). Moreover, the myocardiocytes showed a relatively PAS positive reaction (Fig. 10).

The cardiac muscle sarcoplasm is an eosinophilic, full of parallel contractile myofibrils that are consisted of myofilaments. They exhibit a cross-striated banding pattern. The sarcoplasm shows its characteristic striations of alternating dark and light bands. The dark band is called anisotropic (A- band). The light band is called isotropic or (I-band) and appear pale in fresh state. These alternating light and dark bands caused the apparent cross striations which were seen in the myocardiocytes (Fig. 8).

These bundles of cardiac muscle cells are later-

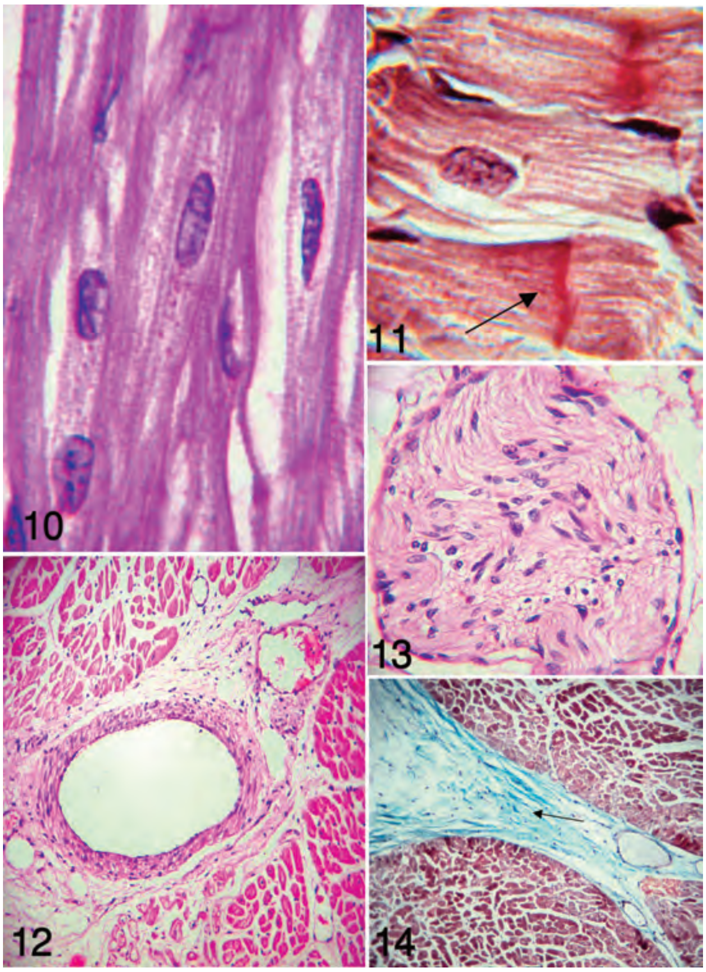

Fig. 10. A micrograph showing the PAS positive reaction of cardiomyocytes. Stain: PAS X1000.
Fig. 11. A micrograph showing the intercalated discs. Stain: Green Masson's Trichrome X1000.
Fig. 12. A micrograph of the left atrium myocardium showing the highly vascularized inter bundles connective tissue. Stain: H and E X100.
Fig. 13. A micrograph showing the nerve bundle. Stain: H and E X400 .
Fig. 14. A micrograph of the inter bundles connective tissue showing the collagen fibers (arrow) . Stain: Green Masson's Trichrome X100.

ally separated from each other by a considerable amount of loose connective tissue that is mainly composed of fine collagen fibers (Fig. 14). Moreover, it is housing blood vessels, lymph vessels and nerve bundles (Fig. 12).

There are peripheral nerve fibers are seen in the intercellular connective tissue, extending in between the myocardial fibers. These peripheral nerves are looked like a telephone cable, forming nerve plexus. Moreover, the peripheral nerves consist of many fibers which are grouped together into large or smaller bundles by connective tissue. These bundles are surrounded by the epineurium, an external sheath of dense connective tissue surrounding the entire fibers. From the epineurium, thin septa of connective tissue extend inward, surrounding the fascicles or bundles of fibers within a muscle. The connective tissue around each fascicle is called the perineurium. Each nerve fiber is itself surrounded by a more delicate loose connective tissue, the endoneurium in which blood vessels may also be present. At a great magnification, the elementary structural units of nerves become visible. The nerve fibers can be seen to be made up here of a central axon surrounded by an enveloping myelin sheath (Fig. 13).

There are some bundles of modified cardiac muscle cells running in between normal cardiac muscle fibers. These bundles have the two types of cells; P. cells (perinuclear clear zone cells) and T. cells (Transitional cells) that are present in the subendocardial layer of the endocardium. Moreover, these cells are considered the internodal and interatrial pathways (Figs. 6, 7).

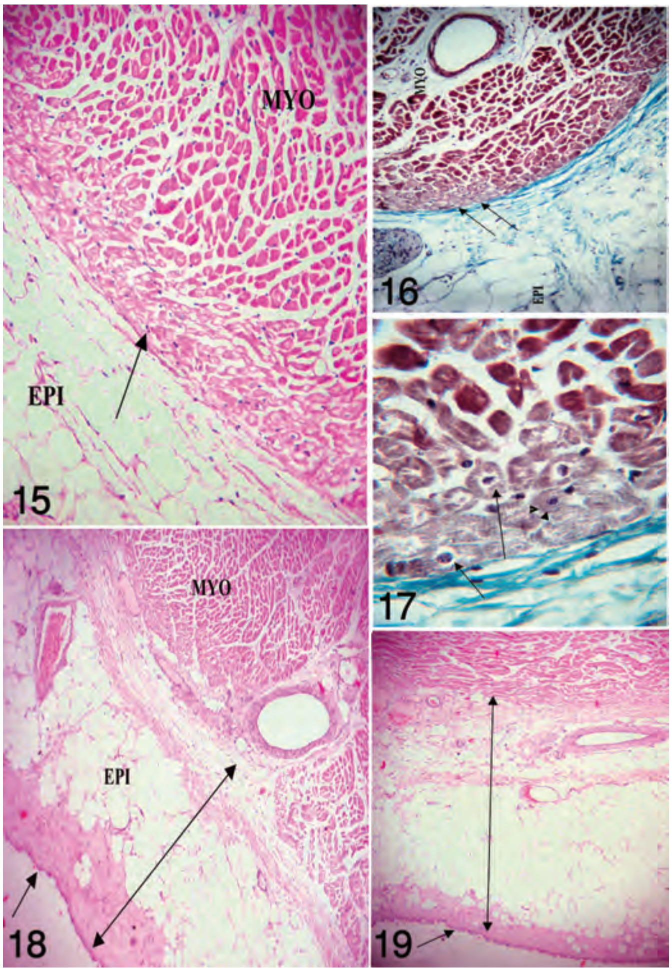

Fig. 15. A micrograph showing the myocardium (MYO), epicardium (EPI) and bundle of P. and T. cells (arrow), Stain: H and E X40.

Fig. 16. A micrograph showing the myocardium (MYO), epicardium (EPI) and bundle of P. and T. cells (arrow), Stain: Green Masson's Trichrome . X40.

Fig. 17. Higher magnification of (Fig. 16) showing P. cells (arrow) and T. cells (arrow head). Stain: Green Masson's Trichrome X400.

Fig. 18. A micrograph showing the myocardium (MYO), epicardium (EPI), the subepicardium (double head arrow), and the Mesothelium (arrow) Stain: H and E X40.

Fig. 19. A micrograph of the epicardium showing the subepicardium (double head arrow), and the Mesothelium (arrow). Stain: H and E X40.

Sometimes, bundles of the working cardiomyocytes are extended from the myocardial layer to the subepicardial layer in the epicardium. These bundles are surrounded by a subepicardial connective tissue. Moreover, these bundles that run near the subepicardium appeared having two types of modified cardiac muscle cells that typically similar to P-cells and T-cells of subendocardium. Two types of these cells also has less myofibrils than the working myocardiocytes, therefore, they are distinctively paler than the working myocardiocytes (Figs. 15, 16, 17).

The epicardium, is considered the outer most layer of the heart, is a relatively thin in comparison with the myocardium and is consisted of a subepicardial layer and mesothelium (Figs. 18, 19). The subepicardial is the layer that connect myocardium with epicardium and is formed from loose connective tissue that mainly consists of collagen fibers, housing many blood vessels, lymph vessels, nerves that supply the heart and also many adipocytes. The heart is covered externally by a single layer of simple squamous epithelium (mesothelium) that supported by a subepicardial connective tissue (Figs. 15, 16, 18, 19).

Discussion

The current work revealed that the left atrium is consisted of three major layers or tunics; the internal endocardium, the middle myocardium, and the external epicardium. Such investigation is very close and similar to the finding of Cormack (2001); Eurell and Frappier (2006), Samuelson (2007), Mescher (2010), and Bacha and Bacha (2012). Moreover, this result is very close to those described by Vladova *et al* (2009) in cat.

The endocardium consists of three layers; the endothelial layer, subendothelial layer and subendocardial layer. Such finding is partially agreement with Eroschenko (2008), who stated that the endocardium consists of a simple squamous endothelium and a thin subendothelial connective tissue. Furthermore, the subendocardial connective tissue layer is found deeper to the endocardium, connecting the latter with the myocardium. And also, this finding is in parallelism with Vladova *et al.* (2009) in cat who described that the endocardium consists of three sub layers; endothelium, subendothelium and conjunctive tissues passing into the myocardial tissue. Moreover, this investigation is partially agreement with Youssef *et al.* (1988) in albino rats who assumed that the endocardium consisted of the endocardium proper, beneath which lay the subendocardial layer that intervened between the endocardium proper and the myocardium. The endocardium proper is formed of two layers; an inner layer and an outer layer.

The endothelium is considered the inner most layer of the endocardium. It is composed of single layer of simple squamous epithelium and sometime simple cuboidal epithelium. This result is in agreement with Eurell (2004); Junqueira *et al.* (2007); Gartner and Hiatt (2007); Cui *et al.* (2011) and Bacha and Bacha (2012). Furthermore, such investigation is in coincidence with Youssef *et al.* (1988) in albino rats who clarified that the endothelial layer is the inner layer of the endocardium and is formed of polygonal endothelial cells.

The subendothelial layer, is the second layer of the endocardium, is a relatively thick and consists of connective tissue cells and fibers that are mainly composed of fine collagen fibers. Such result is very close and similar to the finding that described by Youssef *et al.* (1988) in albino rats, who confirmed that the subendothelial layer, is the outer layer of the endocardium and is formed of connective tissue cells and fibers that are mainly of elastic and collagen fibers.

The subendothelial layer is reacted positively with periodic acid schiff technique (PAS); magenta color that indicating the presence of neutral mucopoly saccharides. Moreover, no clear cut border could be seen separating the endothelium and subendothelial layer. This result is very close to those described by Vladova *et al.* (2009) in cat.

The subendocardial layer has two types of modified cardiac muscle cells; the first one, is round or ovoid with perinuclear clear zone, has few myofibrils in the cytoplasm with single, central, large nucleus with distinct nucleoli and smaller in size than working cardiomyocytes in the cross sections. Meanwhile, in longitudinal sections, it is appeared elongated with wide, expanded central region and narrow, slender peripheral region of these cells. These cells are named perinuclear clear zone cells (P" cells). Meanwhile, the second cell, transitional cells are also observed round or ovoid but smaller in size than the perinuclear clear zone cells. It is without perinuclear clear zone, has more myofibrils than the perinuclear clear zone cells with single, central, large nucleus with distinct nucleoli in the cross sections. Meanwhile, in longitudinal sections, it is appeared more elongated, slender and narrower in diameter than the perinuclear clear zone cells and the working cardiomyocytes. And also, it is observed without wide, expanded central region. Such result is very close and similar to the finding that described after Youssef *et al.* (1988)in albino rats.

The endocardium showed a strongly PAS positive reaction. This is indicating that the endocardium of the camel heart is including large amount of neutral mucopoly saccharides. Such result is very close and similar to the finding that described by Youssef *et al.* (1988) in albino rats, who demonstrated that, the PAS reaction varied in the three coats of the atrial wall. The endocardium showed a strong PAS reaction.

The myocardium is the middle layer of the left atrium and representing the tunica media. It is considered the thickest layer of the left atrium, making up the bulk or the main mass of the left atrium. Furthermore, it is sandwiched between an outer epicardium, that covers the wall, and an inner endocardium, that lines the chamber. Moreover, it is consisting of bundles of the working cardiac myocytes (myocardiocytes) throughout most of the left atrium. This layer is consisting of the cardiac muscle cells that arranged in strands or branching columns. This finding is in close agreement with Marei *et al.* (1994) in camel, Dellmann and Eurell(1998) in bovines, Cormack (2001) in human, Eurell (2004); Eurell and Frappier (2006) and

Samuelson (2007) in bovines.

The myocardium consists of cardiac muscle cells arranged in layers that surround the left atrium in a complex spiral. The arrangement of these muscle cells is extremely varied, so that in sections, cells are seen to be oriented in many directions. This investigation is completely goes h and in h and with Fawcett and Jensh (1997); Gartner and Hiatt (2007) and Mescher (2010).

These bundles of cardiac muscle cells are laterally separated from each other by a considerable amount of loose connective tissue that is mainly composed of fine collagen. Moreover, it is rich with a dense capillary network, lymph vessels, and autonomic nerve fibers. This finding is in close agreement with Marei *et al*. (1994) in camel, Dellmann and Eurell (1998) in bovines, Cormack (2001) in human, Eurell (2004), Eurell and Frappier (2006), Samuelson (2007) in bovines, and Mescher (2010) in human. They reported that, bundle of cardiac muscle cells are embedded in loose connective tissue that contains a dense capillary network, lymph vessels, and autonomic nerve fibers. The amount of interstitial connective tissue is subject to local variations and is greater in the myocardium of the left ventricle than of the left one.

Our result revealed that there are peripheral nerve fibers are seen in the intercellular connective tissue, extending in between the myocardial fibers. These peripheral nerves are looked like a telephone cable, forming nerve plexus. Moreover, the peripheral nerves consist of many fibers which are grouped together into large or smaller bundles by connective tissue. These bundles are surrounded by the epineurium, an external sheath of dense connective tissue surrounding the entire fibers. From the epineurium, thin septa of connective tissue extend inward, surrounding the fascicles or bundles of fibers within a muscle. The connective tissue around each fascicle is called the perineurium. Each nerve fiber is itself surrounded by a more delicate loose connective tissue, the endoneurium in which blood vessels may also be present. At a great magnification, the elementary structural units of nerves become visible. The nerve fibers can be seen to be made up here of a central axon surrounded by an enveloping myelin sheath. This investigation is completely goes h and in h and with Fiedler and Lieder (1975) in human.

This intercellular connective tissue is reacted positively with PAS. This result is very close and similar to the finding that described by Youssef *et al* (1988)in albino rats and Marei *et al*. (1994) in camel.

Most of the cardiac muscle cells possess only a single, relatively large, oval, ovoid pale-staining, more euchromatic and centrally placed nucleus, however, some binucleated cells are occasionally observed, occupying a central position in the muscle cell and some of them showed prominent nucleoli. The nuclear chromatin is dispersed and in most cases tended to be condensed peripherally. Such investigation is very close and similar to the finding that described by Youssef *et al.* (1988)in albino rats, Marei *et al*. (1994) in dromedary camel, Osman *et al*. (2004) in dromedary camel and Abeer E. El-Mehy *et al*. (2008) in albino rat who claimed that some myocardiocytes possessed single, oval and euchromatic nuclei while others possessed double nuclei. The nuclei were centrally located and some of them showed prominent nucleoli. Furthermore, our result revealed that in cross sections, the cardiac muscle fibers appear irregular polygonal cells of various sizes with a large, round, pale-staining, euchromatic, centrally placed, single nucleus and also sometimes, binucleated cells. These results are in coincidence with Eurell (2004); Eurell and Frappier (2006) and Samuelson (2007) in bovines.

In cross sections, the cardiac muscle fibers appear irregular polygonal cells of various sizes with a large, round, pale-staining, euchromatic, centrally placed, single nucleus and also sometimes, binucleated cells. These results are in coincidence with Eurell and Frappier (2006) and Samuelson (2007) in bovines.

The myocardiocytes showed a relatively PAS positive reaction. These results are in parallelism with Vladova (2009) in cat who reported that the cardiomyocytes in the heart ventricle showed light pink sarcoplasm after the PAS reaction. In higher magnification it was found that this was due to tiny light pink micro granules filling the cardiomyocytes. Moreover, there was no cytochemical reactivity after the staining with alcian blue that indicating the absence of the acidic mucopoly saccharides within the cardiac muscle cell cytoplasm, and also, this finding goes h and in h and with Youssef *et al.* (1988) in albino rats who assumed that the myocardium showed a relatively PAS weaker reaction and alcian blue negative reaction.

Furthermore, a strongly PAS positive reaction is also apparent in the wall of the blood vessels within the myocardium. The PAS reaction is directly proportional to the size of the arteries and the arterioles. This finding is in a similarity with Youssef *et al.* (1988)in albino rats.

The cardiac muscle sarcoplasm is an eosinophilic, full of parallel contractile myofibrils that are consisted of myofilaments. They exhibit a cross-striated banding pattern. The sarcoplasm shows its characteristic striations of alternating dark and light bands. The dark band is called anisotropic (A-band). The light band is called isotropic or (I-band) and appear pale in fresh state. These alternating light and dark bands caused the apparent cross striations which were seen in the myocardiocytes. Such result is similar to the finding of Youssef *et al.* (1988) in albino rats, Marei *et al*. (1994) in camel, Gartner and Hiatt (2007); Mescher (2010); Cui *et al* (2011) and Bacha and Bacha (2012) in human.

Sometimes, a clear zone of perinuclear sarcoplasm, free of myofibrils, may be seen in some of the sections. Such investigation is very close and similar to those described by Marei *et al*.(1994) in camel who clarified that in some sections, the nucleus of the myocardiocytes is surrounded by a pale area that free from the myofibrils.

The epicardium, is considered the outer most layer of the heart (inner visceral layer of the pericardium), corresponding to the tunica adventitia. This layer is a relatively thin in comparison with the myocardium and is consisted of a subepicardial layer and mesothelium. Such investigation is very close and similar to the finding that stated by several authors; Cormack (2001) in human, Eurell (2004); Eurell and Frappier (2006) and Samuelson (2007) in bovines, Junqueira *et al.* (2007); Gartner and Hiatt (2007); Mescher (2010); Cui *et al* (2011) and Bacha and Bacha (2012) in human.

The subepicardial, is the layer that connect myocardium with epicardium and is formed from loose connective tissue that mainly consists of collagen, housing many blood vessels, lymph vessels, nerves that supply the heart and also a wide layer of adipocytes is observed. Such result is similar to the finding of Cormack (2001) in human, Eurell (2004), Eurell and Frappier (2006), Samuelson (2007) in bovines, Junqueira *et al*. (2007); Gartner and Hiatt (2007); Mescher (2010); Cui *et al* (2011) and Bacha and Bacha (2012) in human.

The left atrium is covered externally by a single layer of a thin and flattened cells that are typical of simple squamous epithelial cells (mesothelium) that supported by a subepicardial connective tissue. Such is similar to the finding of Eurell and Frappier (2006), Samuelson (2007) in bovines, Gartner and Hiatt (2007), Mescher (2010), Cui *et al* (2011) and Bacha and Bacha (2012) in human.

Conclusion

We concluded that the left atrium histologically is consisted of three major tunics; the internal endocardium that lined the atrial wall and consisting of the endothelial layer of simple squamous epithelium that lining the atrium, subendothelial layer of loose connective tissue supporting the endothelium and the subendocardial layer that connecting the endocardium with the myocardium. The middle myocardiumis forming the main mass of the atrial wall and is mainly formed from bundles of the working cardiac myocytes. The left atrium is externally covered with the epicardium that is consisting of a subepicardial layer of loose connective tissue and themesothelium of simple squamous epithelium. The wall of the left atrium is relatively thin in comparison with the ventricular wall as the over load of the mechanical forces and high pressure on the ventricle during systole.

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