International Journal of Food, Agriculture and Veterinary Sciences ISSN: 2277-209X (Online)
An Open Access, Online International Journal Available at http://www.cibtech.org/jfav.htm
2015 Vol. 5 (2) May-August, pp. 20-27/Allouch
Research Article

VENTRICULAR MYOCARDIAL ARCHITECTURAL OF THE HEART IN SHEEP

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ABSTRACT
This study aims to know the ventricular mass architecture of the sheep heart and explain the constriction and diastole mode anatomically. The ventricular myocardial architecture consists of three layers: The subepicardial, middle and subendocardial layers. The subepicardial layer was covering the ventricular mass, the fascicles myocardium directed cranioventrally on the left side, nearly vertically on the right side of the heart. The middle layer formed the two tubes for the tow ventricles, directed transversally and devoid the septal wall of the right ventricle. The subendocardial layer was formed by the subepicardial layer at the vortex cordis, and directed internally to continues craniodorsally or vertically at the origin of the papillary muscles and the trabeculae carnea to the base of the heart.

***Keywords**: Architecture Heart Sheep*

INTRODUCTION
The ventricular mass architectural of the sheep heart has an active role in the heart muscle work dynamically. IL is characterized of a complex architectural in the ventricular mass (Coucelo *et al.,* 2000). With regard to the number and arrangement of the myocardial muscle layers of the ventricular mass (Charles *et al.,* 2000), (Katherine, 2005) in sheep, (Sanchez- *et al.,* 1994) in bull (Karkoura, 1989) in camel, (Miller *et al.,* 1979) in dog and (Schummer, 1976) in domestic animals (Teran and Hurle, 1982; Syho and Nihoyannopoulos, 2006) in human revealed that the muscle bunds of the ventricular mass wall arranged in three layers: superficial, middle and deep one. Charles *et al.,* (2000) recoded that the human and sheep heart are similar in Features and characteristics.
Concerning the superficial layer (Sanchez *et al.,* 1994) in bull, (Karkoura, 1989) in camel (Schummer, 1976) in domestic animals, mentioned that this layer was common for both ventricles. The direction of the fibers superficial layer on the auricular surface were directed from right to left and on the atrial surface in reverse (Ghoshal, 1975) in domestic animals, (Karkoura, 1989) in camel, (Greenbaum *et al.,* 1981; Teran and Hurle, 1982) in human (Karkoura, 1989) in camel added that the direction of fibers of the superficial layer had clockwise manner at the apex of the heart (Karkoura, 1989 in camel; Teran and Hurle, 1982 in human; Sanchez *et al.,* 1994) in bull the fibers of the superficial layer of the myocardium at the vortices of the heart continued as the deep layer of the ventricular mass.
On the other hand, the middle layer fibers of the ventricular mass were separated and independent in each ventricle, It formed proper tube in each ventricle **(**Katherine, 2005) in sheep, (Schummer, 1976) in domestic animals, (Sanchez *et al.,* 1994) in bull, (Karkoura, 1989) in camel (Teran and Hurle, 1982) in human.
Moreover, the deep layer, it was vertically on the ventricular septum wall (Ghoshal, 1975) in domestic animals, (Karkoura, 1989) in camel (Teran and Hurle, 1982) in human. While (Sanchez *et al.,* 1994) in bull recorded that the deep layer was composed of muscle fascicles that lay mainly vertically in both ventricles, the architecture myocardium was an important fact in cardiac muscle dynamcation. Moreover; the quality and quantity changes in architectural myocardium were in abnormal heart

MATERIALS AND METHODS
Heart of twenty five adult sheep of both sexes, 3-5 years old was used for this study. Sheep heads were obtained from slaughterhouse Buraydah in KSA (Figure 1).

First, Pericardium and fat were removed. The auricle and the large blood vessels which were attached to cardiac base were cut. Then the specimens were washed by water stream to remove thrombi blood. The specimens were put in formaline 10% with acetic acid toChipped awayconnective tissue between the muscle fibers.

The superficial layer fibers were studied after putting them in deep freezer for one week by using anatomical forceps to know the origin and the insertion of this layer. On the other hand, the superficial layer fibers was exfoliated to look myocardium fibers directions and form. Moreover, the deep layer was studied after separating the middle layer completely until the interior surface of myocardium or from the interior surface of the ventricular wall.

RESULS AND DISCUSSION

Results

The study of the ventricular myocardial architecture of the heart in sheep revealed that the ventricular myocardial wall arranged of three layers: subepicardial (superficial), myocardial (middle) and subendocardial (deep) layer.

The results showed that the subepicardial layer (Figures 2,3,4,10) covers both of the ventricles, right and left generally through complete. The fibers of this layer rise from the fibrous rings of theleft and right atrioventricular as well as from the fibrous rings of the aortic and pulmonary arteries. Through following of this layer direction on the ventricular (left) surface. It was the observed fibers course obliquely and lightly caudoventrally until the cordis apex integrated with each other. On the other hand, the fibers of the superficial (subepicardial) layer on the auricular (right) surface of the heart course unlike of the left surface. It coursed cranioventrally. It looked continuous from the left ventricle to the right one vertically. When the subepicardial layer fibers reach to the apex of the heart, it looked circular. It directed clockwise forming two vortex cordis (Figure 4, 5).

Each vortex arises from the corresponding ventricle. This vortex represented an involvement of the superficial (subepicardial) layer fibers which directed from the caudal and left surfaces of the left ventricle in hills shape forming caudal corne gradually. While the fibers directed from the cranial and right surface of the heart forms the cranial crone of the left ventricle. The two corns form together a reverse involvement to make left ventricle vortex cordis.

The involvement directed cranially then to the left. At the vortex cordis, the subepicardial layer continues with the subendocardial layers of the left ventricle mass. On the other hand, the right ventricle vortex forms from the subepicardial layer fibers at the apex of the right ventricle in the cardiac notch. The right ventricle vortex extends deeply, it lies about 2-5 cm from the left ventricle vortex.

The results showed that the middle layer of ventricular myocardial architecture (Figures 5,6,7,10) differs from subepicardial layer of ventricular myocardial architecture of completely.

The middle layer of ventricular myocardial forms the basic support of the ventricular wall. The thickness of the middle layer fibers in the left ventricle more than the one in the right, Moreover, the middle layer fibers arrange transversely and spirally.

It consists from two independent and separated muscular tubes. Each tube is provided by two openings: The basic opening and the apical one. The basic opening of the right ventricle has an oval shape. It is on the fibrous ring of the right atrioventricular opening level. The diameter is bigger than the basic opening of the left ventricle, while the apical opening of the right ventricle a circular shape. It lies dorsally next to the right ventricle vortex.

Moreover, the basic opening of the left ventricle, takes a triangular shape, it locates on the fibrous ring of the left atrioventricular opening level. Its diameter is smaller than the basic opening of the right ventricle. While the apical opening of the left ventricle a circular shape. It lies at the level of the cordis vortex. On the other hand, the muscular tube of the left ventricle has a triangular shape, and its wall is thicker than that of the right ventricle wall .The middle layer fibers of the left ventricle supported by the subepicardia layer fibers at the paraconal and subsinousal grooves. The fibers of the middle layer form the septum wall which consists of the middle layer fibers only.

While the muscular tube of the right ventricle has a circular shape. It is wall is thinner than the left ventricle.
The middle layer fibers of the right ventricle lack the attachment of the septum wall which consists of the middle layer fibers of the left ventricle only.
The subendocardial layer fibers (Figures 8,9,10) study elements more accuracy anatomically. So, this study revealed that the subendocardial layer fibers were as a continuous for the subepicardial layer fibers at the cordis vortex. After removing the papillary muscles and the trabeculae carnae. The subendocardiallayer fibers directed craniodorsally to arrive at the fibrous rings of the right and left atrioventricular openings and the aortic and pulmonary openings, where it inserted dorsally in the fibrous rings. Through these deep subendocardiallayer fibers course, the subendocardiallayer fibers form the papillary muscles and the trabeculae carneafor the two ventricles. Moreover, the subendocardiallayer fibers ended at the chordae tendineaeroot and in the cusps. The subendocardiallayer fibers directed obliquely and craniodorsally in the interior wall of the ventricular mass. The results showed that there weren't any separated edges between the subendocardiallayer fibers which form the papillary muscles and the trabeculae carnaeand between the subendocardiallayer fibers which form the ventricular mass wall of the right and left ventricles. They will be integrated with each other at the adhesion points.
Finally, The ventricular architecture may express that the ventricular mass wall of three layers which have different directions and have a special ordinal pattern which has an effective role in the systole and diastole. Any disarranging of this ventricular architecture led to irregularity and defect in the systole and diastole process. This means that, each layer has its independent programmed contribution in the ventricular wall general activity.
This matrix of the three layer fibers acts as a continuous chain to give the cardiac muscle the power.
The different fibers direction eases the power transfer from the subepicardial layer to the subendocardial one through the middle layer to complete the systole and diastole.

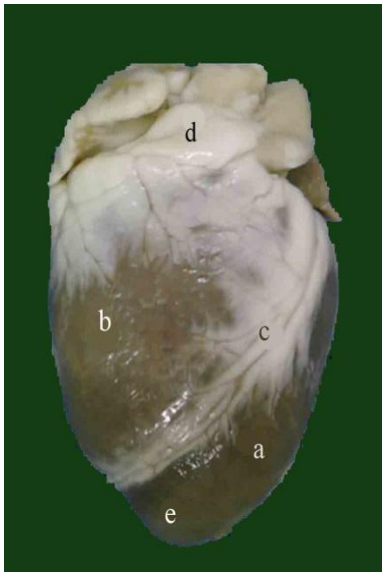

Figure 1: A photograph showing the normal heart of sheep (Left surface)
a- Left ventricle.
b- Right ventricle.
c- Paraconal interventricular groove.
d- Base cordis
e- Cordis apex

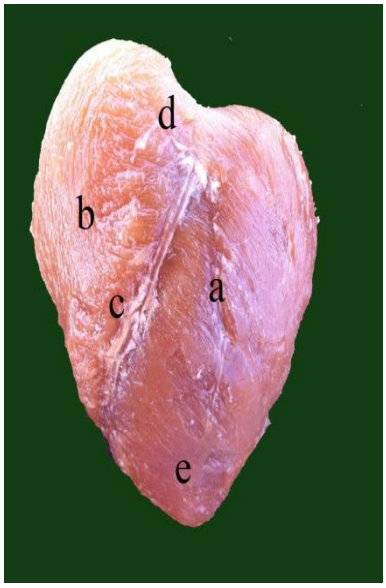

Figure 2: A photograph showing the subepicardial layer of the heart of sheep Left surface)
a- Left ventricle.
b- Right ventricle.
c- Paraconal interventricular groove.
d- Base cordis
e- Cordis apex

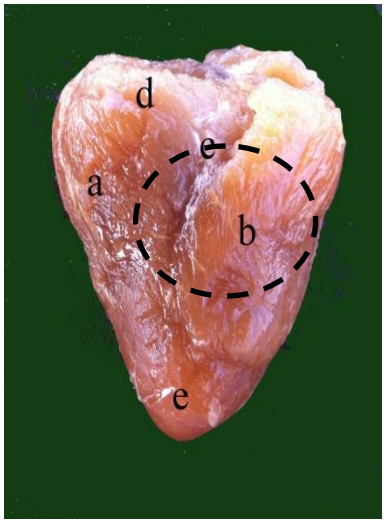

Figure 3: A photograph showing the subepicardial layer of the heart of sheep (Right surface)
a- Left ventricle.
b- Right ventricle.
c- Subsinusal interventricular groove.
d- Base cordis
e- Cordis apex

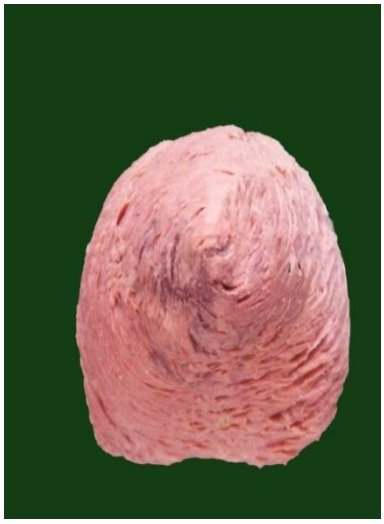

Figure 4: A photograph showing the arrangement of the subepicardial layer of myocardial fascicles on Cordis apex forming vortex cordis

Figure 5: A photograph showing the arrangement of the middle layer of myocardial fascicles of the left ventricle.

Figure 6: A photograph showing the arrangement of the middle layer of myocardial fascicles of the right ventricle

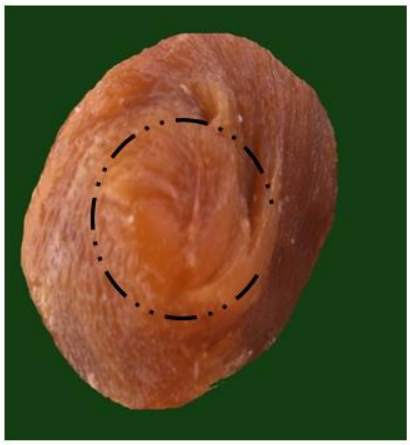

Figure 7: A photograph showing the arrangement of the middle layer at the vortex cordis , transfer the superficial layer to the middle layer

Figure 8: A photograph showing the arrangement of the subendocardiallayer of myocardial fascicles of the right ventricle with the papillary

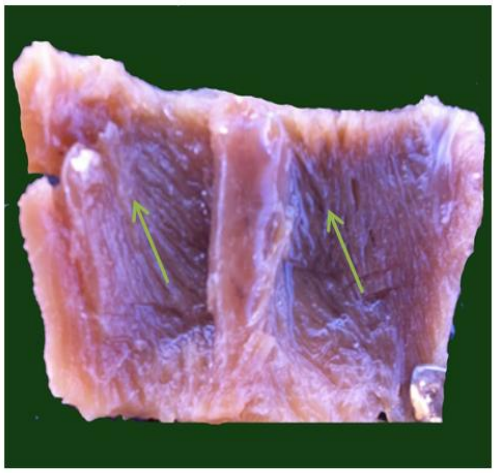

Figure 9: A photograph showing the arrangement of the subendocardial layer of myocardial fascicles of the left ventricle with the papillary

Figure 10: A photograph showing the arrangement of the superficial (1), middle (2) and deep (3) layers of myocardial fascicles of the ventricles

Discussion

In the present work, classical dissection and maceration methods were adopted. The current work has demonstrated three layers of muscle fascicles, superficial, middle and deep, the result which is in agreement with that have been given by (Schummer, 1976) in domestic animals (Sanchez-quintana *et al.,* 1994) in bull (Karkoura, 1989) in camel, (Miller *et al.,* 1979) in dog (Teran and Hurle, 1982) and (Syho and Nihoyannopoulos, 2006) in human (Delgobo *et al.,* 2014). The heart, in a simple linear analysis, which is composed by the same layers: endothelium - endocardium, tunica media - myocardium, tunica adventitia- pericardiumthe dimensions of the heart sheep closely resemble the human heart.

On the other hand, our results disagreed with (Francisco *et al.,* 2005) and (Luding, 2005) in human, whomentioned that the ventricular mass was arranged in two groups of muscular fibers, subepicardial and deep (subendocardial) layers. Moreover, (Sedmera, 2005) mentioned that the general arrangement of the muscle fascicles of the heart had spiral shape and tube.

In this study the subepicardial layer of the ventricular mass wall was raised from the fibrous rings of the left and right atrioventricular as well as from the fibrous rings of the aortic and pulmonary arteries the observed fibers course obliquely and lightly caudoventrally until the cordis apex integrated with each other while the fibers of the subepicardial layer on the auricular (right) surface of the heart course unlike of the left surface. It coursed cranioventrally to reach to the vortex cordis clockwise. This agrees with (Goshal, 1975; Shummer, 1976) in domestic animals, (Teran and Hurle, 1982; Kaibogaku, 1989; William and Warwik, 2000) in human.

(Karkoura, 1989) in camel, (Kaibogaku, 1989) in human described that the superficial layer direction like clockwise when looking from cordis apex.

(Kathrine, 2005) in sheep mentioned the lateral cranial wall of the left ventricle was arranged through vertical sheets and slides, and had spiral shape.

(Sanchez *et al.*, 1994) in bull mentioned that the directions fibers of the superficial layer on the anterior surface were arranged vertically, The exception was the upper part of the right ventricle, together with the origin of the pulmonary artery, were the fibers obliquely from left to right and in the inferior part of the left ventricle near the apex, were they ran obliquely from right to left. While (Syho and Nihoyannopoulos**,** 2006) in human recorded that the superficial layer fascicles were arranged peripherally.

On the other hand, the subepicardiallayer fascicles became spiral shape at the apex heart then continued deeply forming the vortex cordis, After that it continued as subendocardial layer (Anderson *et al.*, 2005) mentioned that the apex of the left ventricle had not the middle muscular layer. Booth of the subepicardialand subendocardial) layers were continuous at the apex. This study revealed that the apex heart was provided by two vorticec left and right. The left vortex was forming by the subepicardial layer of each ventricle, it had the spiral pattern (Kaibagaku, 1989) While (Karkoura, 1989) added that the vortex cordis was provided by two cranial and caudal corns, which contributed in vortex cordis forming. Moreover, in this study, the vortex of the right ventricle was n t clear like the vortex of the left ventricle. It was just a simple spiral roll, which continued directly to form the deep (subendocardial) layer of the right ventricle.

In contrary, (Anderson *et al.*, 2005) in human heart revealed that the vortex of the left ventricle was far from the middle layer, each of the superficial and deep layers were connected in this vortex.

On the other hand, the architectural design of the middle layer fascicles was spiral and transversely, forming a muscular tube special for each ventricle. The wall of the right ventricle tube was thinner and weaker than one of the left ventricle tube. It did n t contribute in interventricular septum forming which was formed only by the left ventricular tube wall (Luding, 2005; Kathrine, 2005) in sheep, (Shummer, 1976) in domestic animals (Karkoura, 1989) in camel (Sanchez-quintana *et al.*, 1994) in bull (William and Warwik, 2000), (Choukri *et al.*, 2012) in human stated that the fibers in the midmycardium were circumferential (Delgobo *et al.*, 2014). The variation in the thickness of the myocardium is a result of the difference in force needed to eject the blood of a given camera, and thus the thicker portion of the myocardium is the one that involves the left ventricle. On the contrary (Sedmera, 2005) mentioned that the architectural of the middle layer was represented by a single layer tube (Luding, 2005) recorded that the middle layer was double of fascicles of spiral fibers in human.

The muscular tube of the left ventricle was thicker than the right one. This thickness was become of that the outflow blood in the left ventricle.

The results showed that the subendocardial (deep) layer was as a continuous of the subepicardial (superficial) layer at the apex of the heart. In other way, the subendocardial layer was forming when the subepicardial layer wrapped deeply at the vortex cordis. Then, the subendocardial layer directed dorsally and obliquely, but it was vertical at the origin of the papillary muscles and chordae tendineae. It was inserted in the fibrous rings of the right and left atrioventricular orifices and in the aortic and pulmonary fibrous rings.

(Goshal, 1975; Shummer, 1976) in domestic animals (Greenbaum *et al.*, 1982) in human and (Karkoura, 1989) in camel. While (Sanchez *et al.*, 1994) in bull recorded that the deep layer was composed of muscle fascicles that lay mainly vertically in both ventricles. In the left ventricle fascicles of the deep layer arose

from the apex and originated from the invaginated fascicles of the superficial layer, then the muscle fascicles incorporated into the papillary muscles of the left ventricle and either were inserted into the chordae tendineae (Francisco *et al.,* 2005) mentioned that the deep layer fibrous directed transversally. In contrary (Greenbaum *et al.,* 1982; Syho and Nihoyannopoulos, 2006) recorded that the deep layer fibers direction in human was longitudinally forming papillary muscles and trabeculae carnea.

Finally, the architectural of the ventricular mass was consisted of three layers, which had different directions and distinguished arranged pattern. This pattern played an important role in evolution the relation between the distal and systole processes. Any change in this architectural led to abnormal functions. So, each layer had its programmed contribution in the ventricular wall activity lonely. Moreover, this architectural of the ventricular mass wall acted as a serial layers, to send the need power for the cardiac muscle.

The architectural included the direction fibers from the superficial layer to the subendocardial layer through the middle layer, activating each other to give the cardiac muscle the demand power.

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