

Histological Studies on the Papillary Muscles of the Heart in buffaloes (*Bubalus bubalis*)

Naveen Kumar¹, Girish Hemanth Kolati¹, Praneeth Datta Naikanti¹ and Prasanth Babu Ankem^{2*}

¹BVSc & A.H. Student, College of Veterinary Science, Proddatur, Kadapa, Andhra Pradesh, INDIA

²Assistant Professor, Department of Anatomy, College of Veterinary Science, Proddatur, Kadapa, Andhra Pradesh, INDIA

*Corresponding Author: prasanthankem@gmail.com

How to cite this paper: Kumar, N., Kolati, G., Naikanti, P., & Ankem, P. (2020). Histological Studies on the Papillary Muscles of the Heart in Buffaloes (*Bubalus bubalis*). *International Journal of Livestock Research*, 10(8), 213-216. doi: <http://dx.doi.org/10.5455/ijlr.20200609072830>

Received : Jun 09, 2020
Accepted : Jul 09, 2020
Published : Aug 31, 2020

Copyright © Kumar *et al.*, 2020

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



Open Access

Abstract

Histologically, the papillary muscles of the heart of buffalo consisted of three layers; endothelium, subendothelial and myocardial layers from within outwards. Endothelium was a simple squamous epithelium, which was supported by a subendothelial layer which consisted of loose connective tissue mainly collagen, elastic fibers and adipose tissue. The endothelial and subendothelial layers together form an endocardium. The central layer, considered the normal myocardial layer, consisted of cardiac muscle. The muscle fibers appeared long, striated, branched and anastomosed; some binucleated cells were occasionally observed, with centrally placed nuclei having prominent nucleoli. The sarcoplasm of cardiac muscle was eosinophilic, full of parallel contractile myofibrils that consisted of myofilaments with a very strong cross striated banding pattern. The purkinje fibers were organized into bundles at the subendocardial region and in between and surrounding the cardiac muscle bundles. Chordae tendinae also consisted of three layers; outer endothelial, middle subendothelial and central fibrous layer.

Keywords: Buffaloes, Heart, Histology, Papillary Muscles

Introduction

The right and left atrioventricular orifices in the heart are guarded by tri and bi cusped valves respectively. The peripheral or basal edges of these cusps are attached to the atrioventricular opening while the central edges are connected with the ventricle by chordae tendineae by means of papillary muscles. In the left ventricle, the chordae tendineae are fewer but larger than it in the right ventricle. Contractions of papillary muscles pull the chordae tendinae, which pull the atrioventricular valves and prevent them from opening towards the atria during the ventricular systole. These structures are in direct contact with the blood flow and actuate determining the adequate blood course, participating directly in the myocardial contractile function (Getty, 1975, Nickel *et al.*, 1984; Reece, 2009; Dyce, 2002; Smuts and Bezuidenhout, 1997 and Budras *et al.*, 2003).

The histoanatomical studies on the papillary muscles of heart in domestic animals (Eurell and Frappier, 2006) and in camel (Ghonimi *et al.*, 2014) are available, but similar studies in buffaloes are not available. Hence, the present study was undertaken to study the histology of papillary muscles and also the structure and distribution of purkinje fibers within the papillary muscle of heart in buffaloes.

Materials and Methods

Hearts of six apparently healthy mature buffaloes were collected from the local slaughter houses around Proddatur and Kadapa for histological studies on papillary muscles. Papillary muscles were dissected immediately from the hearts and fixed in 10% neutral buffered formalin and routine tissue processing procedures were applied. The tissue pieces were processed for paraffin sections of 5 to 6-micron thickness and were subjected to haematoxylin and eosin for routine histomorphology. Masson's Trichrome method for differentiation of collagen and muscle fibres (Luna, 1968).

Results and Discussion

Histologically, the papillary muscles consisted of three layers; endothelium, subendothelial and myocardial layers from within outwards (Fig. 1). However, Ghonimi *et al.* (2014) mentioned two layers, the central (core) myocardium and the peripheral endocardium in camel. The endothelium externally present was the simple squamous epithelium that was reflected from the ventricular endothelium. It was supported by the sub endothelial layer which consisted of loose connective tissue mainly collagen, elastic fibers and adipose tissue. The endothelial and subendothelial layers together formed an endocardium. This endocardium completely surrounded the papillary muscle in all directions and acted as the papillary muscles capsule. Similar findings were observed by Gusukuma *et al.* (2004) in human and swine, Eurell and Frappier (2006) in domestic animals and Ghonimi *et al.* (2014) in camel.

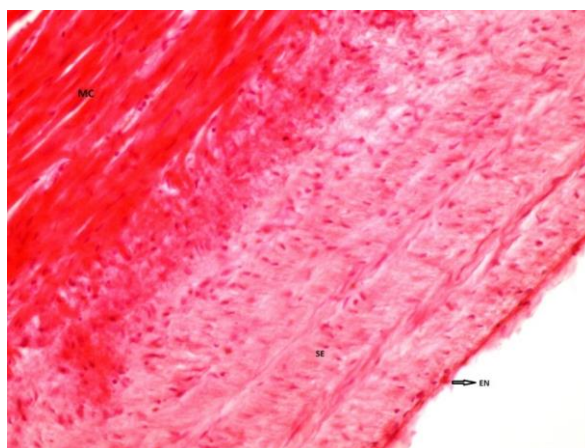


Figure 1: Photomicrograph of papillary muscle of heart of buffaloes showing endothelium (EN), Subendothelial layer (SE) and myocardial layer (MC). Haematoxylin & Eosin x 400

The central layer was the normal myocardial layer as in the ventricular wall and the moderator band. In the longitudinal sections, cardiac muscle appeared long, striated, branched and anastomosed, forming a network and joined end to end and side to side at intercalated disks, forming the myocardial fibers (Fig. 1). Most of the cardiac muscle cells possessed only a single, relatively large, oval, ovoid pale-staining, more euchromatic and centrally

placed nucleus. In cross sections, the cardiac muscle fibers appeared as irregular polygonal cells of various sizes with a large, round, pale staining, euchromatic, centrally placed, single nucleus. The sarcoplasm of cardiac muscle was eosinophilic, full of parallel contractile myofibrils. They exhibited a very strong cross striated banding pattern and the sarcoplasm showed its characteristic striations of alternating dark and light bands. However, some binucleated cells were occasionally observed, with centrally placed nuclei having prominent nucleoli. These findings were in agreement with findings of Marei *et al.* (1994) and Ghonimi *et al.* (2014) in camel.

The purkinje fibers were present beside the longitudinal cardiac muscle bundles. They were organized into bundles at the subendocardial region and in between and surrounding the cardiac muscle bundles. These purkinje cells were round, larger in size than the working cardiac myocytes, showing variety in number and size (Fig. 2). Similar findings were reported by Satyamoorthy and Ramesh (2008) in horses, Parto *et al.* (2013) in ostrich, Marei *et al.* (1994) and Ghonimi *et al.* (2014) in camel. However, in human and dog the purkinje cells in the network were cylindrical or fusiform in shape and arranged in a parallel pattern (Cranefield *et al.*, 1972). In sheep and goat, the chain of purkinje cells were larger than myocyte and 2-8 oval cells formed these network (Shimada *et al.*, 1992). The cytoplasm of purkinje cell was pale as it contained very few myofibrils than normal myocardiocytes. It contained a single, central, large nucleus but was sometimes binucleated with prominent nucleoli. The nuclear chromatin was dispersed and, in most cases, tended to be condensed peripherally. Similar findings were also reported by Marei *et al.* (1994) and Ghonimi *et al.* (2014) in camel.

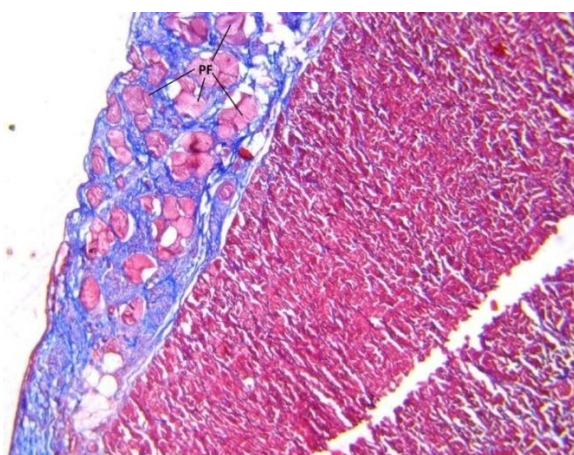


Figure 2: Photomicrograph of papillary muscle of heart of buffaloes showing Purkinje

Chordae tendinae also consisted of three layers, outer endothelial, middle sub endothelial and centrally fibrous layers, the endothelial layer of papillary muscles extended and continued on the surface of the chordate tendinae, which was lined by simple squamous epithelium. Under the endothelium sub endothelial layer was present, which consisted of loose connective tissue mainly collagen and elastic fibers. The endothelial and subendothelial layers together formed an endocardium. The central core consisted of thick collagen fiber bundles, which ran in parallel direction. In the entire length of chordate tendinae these collagen bundles were arranged as interrupted bundles (Fig. 3).

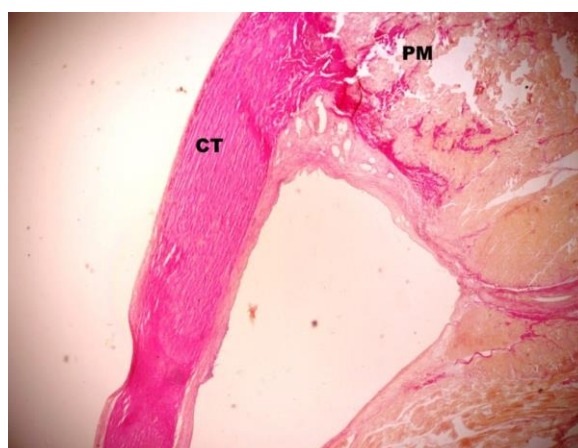


Figure 3: Photomicrograph of showing chordae tendinae (CT) and papillary muscle

Conclusion

Histologically, the papillary muscles in the heart of buffaloes consisted of three layers; endothelium, subendothelial and myocardial layer from within outwards. The endothelial and subendothelial layers together formed an endocardium. The central layer considered as the normal myocardial layer consisted of cardiac muscle. The muscle fibers appeared long, striated, branched and anastomosed, forming a network and joined end to end and side to side at intercalated disks, forming the myocardial fibers. The sarcoplasm of cardiac muscle was eosinophilic, full of parallel contractile myofibrils that consisted of myofilaments. The Purkinje fibers present were organized into bundles at the subendocardial region and in between and surrounding the cardiac muscle bundles. Chordae tendinae also consisted of three layers, outer endothelial, middle sub endothelial and centrally fibrous layers.

Conflict of Interests

There is no conflict of interest.

Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

References

1. Budras, K., Sack, W.O & Rock, S. (2003). (4th edn). *Anatomy of the horse*. Schlutersche Hannover, Germany.
2. Cranefield, P.F., Wit, A. L & Hoffman, B. F. (1972). Conduction of the cardiac impulse. 3. Characteristics of very slow conduction,”. *Journal of General Physiology*, 59(2): 227–246.
3. Dyce, K.M., Sack, W.O & Wensing, C. J. G. (2002). (3rd edn). *Text Book of Veterinary Anatomy*, WB Saunders, London.
4. Eurell, J & Frappier, B.L. (2006). (6th edn). *Dellmann's Textbook of Veterinary Histology*, Blackwell. New York, London.
5. Getty, R. (1975). (5th Edn). *Sisson and Grossman's, the Anatomy of the Domestic Animals*, Philadelphia: WB Saunders.
6. Ghonimi, W., Abuel-atta, A. A., Bareedy, M.H & Balah, A. (2014). Papillary Muscles in the Heart Ventricles of the Mature Dromedary Camel (*Camelus dromedaries*) with Special References to the Chordae Tendineae: Gross and Microanatomy. *Journal of Cytology and Histology*: 5 (4):1-7.
7. Gusukuma, W.L., Prates, J.C & Smith, R.L. (2004). Chordae tendineae architecture in the papillary muscle insertion. *International Journal of Morphology*, 22: 267-272.
8. Luna, I.G. (1968). (3rd Edn). *Manual of Histological Staining Method of the Armed Force Institute of Pathology*. McGraw Hill Book co. New York.
9. Marei, H.E., Osman, A.K & Caceci, T. (1994). *A histological approach on the myoendocrine cells of the camel heart*. Ph. D. Thesis. Faculty of Veterinary Medicine, Suez Canal University, Egypt.
10. Nickel, R., Schummer, A & Seiferle, E. (1984). (2nd edn). *Lehrbuch der Anatomie der Haustiere*. Verlag Paul Parey. Parey, Berlin, Hamburg.
11. Parto, P., Tadjalli, M and Ghazi, S.R. (2010). Macroscopic and microscopic studies on moderator bands in the heart of ostrich (*Struthio camelus*). *Global Veterinarian*. 4: 374-379.
12. Reece, W.O. (2009). (4th Edn). *Textbook of functional anatomy and physiology of domestic animals*. Wiley-Blackwell, Ames.
13. Sathyamoorthy, O.R & Ramesh, G. (2008). Microanatomical studies on the moderator band (trabecula septomarginalis) of horses (*Equus caballus*). *Journal of Veterinary and Animal Science*, 39: 33-35.
14. Shimada., Ushiki & Fujita, T. (1992). Purkinje fibers of the heart, *Shinyaku to Chiryō*, 42: 11–13.
15. Smuts, M.M.S & Bezuidenhout, A.J. (1987). *Anatomy of the dromedary*. Clarendon Press, Oxford.
