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Chordae Tendineae of Male Red Legged Partridge as Observed by Scanning Electron Microscopy

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Abstract: The *chordae tendineae* of the heart are collagenous strands which extend from the apical margin of papillary muscles of the heart to the various areas on the ventricular surface of the valve leaflets. They convey the contraction of the papillary muscles to the valve and so prevent the latter's eversion. Five hearts of the partridge were collected and opened the left side of the heart. Routine paraffin sectioning with special staining method and Scanning electron microscopy was done. Results manifested that basically *chordae tendineae* is a connective tissue covered by endocardium. The core connective tissue of *chordae tendineae* in the proximal part was loose connective tissue and in distal parts was dense irregular connective tissue whereas in the middle part it was dense regular connective tissue.

Key words: Chordae tendineae · Heart · Partridge

INTRODUCTION

The chordal tendinous system of the heart is one of the most important functional systems involved in the circulation of the blood [1]. These strong cords spring from the tip of each papillary muscle. The right atrioventricular valve is formed by a single muscular cusp with no *chordae tendineae* in chicken, but the free border of tricuspid valve in left atrioventricular opening, carry a varying number of *chordae tendineae* [2].

There are some literature that were conducted on the *chordae tendineae* in mammals and birds such as the determination of collagen fibril diameter and collagen type in human heart [3,4], rabbit and sheep hearts [3], male ostrich [5] SEM study of *chordae tendineae* in human [6-8], study of distal junction of papillary muscle in rat [9], morphogenesis of *chordae tendineae* in human [10], lymphatic capillary in chordae [11], structure of *chordae tendineae* in human [12,13], chicken [14] and horse [15] have been studied.

No information is available concerning histological study of *chordae tendineae* in the partridge heart, thus this study revealed their morphological features.

MATERIALS AND METHODS

To follow-up this study, 5 apparently healthy adult male partridge were considered. Hearts were assigned from the slaughterhouse immediately after slaughter.

Histological Study: The *chordae tendineae* of left atrioventricular valve were dissected and they were divided into proximal part (attach to the valve), middle part and distal part (attach to the papillary muscle). Subsequently each part was divided into two parts. One part was fixed in 10% buffer neutral formalin for light microscopy. The other part was fixed in 2.5% gluteraldehyde for scanning electron microscopy (SEM) study.

All fixed specimens were processed and sectioned 6 µm through light microscopic analyses. Altimetry the sections were stained by using Green Masson's Trichrome and Orcein-Van Gisson`s [16] .

Electron Microscopy: The specimens were washed in 0.1% phosphate buffer, post fixed in 1% osmium tetroxide, dehydrated through a graded ethanol series. Clearing was carried out with methyl desialasan. Then the specimens were dried vaccum and critical point drying. They were mounted onto stubs using conductive double adhesive tape and then coated with gold for 45 seconds and examined under a scanning electron microscope (Hitachi HHS-2R). The electromicrograph were prepared and studied.

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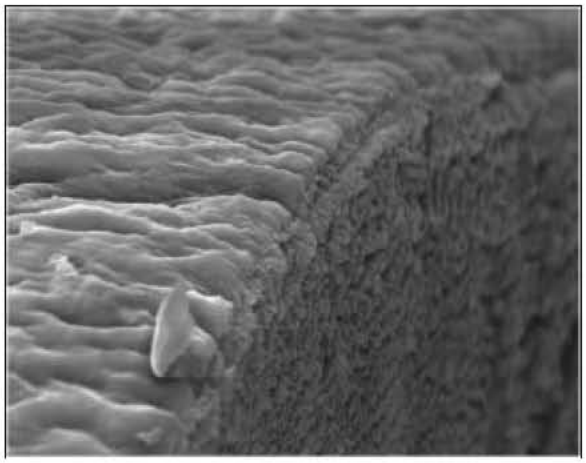

Fig. 1: Cross section of chordae tendineae in partridge heart, showing parallel connective tissue fibers (×10100).

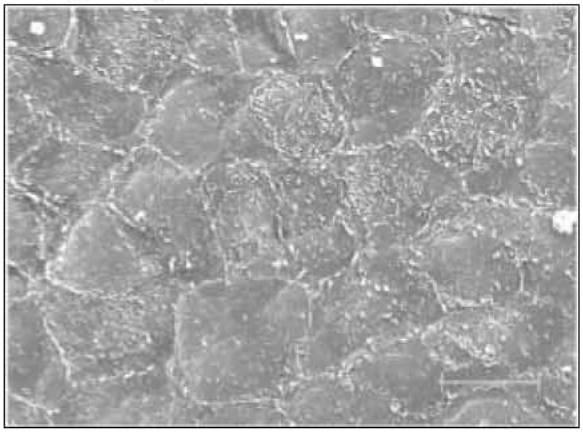

Fig. 2: Scanning electron micrograph of polygonal endothelial cell with small microvilli surronding the chordae tendineae in partridge heart (×10300).

Fig. 3: Scanning electromicrograph of proximal part of chordae tendineae in partridge heart (×10000).

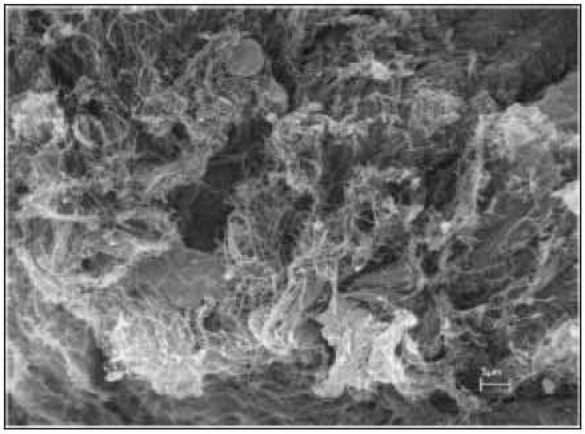

Fig. 4: Electromicrograph of the proximal part of the chordae, showing dense irregular connective tissue (× 10990).

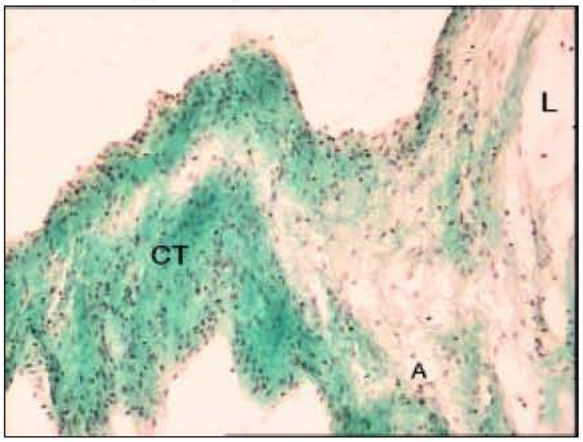

Fig. 5: Micrograph of proximal part of the chordae tendineae, showing dense irregular connective tissue (CT) with lymphatic vessels (L) and adipose cells (A) between the fibers. Green Masson`s Trichrome (× 400).

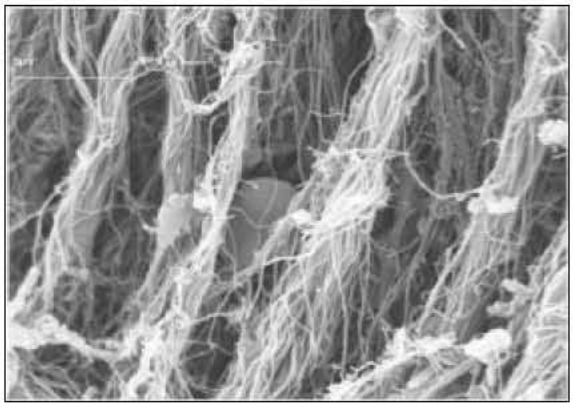

Fig. 6: Electronmicrograph of the middle part of the chordae tendineae, showing ovoid fibroblast (F) between rows of collagen fibrils (Cf) (×10990).

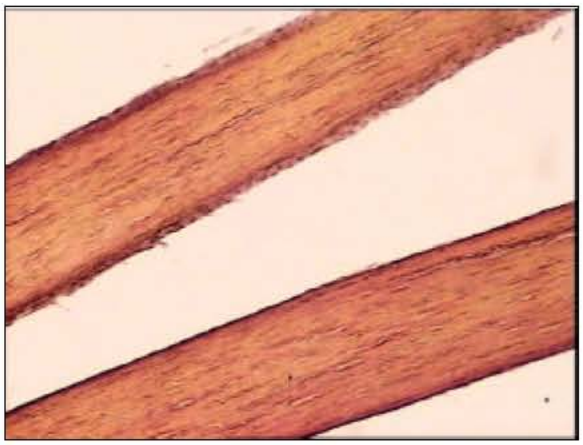

Fig. 7: Longitudinal section of the middle part of the chordae tendineae showing parallel pattern of connective tissue. Orcein-Van Gisson`s (×40).

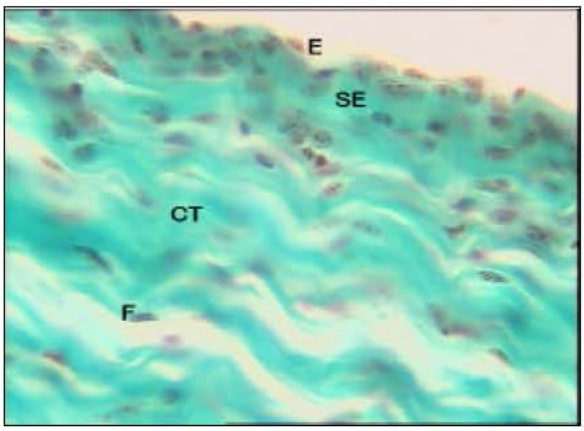

Fig. 8: Longitudinal section of the middle part of the chordae tendineae showing Wavy pattern of connective tissue (CT). Endothelium (E), Fibroblast (F), Subendothelial Layer (SE). Green Masson`s Trichrome (×400).

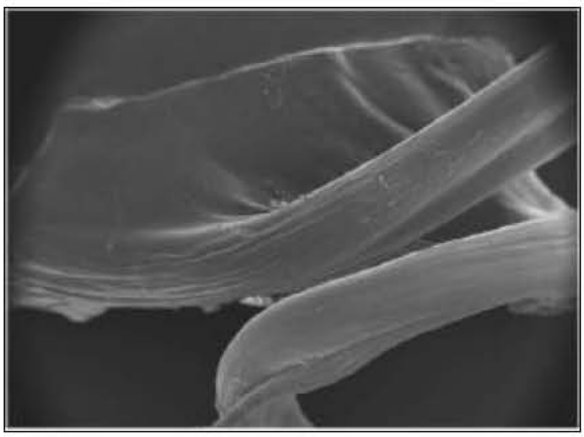

Fig. 9: Electromicrograph of junctional area (J) of the chordae tendineae to papillary muscle (× 10000).

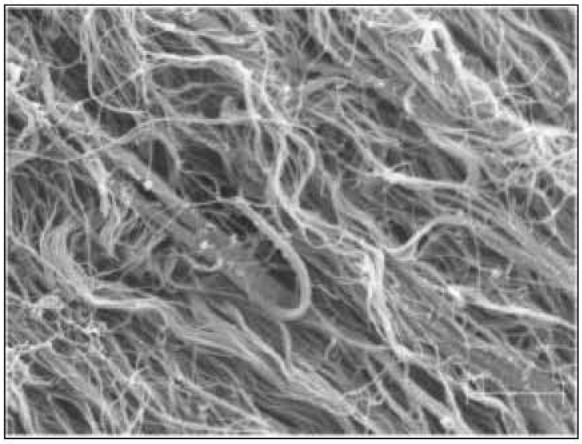

Fig. 10: Electromicrograph of the distal part of the chordae tendineae showing the irregularity of collagen fibrils (×10990).

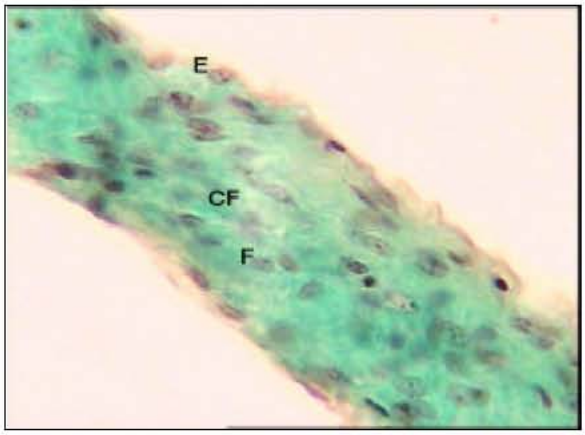

Fig. 11: Micrograph of the distal part of the chordae, showing dense irregular connective tissue, collagen fiber (CF), Fibroblast (F) and Endothelium (En). Green Masson`s Trichrome (×400)

RESULTS

The light microscopic and transmission electron microscopic studies confirmed that the histological structure of *chordae tendineae* in partridge basically was connective tissue composed of collagenous fibers, few elastic fibers and fibroblasts. The chordae were covered by endocardium, composed of a superficial layer of endothelial cells and an underlying layer of irregular connective tissue contain fibroblasts, collagenous fibers and a great number of elastic fibers that lie circumferentially (Fig. 1). The chordae`s endocardium is continuous with that of papillary muscle and valves leaflet. Endothelial cells are polygonal and contain small microvilli. They held together by interdigitating junctions(Fig. 2).

The proximal part of *chordae tendineae* consisted of dense irregular connective tissue in periphery and loose connective tissue in the center with delicate networks of lymphatic capillaries which were of different size caliber. Lymphatic capillaries were composed of continuous endothelium which was surrounded by a thin layer of collagenous fibers. Also clusters of adipose cells were seen in the proximal part of the *chordae tendineae* (Fig. 3,4,5).

The structure of the middle part of the *chordae tendineae* was dense regular connective tissue that collagen fibers were arranged in compact, regular parallel rows and between them. There were fibroblasts with ovoid nucleus(Fig. 6,7,8)

The histological organization of Fibers in the junctional area of chordae tendineae to valve is dense irregular connective tissue with fibroblasts (Fig. 9,10,11).

DISCUSSION

There were no papillary muscle and *chordae tendineae* on the right atrioventricular valve in the partridge heart. The left atrioventricular or tricuspid valve complex of partrige heart consists of functional units which include the annulus fibrosus, valve leaflets, *chordae tendineae* and papillary muscles. The mechanical properties of these functional units depend on the link between the muscle and the valve. This link is arranged in a branching network of tendinous cords composed of collagen and elastic fibers, which transmit contractions of papillary muscle to the valve leaflets [1,14,17]

The *chordae tendineae* in the partridge heart has interchordal attachment and it's similar to that of chicken [14], human [12,18,19], human and swine [13], sheep and rabbit [3] and ostrich [5].

The chordae in the partridge heart attach directly to the edge of the valve, but in the heart of human, their attachment is few millimeters back from the edge [12,20].

The *chordae tendineae* consists of a dense collagenous central core, surrounded by a layer of connective issue, that covered by flat endothelial cells. These results are similar to horse [15], ostrich [5] and human [12].

The regular wave pattern of collagen in the chordal core of middle part in the heart of partridge support the result in the heart of sheep and rabbit [3], mouse [21], human [7,12], goat and cattle [22], ostrich [5] and horse [15]. This architectural arrangement is necessary for the tissue that is under constant dynamic stress. But, in the heart of the kid this architecture changes to the loose connective tissue in the periphery and dense irregular connective tissue in the core of the chordae [22] similar to proximal part of chordae in the ostrich.

Distribution of elastic fibers under the endothelium and a few longitudinal fibers in the core of the *chordae tendineae* between collagen fibers, partly agree with occasional endocardial elastic fibers in the dog's heart [23]. The presence of lymphatic capillary in proximal part of the chordae is similar to that of the human [11] and ostrich [5].

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REFERENCES

1. Dyce, M., O. Sato and J.G. Wensing, 1987. Textbook of veterinary anatomy. Philadelphia: W.B.Saunders Company.
2. Nickel, R., A. Schummer and E. Seiferle, 1977. Anatomy of the domestic birds. Hamburg: Verlag Paul Parey.
3. Berkovitz, B.K. and S. Robinson, 1991. Ultrastructural quantification of collagen fibrils in chordae tendineae of the sheep and rabbit. J. Anat., 178: 127-132.
4. Sato, I. and K. Shimada, 2001. Quantitative analysis of tenacin in chordeae tendineae of human left atrioventricular papillary muscle with aging. Ann. Anat., 183: 443-448.
5. Parto, P. M. Tadjalli and S.R. Ghazi, 2009. Light and ultrastructural study of the chordae tendineae in the heart of ostrich *(Struthio camelus)*. W.J. Med. Sci., 4(2): 93-97.
6. Lim, K.O., 1980. Mechanical properties and ultrastructure of normal human tricuspid valve chordea tendineae. Jpn. J. Physiol., 30: 455-464.
7. Lim, K.O. and D.R. Boughner, 1977. Scanning electron microscopical study of human mitral valve chordae tendineae. Arch. Pathol. Lab. Med., 110: 236-238.
8. Sato, I., 2002. Coil-like structure of the inner core of chordae tendineae. Circ. Anat., 15: 196-198.
9. Gotoch, T., 1994. Ultrastructure of the rat papillary muscle-chordae tendineae junction. J. Electro Microsc., 43: 151-154.

10. Morse, D.E., W.C. Hamlett and C.W. Nobel, 1984. Morphogenesis of chordae tendineae, scanning electron microscopy. Anat. Rec., 210: 629-638.
11. Ichikawa, S., S.Uchino and Y. Hirata, 1989. Lymphatics of the cardiac chordae tendineae with particular consideration of their origin. Lymphol., 22: 123-131.
12. Millington-Sanders, C., A. Meir, L. Lawrence and C. Stolinski, 1998. Structure of chordae tendineae in the left ventricle of the human heart. J. Anat., 192: 573-581.
13. Gusukuma, L.W., J.C. Prates and R.L. Smith, 2004. Chordae tendineae architecture in papillary muscle insertion. Int. J. Morphol., 22: 267-272.
14. Yildiz, D. and K. Cavusoglu, 2004. The chordae tendineae of the heart in chicken. Anat. Histol. Embryol., 33: 189-191.
15. Tadjalli, M. and U. Katza, 2008. Comparative study of chordae tendineae of tricuspid and bicuspid valves in the heart of horse by light and scanning electron microscope. In: 38th Annual Conference of the Anatomical Society of Southern Africa (Abstract), South Africa, Protia University, pp: 23.
16. Luna, L.G., 1968. Manual of histologic staining methods of the armed forces institute of pathology, 3rd ed. American Registry of pathology, New York.
17. Tipirdamaz, S., 2002. Circulatory system. In: The anatomy of the domestic birds. Medisan Publishing, Ankara. pp:129-166.
18. Lam, J.H.C., N. Ranganathan, E.D. Wigle and M.D. Silver, 1970. Morphology of the human mitral valve, I. Chordae tendineae: a new classification. Circulation, 41: 449-458.
19. Robert, W.C. and L.S. Cohen, 1972. Left ventricular papillay muscles. Circulation, 46: 138-154.
20. Hurst, W.J., 1990. The heart, 7th ed. Mc Grow-Hill Company, pp: 22.
21. Icardo, J.M. and E. Colvee, 1995. Atrioventricular valves of the mouse, Collagen skeleton and myotendinous junction. Anat. Rec., 243: 367-375.
22. Safaee, S., 2003. Histological study of the chordae tendineae of tricuspid and bicuspid valve in the heart of cow and goat. DVM thesis. school of veterinary medicine, Shiraz university.
23. Fenoglio, J.J. W. Al, B. Al and B.M. Wagner, 1972. Canine mitral complex:Ultrastructure and electromechanical properties. Circ. Res., 31: 47-30.