A histological study of the corneosclera layer (*Fibrous tunic*) of ostrich (*Struthio camelus*)

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Abstract:

BACKGROUND: The Ostrich is an interesting subject concerning animal evolution and morphology studies. It has been speculated that ostrich eyes would have distinct tissue structures and this has not been previously studied in detail. **OBJECTIVES:** The aim of the present study was to investigate the histology of the outer layer of the ostrich. **METHODS:** Ten mature ostriches were chosen from an ostrich breeding center in Jupar, Kerman, Iran. All of them were in a good shape and healthy condition. After slaughter, their heads were kept in 10 % formalin solution for 7 days and then the eyes were removed. Routine histological techniques were done and 6-µm-thick sections were cut. Sections were stained with standard hematoxylin and eosin (H&E) and Masson's trichrome and PAS. The sections were studied under a light microscope. **RESULTS:** The cornea of ostrich had both dermal and sclera components and the two distinct parts were separated by a distinct zone; in addition, the sclera was divided into an episclera zone and a sclera proper zone. **CONCLUSIONS:** The outer layer of the episclera composed of connective fibers loosely attached to the sclera proper. The inner layer of the sclera consisted of dense connective tissues with two cartilaginous parts continuing over the oraserrata that composed dense connective fibers and ossicles.

Introduction

The eye of ostrich is very large in comparison with the size of the head and the brain, the weight ratio of the two eyes to the brain being almost 1 to 1 (kingsmith, 1971).

The wall of the eyeball is divided into three layers: the outer *fibrous tunic* (corneaosclera layer), the middle vascular tonic(uvea), and the inner or nervous layer. The sclera is the outer fibrous layer of eye which covers most of the eye posteriorly and the cornea anteriorly (Banks, 1993).

The sclera is usually made up of collagenous fibers and may contain ossified cartilage in some teleost species (Kunz, 2004). Scleral ossicles or scleral cartilages display a large degree of variation in presence or absence, number, and morphology with indoors the teleost eye .(Mansoori, Sattari and Franz-Odendaal, 2008; Franz-Odendaal and Hall, 2006). Two distinct scleral ossicle morphologies have recently been identified, and the number of these elements decreased from the ancestral arrangement of four scleral ossicles per eye to the present arrangement of two or less scleral ossicles per eye (Franz-Odendaal, 2008).

The cornea is a curved non-vascular and clear window which mainly consists of an epithelium superimposed a basement membrane (Kapoor and Hara, 2001).The cornea is a transparent window which mainly consists of an epithelium overlying a basement membrane (Kapoor and Hara, 2001), and an endothelium with a basement membrane known as Descemet's membrane separating it from the stroma (Kapoor and Hara, 2001). Although the histology of ostrich eyes from numerous species has been undertaken, no detailed study has been carried out.

Materials and Methods

For this study, the eyes from ten light-adapted ostriches that were killed for reasons other than ocular lesions were examined by using light microscopy. After the ostriches were slaughtered, their heads were kept in 10% formalin solution for 7 days and then the eyes were removed and kept in 10% formalin solution for two more days.

Routine histological techniques were undertaken, and 6-µm-thick sections were cut. Sections were stained with standard hematoxylin and eosin (H&E) and Masson's trichromeand. Histological study was performed using a light microscope, and photographs were taken for detailed illustration of the results (Fig. 1).

Results

The cornea: In this study, we found that the cornea of ostrich had both dermal and sclera components, and the two distinct parts were separated by a distinct zone. The outer dermal portion was composed of four layers: (1) an anterior non-keratinizing stratified squamous epithelium; (2) Bowman's membrance is composed of a compact , acellular, collangenous matrix (3) substantiapropria which is the greater part of the thickness of the cornea it is transparent but not completely homogeneous since it is composed of bundles of collagen fibres ;(4) This was the only component present here, and (5) a posterior single layer of cuboidal to flattened cuboidal cells Figs. 4-6.

The sclera: The sclera was divisible into an episclera zone and a sclera proper zone. The outer layer of the episclera was composed of connective fibers loosely attached to the sclera proper. The inner layer of the sclera consisted of dense connective tissues with two cartilaginous parts continuing over the oraserrata. These two parts were joined together by means of connective fibrils at the posterior of the globe and changed into the corneal connective tissue at the anterior end. The transition from sclera proper to scleral cornea which occurred at the corneoscleral junction or limbus included vessels extention. In this case we see the osteofication and diiffiuse into the cornea and because the age of these ostrich was low the ossicle had not been created (Figs. 2-3 & 7-8).

Figure 1. Sagittal section of Ostrich eye.

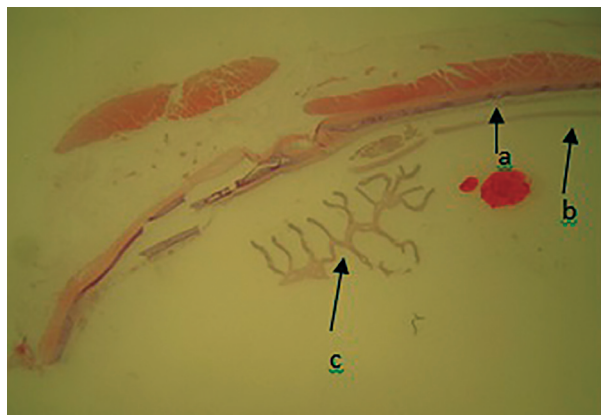

Figure 2. Sagittal section of Ostrich. a, scleral crtilage connective. tissue between two cartilages; c, ora serrata; d, limbus; e cornea. H&E, ×20.

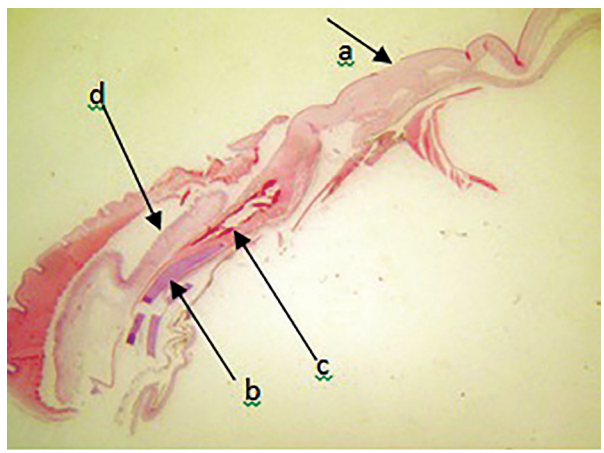

Figure 3. Sagital section of Ostrich . a, sclera ; b tissue between two. Cartilages; c, ora serata ; d , limbus; e cornea , H&E, ×40

Discussion

The sclera: Two cartilaginous segments with

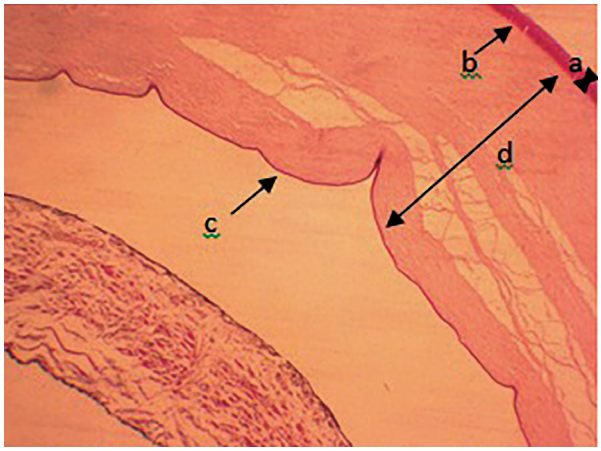

Figure 4. Sagittal section of the cornea. a, epithelium; b, Bowman's layer; c, dermal stroma; d ; scleral stroma. H&E, ×200.

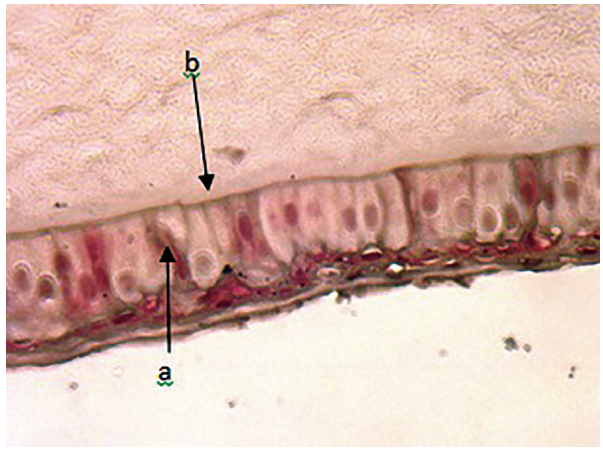

Figure 5. Sagittal section of the ostrich cornea . a, epithelium; b, Bowman's layer; stroma. Masson's trichrome, ×400.

Figure 6. Sagittal section of ostrich eye. A.cunjuctiva. b;connective tissue between two cartilages; c.cornea. H&E, ×200.

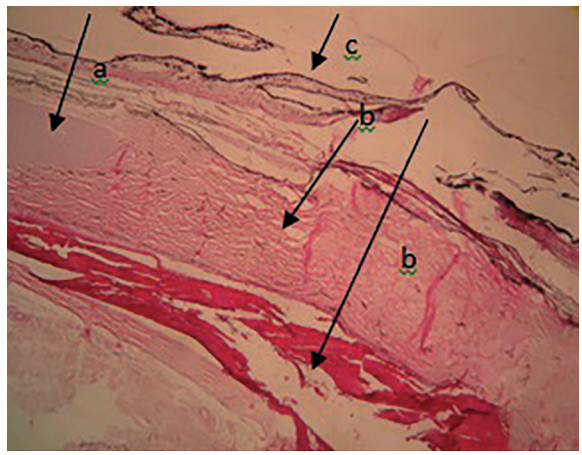

Figure 7. Sagittal section of ostrich eye a, scleral cartilage. b, connective tissue between two cartilages; c, ora serrata.

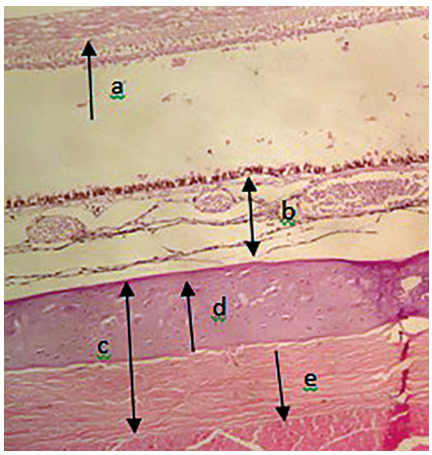

Figure 8. Sagittal section of ostrich eye a. Retina. b,choroid ; c.sclera d, scleral. cartilage;e.connective. tissues.

connective tissue correlation were seen in the sclera of the *Struthio camelus* eye. The first extensive investigation on the distribution of scleral ossicles in the living teleosts was done by (Franz-Odendaal, 2008) and suggested that having no ossicles is more common among teleosts. Chondrostei (bichirs, sturgeons, etc.) and Neopterygii (bow-fins, gars, etc.) do not have scleral ossicles (Franz-Odendaal and Hall, 2006). The oldest actinopterygian fossil has four ossicles; within Chondrostei, the same trend is seen, while modern Chondrostei have none (Franz-Odendaal, 2008). Fish without scleral ossicles have a continuous cartilage element within the sclera (Franz-Odendaal and Ryan, 2007). When two parts of the ossicles are present, these two elements are joined to one another by means of a cartilaginous bridge (Franz-Odendaal and Hall, 2006).

There is a strong correlation between fish habitats, activity level, and presence/absence of scleral

ossicles.

Accordingly, fish that inhabit deep sea environments are most likely to lack scleral ossicles, and 100 % of those that are very active have two ossicles per eye (Franz-Odendaal, 2008). Tuna and swordfish, which are fast swimmers, have large bony rings in their eyes (Nakamura and Yamaguchi 1991).

The cornea: The stratified cuboidal epithelium of the dermal cornea in the Struthio camel us was continuous with the conjunctiva. A corneal epithelium continuous with the conjunctiva and the skin appears to be present in all aquatic vertebrates (Kapoor and Hara, 2001).

A Bowman layer has been identified in only a few species of some birds. In spite of the claim that the Bowman's layer is a normal component of the teleost cornea, it was not present in the species examined by Collin and Collin (Collin and Collin, 1998; 1995). It is an unorganized membrane in some trout species 1968), but it is seen in the cornea of s, at the anterior stroma adjacent to the epithelial cells. This layer is also easily recognizable in the lamprey *Petromyzon marinus* (Van Horn and Edelhauser, 1969; Pederson and Van Horn, 1971) and in cartilaginous fish. The two separated parts of the dermal stroma present in the rabbit fish cornea are in accordance with the investigation of Collin and Collin (Collin and Collin, 1995) on the pipefish *Corythoichthyes paxtoni* and the salamander fish Lepidoga-laxiassalamandroides. Aquatic vertebrate corneas possess one stroma, but up to three stromata are present in some deep sea species (Collin and Collin, 1998). The results of this study confirmed the presence of numerous cells in the dermal stroma as is demonstrated in the Florida garfish *Lepisosteus platyrhincus* (Collin and Northcutt, 1993). The region separating the two stromata of *Struthio camelus* eye occasionally had connective tissue fibrils. This region may be filled with a granular material as in the pipefish (Collin and Collin, 1995) or mucoid tissue as in the salamander fish L. salamandroides (Collin and Collin, 1994) and the eel *Anguilla anguilla* (Walls, 1963). In the deep-sea gadiforme, *Coryphaenoide sarmatus*, which has one layer of dermal stroma and two layers of scleral stroma, a mucoidlayer separates the two main parts: dermal and scleral In some species, an autochthonous layer which thickens towards the periphery and terminates at the scleral margin has been reported (Kapoor and Hara, 2001). Munk (1968) described the same layer in the cornea of Amiacalva in a light microscopic study. Electron microscopic studies demonstrated that the autochthonous layer may be an iridescent layer (Kapoor and Hara, 2001). Corneal iridescence has been observed in some species (Collin and Collin, 1998; 1995; 1994). Light microscopic investigation of the *S. javus* cornea confirmed the presence of a connective tissue layer between the separating layer and the scleral stroma. This finding, when compared with reported data, suggests that this layer may represent an iridescent layer. Among bony fish, Descemet's membrane as the basement membrane of the corneal endothelium is present in most species (Kapoor and Hara, 2001), but it was not seen in the eye of *S. javus*. It is also absent in the sea lamprey *P. marinus* (Van Horn, Edelhauser, 1969; Pederson, Van Horn, 1971). Although there is a single layer of endothelial cells in the posterior cornea in bony fish examined by Collin and Collin (Collin and Collin, 1998; 1995; 1994; 2000; Collin and Northcutt, 1993), there was no cellular layer in the posterior cornea of the eye of the rabbit fish, and also a complete absence of the endothelium is seen in some cartilaginous fish.

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مطالعه بافت شناسی لایه قرنیه-صلبیه‌ای شترمرغ

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چکیده

زمینه مطالعه: شترمرغ یک موضوع جالب برای مطالعات تکاملی و ریخت‌شناسی جانوران است. بر اساس برخی مطالعات چشم شترمرغ از ساختارهای بافتی مجزا تشکیل شده است، که جزئیات این موضوع در مطالعات گذشته مورد بررسی قرار نگرفته است. **هدف:** این مطالعه به منظور بررسی بافت‌شناسی لایه قرنیه-صلبیه‌ای شترمرغ می باشد. **روش کار:** این پژوهش به بررسی بافت‌شناسی لایه خارجی چشم ده شتر مرغ بالغ که از مرکز پرورش شترمرغ جوپار تهیه گردید می پردازد. همه شترمرغ ها سالم و از وضعیت بدنی خوبی برخوردار بودند. بعد از کشتار سرآن ها جدا شده و در فرمالین ۱۰٪ به مدت ۷ روز نگهداری شد و سپس چشم ها از سرها خارج گردید. روش های معمول بافت‌شناسی انجام شد و بخشی به ضخامت ۶ میکرومتر بریده شد. بخش ها با رنگ‌آمیزی های معمول مثل هماتوکسیلین استاندارد و ائوزین و تری کروماسون ماسون رنگ‌آمیزی گردید و زیر میکروسکوپ نوری مورد مطالعه قرار گرفت. **نتایج:** قرنیه شترمرغ از ۲ قسمت درم و صلبیه تشکیل شده است و این دو قسمت توسط یک منطقه از هم جدا می‌شود. صلبیه تقسیم شده است به ۲ قسمت منطقه روی صلبیه و منطقه مناسب صلبیه. **نتیجه‌گیری نهایی:** منطقه خارجی روی صلبیه تشکیل شده است از بافت همبند فیبری سست که به منطقه مناسب صلبیه متصل است. لایه داخلی صلبیه شامل بافت هم بند سخت به همراه ۲ قسمت غضروفی مانند که تا ناحیه اوراسراتا ادامه دارند که شامل بافت همبند سخت و غضروف استخوانی می‌باشد.

واژه های کلیدی: قرنیه، شترمرغ، بافت‌شناسی، صلبیه

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