

# MORPHOGENESIS AND HISTOMORPHOLOGY OF THE SCLERA IN LAYER AND BROILER CHICKEN\*

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## ABSTRACT

*A study on the morphogenesis and histomorphology of the sclera was carried out in the layer and broiler chicken. Tissue material was collected from 60 embryonated eggs at different days of incubation and 168 white leg horn birds at different age groups. The primordium of the sclera was found as concentrated mesenchymal layer around the optic cup on the fourth day of incubation. The development succeeded till fourteenth day and after that it resembled the post-hatch birds. The sclera was thicker which varied in different regions of the eyeball in post hatch birds. The thickness increased rapidly till 20th week and slowed down after 20 weeks in layers while it increased constantly till 8th week in broilers. Histologically, no significant structural changes between the sexes and the right and left side of the eyeball in the corresponding age groups was noticed.*

**Key words:** Morphogenesis, Histomorphology, Sclera, Layer and Broiler chicken.

## INTRODUCTION

The presence of cartilagenous cup and scleral ossicles are unique to the birds, which serve to prevent the globe from changing the shape during accommodation and facilitating the distortion of the refractive apparatus. The paucity of more recent embryological studies on the sclera and lack of literature on the age related histomorphology and histometry in broiler and layer chicken prompted the present work .

## MATERIALS AND METHODS

Sixty embryonated eggs of White Leghorn birds were collected from second day to twentieth day of incubation at two days interval. Serial sections of the cephalic end of the embryos were made up to eighth day and later eyeballs were removed, processed and sections were cut and

stained for embryological studies. For histological studies, the eyeballs were collected from 12 birds each in day-old, 4, 8, 12, 16,20,28,40 and 72 week-old birds. The eyeballs were fixed in different fixatives and processed for paraffin embedding. Sections of 5-6µm thickness were used for routine and special histological staining. The thickness of the sclera was measured at the centre of the fundus and recorded by using the oculometer.

## RESULTS AND DISCUSSION

### Morphogenesis

On the fourth day of incubation, the mesenchymal cells were concentrated around the optic cup and differentiated into two layers that formed primordium of the sclera and chorioid, which is similar to the findings of Hilderbrand (1974) in chicks and Latshaw (1987) in mammals. During the

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fifth day, these concentrated mesenchymal cells were differentiated into an outer thicker and inner spongy zone (Fig.1) as stated by Hamilton (1952) in domestic fowl. The outer thicker zone was divided into an outer layer with fibroblasts and an inner layer with chondroblasts, during the sixth day.

During the eighth day of incubation, few endothelial-lined spaces were noticed at the corneoscleral junction. The canal of Schlemm was noticed as a series of vacuoles just peripheral to the margin of the anterior chamber. The mesenchymal cells differentiated to form the scleral plate. In the cartilagenous layer, the chondrocytes were seen in the lacunae. The outer layer formed the collagen bundles with fibroblasts. The above findings concurred with the results of Hamilton (1952) in chicks. During the tenth day, the chondrocytes were laid in a hyaline ground substance in the cartilagenous part of the sclera. During the fourteenth day of incubation, the scleral ossicles were formed at the scleral plate. From sixteenth to twentieth day of incubation, the structure was almost similar to that of post-hatch birds.

### Histometry

In the histometrical study, the scleral thickness was measured at the centre as  $90.74 \pm 0.92 \mu\text{m}$  in day-old birds and increased rapidly upto  $132 \pm 3.33 \mu\text{m}$  in 20 weeks of age and after that the increase slowed and reached to  $166 \pm 2.75 \mu\text{m}$  in 72 week old layers. In day-old broiler birds the thickness of the sclera was  $95.4 \pm 0.52 \mu\text{m}$  and in eight week-old birds it was  $158.2 \pm 1.7 \mu\text{m}$ . The increase in the thickness was regular up to 8 weeks of age in broilers. No significant structural changes between the sexes and right and left sides of the eyeball in the corresponding age groups were noticed.

### Histomorphology

The sclera consisted of an outer fibrous and an inner cartilagenous layer (Fig.2) alike in quails

(Fitzgerald, 1969), but contrary to the reports of Dellmann and Eurell (1998) in domestic animals where the sclera consist of only fibrous part.

The fibrous layer was  $60 \mu\text{m}$  thick in adult birds and slightly thinner than the underlying cartilage. The fibrous part consisted of closely packed collagen bundles, a few elastic fibres and flattened fibroblasts (Fig.2) in all the age groups studied. The sclera did not receive any direct blood supply in the present study as stated by Hodges (1974) in domestic fowl. The presence of densely packed collagen bundles may resist the intraocular pressure and also to prevent the eyeball to change its shape. In addition, the fibrous part also serves as an origin for the extra ocular muscles.

The fibrous layer did not show any pigmented cells, which are akin to the findings of King-Smith (1971) and Hodges (1974) in chicken. The innermost fibres of the sclera continued with the pia mater in the form of perforated discs called lamina cribrosa through which the optic nerve leaves the eye as in quails (Fitzgerald, 1969) and in mammals (Dellmann and Eurell, 1998). These observations support the theory that the retina underneath the sclera is the extra cranial portion of the brain as stated by Dowling (1987). The cartilagenous layer was made up of hyaline and was thicker than the fibrous part in all the age groups studied and measured  $90 \mu\text{m}$  in thickness at the centre. The sclera was continuous with the cornea and the scleral plate; a flattened disc shaped concave zone intervened between them (King-Smith, 1971). The thickness increased as age advanced in both broiler and layer chicken.

Immediately anterior to the ora terminalis, the wall of the eye increased in thickness and turned inward to form the plate. At this point, the fibrous and the cartilagenous layers of the sclera were separated. The cartilagenous part turned inwards to be overlapped slightly by the layer of scleral ossicles before it finally terminated (Fig.3) in all the age groups studied.

In the corneoscleral junction, the bundles of collagen fibres, elastic fibres, fibroblasts (Fig.3) and few melanocytes were observed where the transparent cornea transformed into opaque sclera. This is concordant with the findings of Hodges (1974) in chicken. The scleral trabecular meshwork consisted of a dense mass of collagen bundles and elastic fibres with endothelial lined intervening spaces. Beneath the trabecular meshwork, a large sinus with endothelial cells, the canal of Schlemm was noticed. This canal was associated with a posterior artery and followed an annular course around the chamber angle. These observations are similar to the findings of Shively and Epling (1969) in chicken.

The pectinate ligament was formed from the Descemet's membrane and consisted of endothelial-lined spaces, the spaces of Fontana, which is similar to the findings of Dellmann and Eurell (1998) in mammals. The spaces of Fontana was not well formed and appeared as discrete bundles of fibres and endothelial cells between the pectinate ligament in all the age groups which is not agreeable with the findings of Gray (1994) in human beings.

#### ACKNOWLEDGEMENT

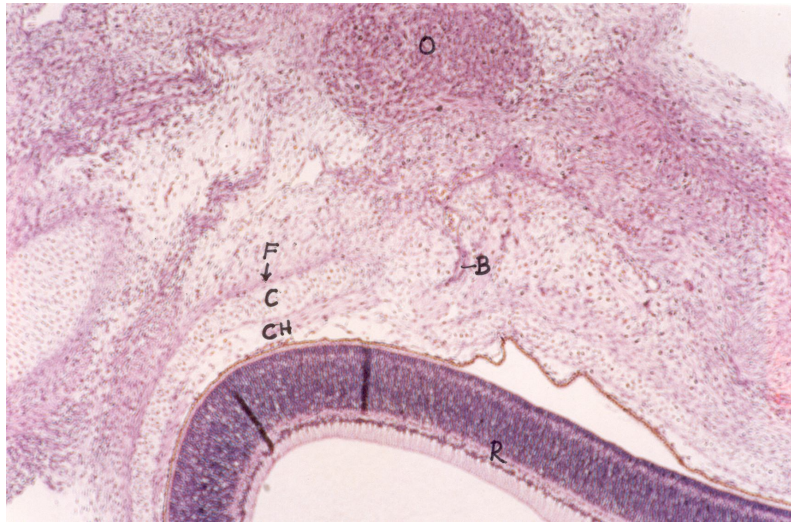
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**Figure 1**

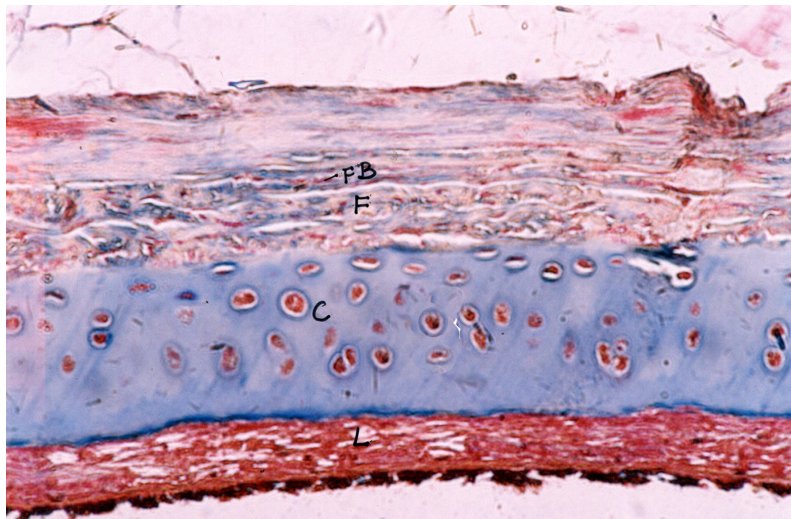
**Photomicrograph of a six day-old embryo showing the differentiation of the chorioid and sclera. H&E x630**



F-Fibrous part of the sclera; B-Blood vessel; R-Retina c-Cartilagenous part of the sclera; O-Optic nerve; CH-Chorioid

**Figure 2**

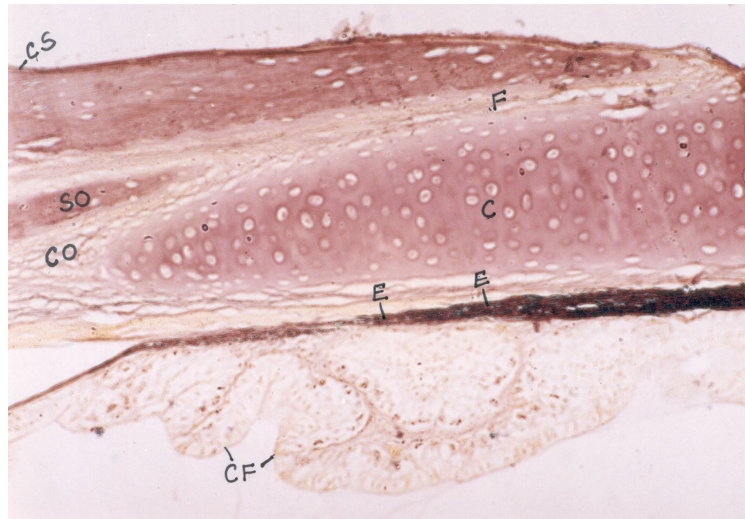
**Photomicrograph of sclera of the left eyeball in a twelve week-old female layer Chicken. Masson trichromex200**



F-Fibrous part of the sclera; C-Cartilagenous part of the sclera; FB-Fibroblast; L-Lamina fusca of the chorioid

**Figure 3**

**Photomicrograph of the sclera of the left eyeball in an eight week-old male broiler chicken showing its anterior insertion. Hart's methodx200**



F-Fibrous part of the sclera; C-Cartilagenous part of the sclera; SO-Scleral ossicles; E-Elastic fibres; CF-Ciliary folds; CO-Collagen fibres