

Morphological investigation of the pecten oculi in quail (*Coturnix coturnix japonica*)

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Summary: In this study pecten oculi was investigated morphologically in quail (*Coturnix coturnix japonica*). It was detected that the pecten oculi was attached to the retina and consisted of 19 folds on average. It was observed that quail pecten was in the pleated group and had a shell like rhomboid shape. The width of the folds was 259 µm on average. The width of the each fold was constant on every region of the fold. In light microscopic investigation, pecten was consisted of large number of capillaries and pigment cells (melanocytes) and the basal edge of pecten lined from the ventral part of the optic disc through the retina ventrally and projected into the vitreous body.

Key words: Anatomy, histology, pecten oculi, quail

Bıldırcında (*Coturnix coturnix japonica*) pecten oculi'nin morfolojik olarak incelenmesi

Özet: Bu çalışmada bıldırcında (*Coturnix coturnix japonica*) pecten oculi, morfolojik olarak incelendi. Ortalama 19 adet kıvrıma sahip olan pecten oculi'nin, retina'ya tutunduğu tespit edildi. Bıldırcında pecten oculi'nin deniz kabağı biçimli, yamuk benzeri bir şekle sahip olduğu ve bu nedenle kıvrımlı tip pecten grubuna dahil olduğu gözlemlendi. Ortalama olarak her bir kıvrım kalınlığı 259 µm olup, bu kalınlık kıvrımlar üzerinde her noktada sabit bulundu. Işık mikroskopik olarak, çok sayıda kapillar ve pigment hücreleri (melanositler) içeren pecten oculi'nin tabanı, discus nervi optici'nin ventral'inden retina'ya doğru yayılım göstermekteydi.

Anahtar Sözcükler: Anatomi, bıldırcın, histoloji, pecten oculi.

Introduction

The quail which belongs to the Phasianidae family is widely used as an experimental model particularly in physiology, pathology, toxicology and anatomy disciplines because of its lower feed consumption, rapid growth, early sexual maturity and also short generation intervals. The meat and egg consumption of the quail has also been increased in recent years (16, 25).

The pecten oculi which is specific to the birds is a unique vascular and pigmented structure (19, 22, 28, 29). The pecten projects from the optic disc into the vitreous body (7, 13, 14, 15, 28) and contains a large number of blood vessels and pigment cells (4, 8, 19, 28).

The studies conducted on the capillaries of the pecten demonstrated that it has a function as a nutritive tissue (7, 23, 28). The eye of the birds is characterized by an avascular retina (17, 26). Pecten oculi can be considered as an alternative structure comparing to the falciform process of some teleosts, the suparetinal vessels of amphibians (7), the conus papillaris of the reptiles (5, 11, 26) and intraretinal vessels of the mammals for vascularisation and nutrition of inner retina (7, 10, 11). Also light is absorbed by the pigments found on the

pigment cells of the pecten which provides a thermoregulation (2) and reduces penetration of light into the eye (27).

The pecten oculi was classified into three groups morphologically as conical, vanned and pleated types. It was reported that kiwi (*Apteryx mantelli*) has a conical type, ostrich (*Struthio camelus*) and rhea (*Rhea americana*) have vanned type and the other bird species commonly have pleated type pecten (21). However, bird species with pleated type pecten have similar structures; some considerable differences can be observed in thickness, number of the folds, shape and dimensions of the pecten (3, 4, 7, 8, 12, 18, 24). It was reported that these differences are directly proportional to the dissimilarities between the species and their daily activities. While day active (diurnal) birds have wide and more complicated pecten structure, night active (nocturnal) birds have narrow and basic formed pecten (4, 11, 21). As nighthawk (*Chordeiles minor*) has a narrow pecten with few folds (4-5 folds) (3), the daylight active bird, red-tailed hawk (*Buteo jamaicensis*) has fan-like pecten which consists of 17-18 accordion folds (6).

Histological structure of these three types of pecten in birds is basically composed of large number of capillaries, pericytes, melanocytes, hyalocytes and connective tissue (3, 20, 28).

In the present study it was aimed to define the anatomical and histological details oriented to the pecten oculi of the quail.

Materials and Methods

The present study was carried out in the Ankara University, Faculty of Veterinary Medicine, Department of Anatomy. The study was performed with 14 adult quails slaughtered in the abattoir. The ethical approval was also obtained for the study. Right and left eyeballs of 9 quails (5 male, 4 female) were dissected together with optic nerve apart from the orbit. The eyeballs were cut from the equatorial region. The posterior region including the pecten oculi was investigated as a fresh cadaver. The materials were photographed using Canon Powershot S70 digital camera fitted to Leica M16 stereomicroscope (Leica, Wetzlar, Germany).

Additional to the detection of the number of the folds, all morphological features of pecten were measured by Leica Application Suite software. The measurements were analyzed statistically considering male-female differences. The data was evaluated by descriptive statistics. As the differences between genders in terms of variables did not demonstrate a normal range, Mann-Whitney U test was used for the intergroup analyses. Besides, instead of mean values, median values were calculated. The significance level was considered as $p < 0.05$.

Regardless of gender, right and left eyeballs of the 5 quails were examined histologically. Samples were washed with physiological saline and fixed in 10% neutral buffered formalin solution. Afterwards, they were processed by the standard paraffin sectioning, blocked in paraplast and finally trimmed a 5 μm sections cut. Mounted sections were stained with Mallory's modified triple stained technique and examined under a light microscope (9).

The anatomical nomenclature of the structures was confirmed by using Nomina Anatomica Avium (1).

Results

It was observed that the pecten oculi in quail was attached to the retina and the long axis of the pecten directed ventrally. Quail had a pleated type pecten and it displayed a folded structure. Beside this pleated type, pecten had short, thick and vertical coursed folds and due to that the quail pecten had a typical shell like aspect (Figure 1). Pecten was attached to the eyeball with its basal border and each fold spired and connected into the retina through this basal border (Figure 1, 2). The opposite side of the attached border, the apical border,

was projected into vitreous body and directed to the lens. Contrary to the basal border, the apical border had a flat surface (Figure 1).

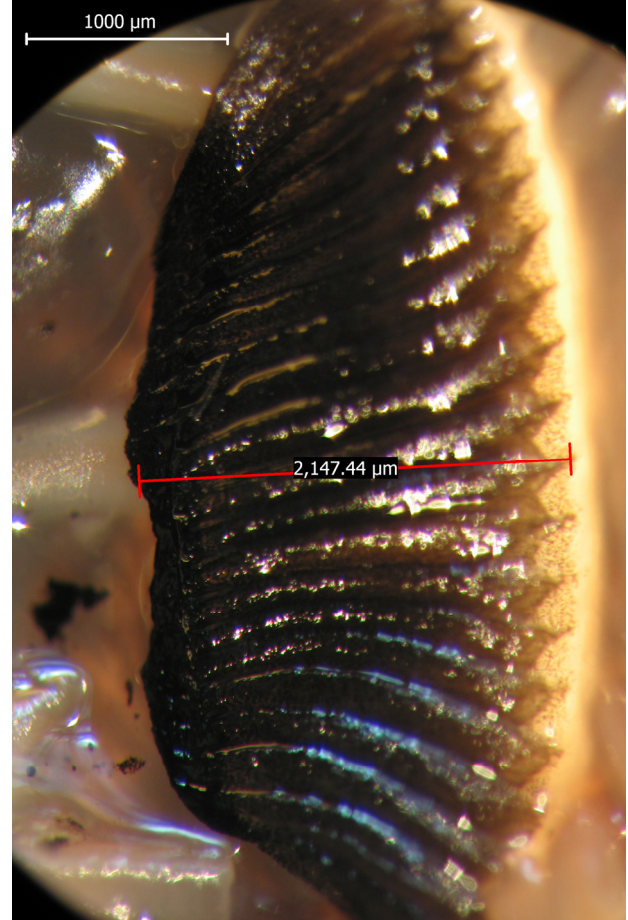


Figure 1. The left pecten oculi of the quail.
Şekil 1. Bildircının sol pecten oculi'si.



Figure 2. The basal border that folds are attached to the retina.
Şekil 2. Kıvrımların retina'ya tutunduğu basal kenar.

It was determined that the pecten was composed of 19 folds on average. In all quails, fold numbers of both left and right pectens were equal for each sample inspected. It was observed that the folds at the middle of the pecten were longer than the ones at the lateral sides (Figure 1). The width of the each fold was measured from both basal and apical border and there was no variability in the width of each fold at basal or apical side. In this study the width of the folds was measured as 259 μm on average.

The numerical values about the pecten oculi and the optic nerve measurements were presented in Table 1. Descriptive statistical analyses were performed in 18 eyes about the width of the pecten in the thickest region, the length of both the basal and the apical border of the pecten, the width of the folds and the diameter of the optic nerve where exiting out sclera (Table 2).

The data of the intergroup statistical analyses were presented in Table 3. Due to the results of the intergroup

statistical analyses, the differences between genders in terms of the length of the basal border and the diameter of the optic nerve were found significant. There was no significant difference with regards to the other variables ($p>0.05$).

Histological examinations demonstrated that the localization of the basal border of pecten was started from the ventral part of the optic disc and extended on the retina. Therefore, histological sections of pecten were obtained from two different regions. In first region which pecten located on the ventral part of the optic disc, optic nerve (arrowhead) dispersed to the retina (arrow) but there was no direct connection existed between the pecten and the optic nerve (Figure 3). Second region in which the pecten was situated on the retina, it was determined that the pecten was only attached to the retina (Figure 4). In parallel with the first region, a direct continuation wasn't observed from retina (arrows) to pecten (Figure 4). Pecten displayed a quite pleated

Table 1. The measurements of pecten oculi and optic nerve
Tablo1. Pecten oculi ve nervus opticus'a ait ölçümler

Gender	Width of Pecten (μm)	Length of Apical Border (μm)	Length of Basal Border (μm)	Width of Folds (μm)	Diameter of Optic Nerve (μm)
Male	2099.78	3587.48	4387.83	328.66	1165.01
Male	1980.74	3198.48	4466.55	280.07	1371.65
Male	2516.55	3401.46	4821.18	300.32	1341.28
Male	1921.76	3109.48	4397.07	302.23	1269.11
Male	2210.21	3228.51	4769.52	274.86	1306.74
Male	2041.03	3466.05	4621.62	316.26	1229.48
Male	1985.34	3219.32	5107.97	264.41	1344.45
Male	2397.45	3301.51	5019.76	297.22	1195.35
Male	2050.67	2920.72	5052.59	278.48	1373.01
Male	2220.79	3415.91	4858.83	259.63	1503.77
Female	2379.19	3399.94	5216.67	295.39	1424.62
Female	2046.40	3567.01	5083.43	300.04	1069.11
Female	2110.39	3008.92	5610.21	348.28	1476.13
Female	2049.99	3852.47	4841.02	295.27	1415.92
Female	2239.82	3519.15	5530.56	303.26	1317.65
Female	1994.10	3612.87	4868.99	275.35	1044.51
Female	2318.04	2868.97	5134.54	288.32	1202.00
Female	2219.88	3852.47	5385.22	323.74	1150.72

Table 2. The descriptive statistical analyses of pecten oculi and optic nerve
Tablo 2. Pecten oculi ve nervus opticus'a ait tanımlayıcı istatistiksel analizler

	Min. - Max. (n=18)	Mean \pm SD (n=18)	SE (n=18)
Width of Pecten (μm)	1921.76 – 2516.55	2154.5628 \pm 167.38394	39.45277
Length of Apical Border (μm)	2868.97 – 3852.47	3362.8178 \pm 284.20731	66.9883
Length of Basal Border (μm)	4387.83 – 5610.21	4954.0867 \pm 356.83272	84.10628
Width of Folds (μm)	259.63 – 348.28	296.2106 \pm 22.90861	5.39961
Diameter of Optic Nerve (μm)	1044.51 - 1503.77	1288.9172 \pm 132.70416	31.27867

Min: Minimum; Max: Maximum; SD: Standard deviation; SE: Standard error

structure and a large number of capillaries (asterisks) were found in this structure (Figure 3). The vascularisation was more intensive at the apical border comparing to the basal border. The localization of pigment cells (melanocytes) (arrowheads) around the capillaries (arrows) was noticed (Figure 5).

Table 3. Intergroup analyses of the pecten oculi
Tablo 3. Pecten oculi'ye ait gruplar arası analizler

	Median	Minimum - Maximum	p
Width of Pecten (μm)			
Male (n=10)	2075.2250	1921.76 – 2516.55	p>0.05
Female (n=8)	2165.1350	1994.10 – 2379.19	
Length of Apical Border (μm)			
Male (n=10)	3265.0100	2920.72 – 3587.48	p>0.05
Female (n=8)	3543.0800	2868.97 – 3852.47	
Length of Basal Border (μm)			
Male (n=10)	4795.3500	4387.83 – 5107.97	p<0.001
Female (n=8)	5175.6050	4841.02 – 5610.21	
Width of Folds (μm)			
Male (n=10)	288.6450	259.63 – 328.66	p>0.05
Female (n=8)	297.7150	275.35 – 348.28	
Diameter of Optic Nerve (μm)			
Male (n=10)	1324.0100	1165.01 – 1503.77	p<0.05
Female (n=8)	1259.8250	1044.51 – 1476.13	

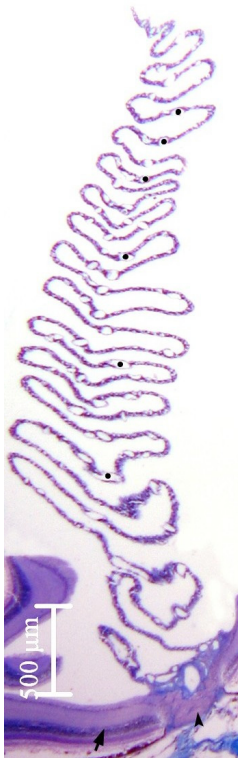


Figure 3. The section taken from which pecten located on the ventral part of the optic disc. Optic nerve (arrowhead) dispersed to the retina (arrow); the capillaries in the pecten (asterisks).
Şekil 3. Pecten'in discus nervi optici'nin ventral kısmına yerleşen bölümünden alınan kesit. Retina'ya (ok) dağılmış n. opticus (okbaşı); pecten'deki kapillarlar (asteriskler).

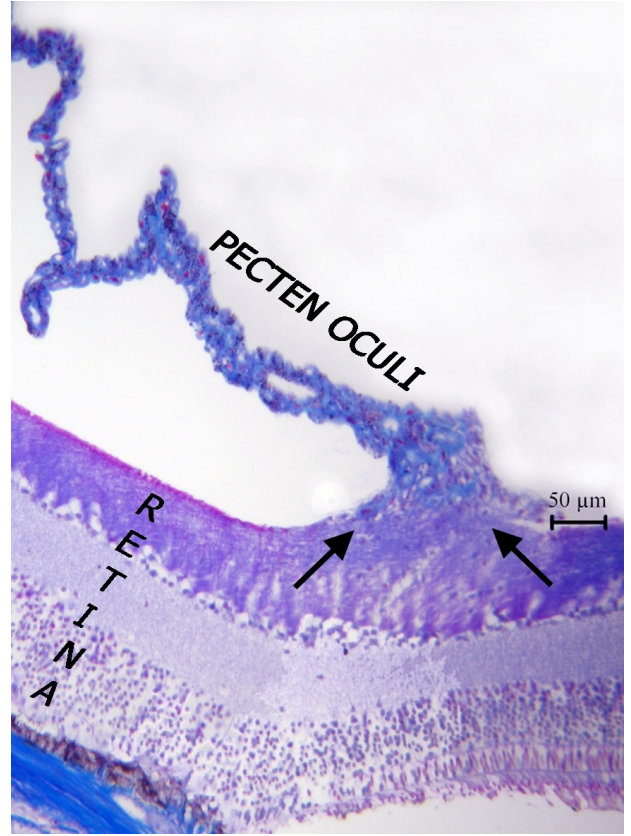


Figure 4. The section taken from which pecten located on the retina (arrow).

Şekil 4. Pecten'in retina (ok) üzerine yerleşen kısmından alınan kesit.

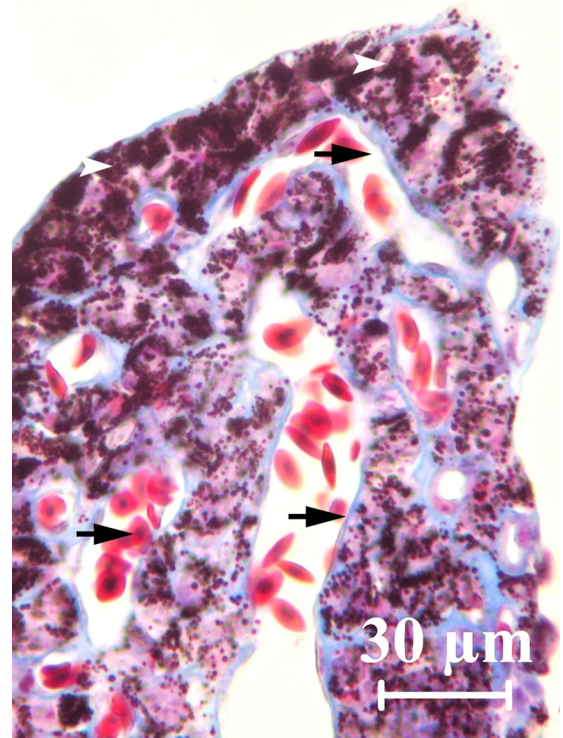


Figure 5. Light micrographic appearance of pecten. Melanocytes (arrowheads); capillaries (arrows).

Şekil 5. Pecten'in ışık mikroskopik görünümü. Melanositler (okbaşları); kapillarlar (oklar).

Discussion and Conclusion

According to Meyer's (21) classification it was determined that the pecten oculi of the quail was in the pleated type group. As the quail which is a daily active bird, had 19 folds on average, the other daily active species, ostrich had 16-19 (19), black kite had 12 (18) and chick had approximately 18 folds in the pecten (13). It could be noticed that there was a correlation between the pecten complexity and the activity of the species in general.

Due to the results of the intergroup statistical analyses, the differences between the genders in terms of the length of the basal border and the diameter of the optic nerve were found significant however a satisfying research hasn't been published yet about the relationship between the diameters of the pecten and genders.

However it was stated that the pecten of the chick was located on the optic disc (13), quail pecten lined from the ventral part of the optic disc through the retina ventrally and projected into the vitreous body. It is known that the pecten oculi in birds which is thought to provide the blood supply of the avascular retina, contains large number of capillaries (3, 20). Histological findings obtained in this study were similar to those defined in other researches before. Pigment cells (melanocytes) were especially found between blood vessels. Similar to literature (2, 7) it was thought that pecten might play a role in thermoregulation and absorption of light.

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