Original Article

Microscopic Characteristics of Lower Eyelid Retractors in Koreans

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Purpose: To identify the microscopic characteristics of lower eyelid retractors in Korean individuals and to elucidate age-related changes in lower eyelid retractors.

Methods: Eighteen Korean lower eyelids from formalin-fixed cadavers were stained with Masson's trichrome. Specimens were divided into two groups based on age at death (group A, ≤65 years; group B, >65 years), and the microscopic findings were analyzed and compared by light microscopy.

Results: The capsulopalpebral fascia (CPF) had distinct junctions and no fusion with orbital septum in 14 eyelids (77.8%). The CPF was fused with the orbital septum in only two eyelids (11.1%). Although not significant, the inferior tarsal muscle was closer to the tarsus in group A (1.24 ± 0.71 mm) than group B (2.14 ± 1.18 mm, p = 0.07), and the tarsal height tended to be longer in group B (4.71 ± 0.55 mm) than group A (4.16 ± 1.01 mm, p = 0.20). Tarsal fatty infiltration was more evident in group B.

Conclusions: The CPF was rarely fused with the orbital septum in our sample of Korean lower eyelids. Although we did not identify any remarkable age-related changes in lower eyelid structures, there was a tendency for the lower retractor to loosen from the tarsus and for increased fatty infiltration in the lower eyelids from elderly individuals.

Key Words: Koreans, Lower eyelid retractors, Microscopic structure

Several previous studies have examined the gross anatomical structure of Asian lower eyelids [1-5]. Doxanas and Anderson [1] identified differences between Asian and non-Asian lower eyelids based on gross dissection, and reported that lower eyelid retractor fusional location with the orbital septum was higher in Asians. These anatomical differences may be associated with differences in the incidence of common senile conditions, such as involutional entropion and ectropion. Lower lid entropion is much more common than ectropion in Asian individuals (11.4% vs. 1.5%, respectively), but ectropion is more common than entropion in non-Asians individuals (6.2% vs. 3.7%, respectively) [6,7]. Previously, Lim et al. [8] and Kakizaki et al. [9] used microscopy to study the fundamental differences between Asian and non-Asian lower eyelids. Lim et al. [8] demonstrated a lack of or limited fusion of capsulopalpebral fascia (CPF) with the orbital septum of Chinese subjects and Kakizaki et al. [9] reported a distinct junction between the orbital septum and the CPF of Japanese subjects.

In the present paper, we report our study of lower eyelids from Korean cadavers and compared our results with previously reported results for Chinese and Japanese subjects. In addition, we also determined the effects of aging on the microscopic changes in Korean lower eyelids.

Materials and Methods

Specimens from normal-appearing lower eyelids of 18 preserved Korean cadavers were prepared (7 right, 11 left). All cadavers were donated to the Medical College of Catholic University of Korea, and written consent and approvals were obtained before use. We followed the guidelines of the Declaration of Helsinki during the preparation of specimens.

All cadavers were fixed in 10% buffered formalin. We resected full-thickness lower eyelids at the mid-portion (10 mm horizontally, 30 mm vertically) and embedded these in liquid paraffin for several hours. The embedded specimens were sectioned into 6-μm sections with a microtome, and then
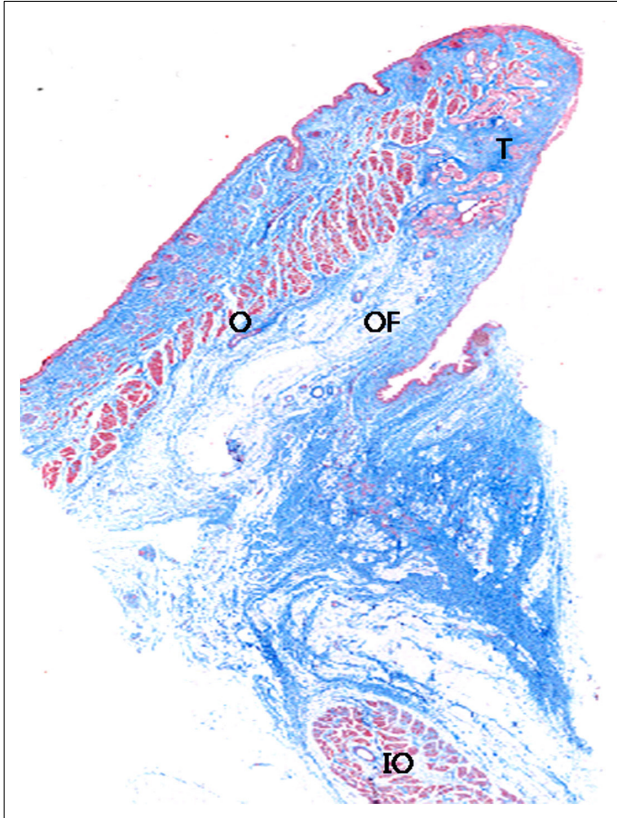
stained with Masson's trichrome. Sections were examined with light microscopy (fluorescence microscope Axioimager M1; Carl Zeiss, Heidenheim, Germany) and photographs were taken using a digital camera (Axiocam HRc, Carl Zeiss) affixed to the microscope.

Fig. 1. Microscopic view of cross section of Asian lower eyelid (Masson trichrome stain, ×40). T = tarsal plate; O = orbicularis; OF = orbital fat; IO = inferior oblique.

Table 1. Age and sex distribution

Groups (age)	Male	Female	Total
Group A (≤65)	4	4	8
Group B (65<)	3	7	10
Total	7	11	18

The relationship of the orbital septum to the CPF and tarsus was examined. In addition, all specimens were divided into two groups based on age at death: aged 65 years or less (group A) and aged more than 65 years (group B). We analyzed and compared tarsal plate height and thickness, lower eyelid thickness, and distance from the inferior tarsal border to the orbital fat and to the inferior tarsal muscle between the two groups. All statistical analyses were performed using Mann-Whitney U analysis of SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA).

Results

Seven eyes were from men and 11 were from women. Eight eyes were classified into group A (mean age ± SD, 55.9 ± 7.4 years; range, 44 to 65 years) and 10 into group B (mean age ± SD, 73.6 ± 6.7 years; range, 67 to 83 years) (Table 1).

Fig. 1 shows microscopic cross-sections of the lower eyelids. In seven eyelids (38.9%), the orbital septum was indistinct and we were unable to identify. The other seven eyelids (38.9%) had distinct junctions between the orbital septum and CPF. The mean distance from the tarsus to the junction was 2.31 ± 1.27 mm (range, 0.81 to 4.22 mm) (Table 2). The CPF was fused with the orbital septum in only two eyelids (11.1%) and there was limited fusion in two other eyelids (11.1%) at the inferior tarsal border.

In 16 eyelids (89%), the CPF was attached to both surfaces of the inferior and posterior tarsal plates. One eyelid (5.5%) was only attached to the inferior tarsal surface, and one eyelid (5.5%) was only attached to the posterior tarsal surface. None of the eyelids had CPF disinsertion from the tarsus. Nine eyelids (three from group A, six from group B) exhibited CPF involvement of three surfaces of the tarsus: anterior, inferior and posterior. There were no eyelids in which the CPF ran solely to the anterior tarsal surface, without involvement of other surfaces. In other words, when the CPF was attached to the anterior tarsal surface, it was always attached to the inferior and posterior tarsal surfaces for all 18 eyelids. CPF attachment to a specific tarsal surface seemed to have no relationship with age.

Table 3 shows the mean values of lower eyelid structures in the two groups. The mean tarsal height was 0.55 mm lon-

Table 2. Relationship of lower eyelid retractor and orbital septum between Asian populations. Unlike that of Caucasians, fusion of the capsulopalpebral fascia (CPF) with the orbital septum occurred in only 11.1% of samples

	Cadavers no.	Relationship of the CPF and orbital septum				Distances (mm) From inferior tarsus	
		Fusion	Limited fusion	No fusion		To the distinct junction	To the smooth muscle
				Indistinct orbital septum	Distinct junction		
Lim et al. [8] (Chinese)	10		3 (30)	7 (70)			1.44
Kakizaki et al. [9] (Japanese)	19			12 (63.2)	7 (36.8)	2.38	
Our study (Koreans)	18	2 (11.1)	2 (11.1)	7 (38.9)	7 (38.9)	2.31 ± 1.27	1.77 ± 1.09

Values are presented as mean ± SD or number (%).

Table 3. The mean values of various lower eyelid structures of each group

Specimen	Mean values			
	Group A (n* =8)	Group B (n* =10)	Total	p-values†
Age of cadaver at death (yr)	55.9 ± 7.4	73.6 ± 6.7	65.6 ± 11.3	
Tarsal plate height (mm)	4.16 ± 1.01	4.71 ± 0.55	4.27 ± 1.32	0.20
Tarsal plate thickness (mm)	1.21 ± 0.28	1.32 ± 0.18	1.27 ± 0.23	0.35
Lower eyelid thickness (mm)	4.64 ± 1.00	4.67 ± 0.89	4.66 ± 0.91	0.94
Distance from inferior tarsal border to inferior tarsal muscle (mm)	1.24 ± 0.71	2.14 ± 1.18	1.77 ± 1.09	0.07
Distance from inferior tarsal border to orbital fat (mm)	0.60 ± 1.38	0.49 ± 0.74	0.54 ± 1.01	0.85

*No. of cadavers.
†Mann-Whitney U analysis, 95% confidence.
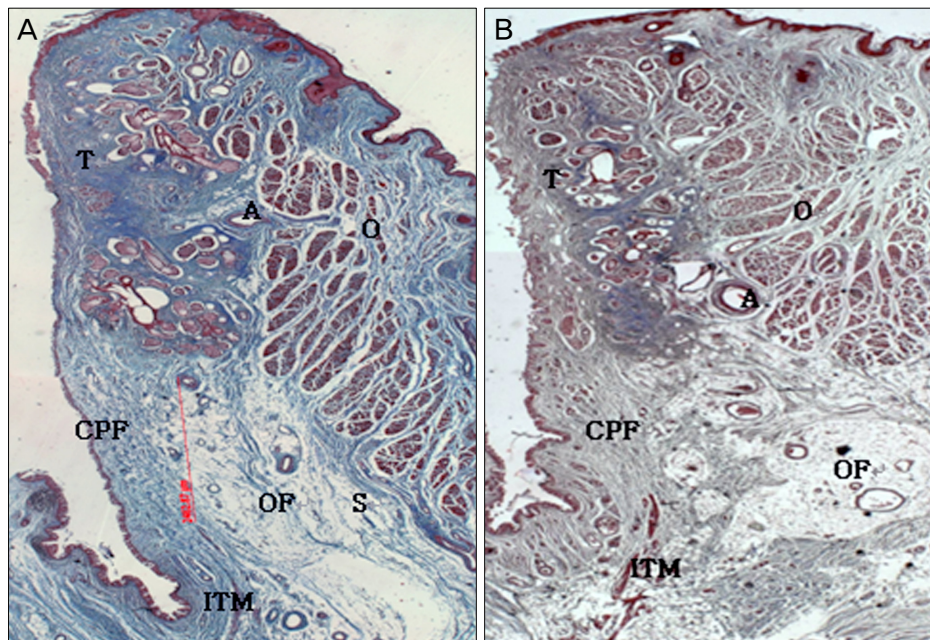
Fig. 2. Microscopic views of cross sections of Korean lower eyelids (Masson trichrome stain, ×250). (A) is a lower eyelid from group A. The capsulopalpebral fascia (CPF) attached to the inferior and posterior tarsal surface and it did not fuse with the orbital septum. (B) is a lower eyelid from group B. The CPF attached to the posterior tarsal surface and the orbital septum is indistinct at the tarsus level. Fatty infiltration is more prominent in (B). Inferior tarsal muscle was observed below the tarsus along the CPF running. T = tarsal plate; O = orbicularis; OF = orbital fat; ITM = inferior tarsal muscle; CPF = capsulopalpebral fascia; S = orbital septum; A = palpebral marginal arcade.

ger in group B, but this difference was not significant (p = 0.20). The thicknesses of the tarsal plate and lower eyelid were similar between the two groups. The tarsal shapes were straight except for four eyes (22.2%), in which they were curved anteriorly (two from group A, two from group B).

Fig. 2 shows representative figures of group A and group B. Orbital fat extended superiorly and anteriorly in all eyelids. Attachment of orbital fat to the inferior tarsus was present in 11 eyelids (61.1%), but not in the other 7 eyelids. The mean distance from the tarsus to the orbital fat apex was 0.60 ± 1.38 mm in group A and 0.49 ± 0.74 mm in group B. Orbital fat and tarsal fatty infiltration were more prominent in group B (Fig. 2B). All fatty infiltrations were limited to the inferior and/or anterior tarsal border, and none were found in the posterior surface. Infiltrated tarsal fat showed no continuity with orbital fat, which was enveloped by orbital septa.

Along the CPF, we observed the location of inferior tarsal muscle, which was at an average distance of 1.77 ± 1.09 mm below the tarsus. As shown in Table 2, the distance from the inferior tarsal border to the first observable smooth muscle nucleus of inferior tarsal muscle was about 0.9 mm shorter in

group A than in group B, but this difference was not significant (p = 0.07). The orbicularis oculi muscle was multiply septated by thin fascial layers. In 15 cases (83.3%; 5 from group A, 9 from group B), preseptal orbicularis oculi muscle was over-riding the pretarsal muscle.

In all eyelids, a medium-sized palpebral marginal arcade was located between the anteroinferior tarsal plate and the pretarsal orbicularis oculi muscle, and was surrounded by distinct fascia. The fascia that surrounded the vessel was very adjacent to the fascia of the orbicularis oculi muscle. In some cases, an artery was embedded in the tarsus. The accessory lacrimal glands of Wolfring were observed around the artery of the palpebral peripheral arcade in five eyelids (27.8%).

Discussion

The anatomical difference in the gross appearance of lower eyelids between Asian and non-Asian individuals has been studied for many years. Asian individuals tend to have puffier, fuller lower eyelids and absent or indistinct lid creases [1-5,8,9]. In a magnetic resonance imaging (MRI) study,

Carter et al. [10] found high levels of anterior and superior orbital fat in Asian eyes. Doxanas and Anderson [1] reported that fusional location of the orbital septum with the CPF was higher in Asian eyelids.

Involutional entropion, which requires surgical correction, is one of the most common senile conditions in Asian eyes. The higher incidence of entropion in Asians than in non-Asians may be caused by anatomical differences and/or by population-specific age-related anatomic changes. We used light microscopy to analyze the structures of 18 Korean lower eyelids and compared our results with those of previous publications. Baek et al. [11] reported CPF repair was performed in Korean patients with entropion at an average age of 68.6 years. Thus, we subdivided our specimens into two age-based groups, with the cut-off age of 65 years.

The relationship between the CPF and the orbital septum in our eyelid samples was similar to that reported previously for Asian eyes [8,9,12]. In a study of Chinese eyes, Lim et al. [8] reported no fusion of the CPF and orbital septum in 70% of cases, and limited fusion in 30% of cases. In another study of Japanese eyes, Kakizaki et al. [9] reported distinct junction of the orbital septum to the CPF in 36.8% of patients. With Korean eyes, Kim et al. [12] reported no fusion of the orbital septum and the CPF at the lower border of the tarsal plate in 71.4% and limited fusion in 28.6% of eyes. In agreement with other studies of Asian lower eyelids, only two of our Korean eyes (11.1%) had fusion of the CPF with the orbital septum, and a distinct junction was present in seven eyes (38.9%). Kakizaki et al. [9] reported an average junction distance of 2.38 mm, in agreement with our results (2.31 ± 1.27 mm) (Table 2).

The mean tarsal height and thickness in our Korean eyelids were 4.27 ± 1.32 mm and 1.27 ± 0.23 mm, respectively. These are similar to those reported for the Chinese tarsus, previously reported by Lim et al. [8] (mean height, 4.12 mm; mean thickness, 1.36 mm). In a microscopic study of 10 specimens reported by Lim et al. [8], the mean Chinese lower eyelid thickness was 3.5 mm. The mean lower eyelid thickness was 4.66 ± 0.91 mm in our Korean cases, which was significantly thicker than the mean Chinese lower lid thickness ($p = 0.003$). As the mean age of specimens was similar in these two studies (67.5 for Chinese cases, 65.6 for Korean cases), we believe that this difference may be affected by racial difference, although the small sample sizes of both studies could have biased the results. There were no significant age-related differences in the thickness of the tarsus and lower eyelid, and the tarsal height ($p = 0.35$, 0.94, and 0.20, respectively).

We found that fatty infiltration was prominent in eyelids of group B (Fig. 2). As expected, all fatty infiltration was confined to the anterior or inferior tarsal surfaces, and was not identified in the posterior border.

In a MRI study of Chinese eyes, Carter et al. [10] found that the superiorly extended orbital fat was attached to the inferior tarsal border. In contrast, microscopic analysis of Japanese eyes by Kakizaki et al. [9] reported no orbital fat attachment to the inferior tarsal border in any of their cases. In the present study, we observed orbital fat attachment to the inferior tarsal border in 61.1% of Korean eyelids. Although we could not compare our data with the data of Lim et al. [8], we suggest that population-based differences might be responsible for these observed differences.

In our cases, most of the CPF attachments were to the inferior tarsus at the inferior and/or posterior border. Whenever the CPF attachment involved the anterior tarsal border, it involved both inferior and posterior tarsal borders. Such phenomena were also observed by the Kakizaki et al. [9] study, although they did not point it out in their publication.

In our cases, the distance from the inferior tarsal border to the inferior tarsal muscle of the lower retractor complexes was 1.77 ± 1.09 mm, longer than that reported by Lim et al. [8] (1.44 mm) for Chinese eyes. This distance was 0.9 mm longer in our older cases, although the difference was a borderline significance ($p = 0.07$). Because we only studied normal-appearing lower eyelids, the apparent loosening of lower retractor complexes was not observed. It might be statistically significant, if we studied eyelids of entropion.

There are several limitations to our study. First, as with all other microscopic studies, artifacts might be introduced during specimen preparation, even though we carefully dissected and fixated all tissue samples. Second, we only considered normal-appearing lower eyelids, so we could not identify or confirm pathologic changes, such as entropion or ectropion, in elderly individuals. Third, it was difficult to make gross comparisons of the amount of skin folds and wrinkles in the two groups. Forth, we did not assess the relationship of orbital fat and bony structures (orbital rim) because we only dissected the lower eyelids, not the bony structures. Fifth, we could not examine the age-related anatomic changes with lid laxity or snap back status. Sixth, the small number of specimens (due to the difficulty of obtaining cadaver eyes) may have biased our results and limited the statistical power of age-based comparisons. Seventh, we compared our findings with those reported in other Asian populations, which could have resulted in a bias due to differences in specimen preparation.

In conclusion, there seem to be only minor microscopic differences in lower eyelid structure among different Asian populations. Those minor differences were found in lower eyelid thickness between Chinese and Korean patients, and also found in the attachment of orbital fat to the tarsus between Japanese and Korean patients. Although we did not identify any remarkable age-related changes in lower eyelid structures, there was a tendency for the lower retractor to loosen from the tarsus and for increased fatty infiltration in the lower eyelids from elderly individuals. We believe this microscopic study of lower eyelid structures would help to improve the understanding and management of many lower eyelid diseases in Asian populations.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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