Three Ligaments Reinforce the Lower Eyelid

By

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Summary: This study was performed to elucidate the ligamentous structures in the lower eyelid other than the Lockwood ligament. Ten lower eyelids (right 5, left 5) of 5 Oriental post-mortems were dissected. The orbital septum was incised along the orbital rim, and then turned over toward the eyelid margin. The orbital fat was exposed and removed as much as possible without injuring the ligamentous structures. The ligamentous structures in the lower eyelid were then investigated macroscopically. There were two other ligaments in the lower eyelid in addition to the Lockwood ligament. All three ligaments originated from the posterior lacrimal crest, but went in different directions. The superior ligament ran on the junction of the orbital septum and the capsulopalpebral fascia, and in the lateral area, it ran on the posterior aspect of the orbital septum and attached to the periosteum of the lateral orbital rim. The inferior ligament went toward the posterior aspect of the inferior oblique muscle after separating from the Lockwood ligament. Ligaments other than the Lockwood ligament were revealed in the lower eyelid. These ligaments are thought to reinforce the fragility of the lower eyelid.

The ligament in the lower eyelid is represented by the Lockwood ligament1, which is formed by the capsulopalpebral fascia (CPF) after the capsulopalpebral head envelops the inferior oblique muscle (IOM)2–4. The Lockwood ligament originates from the anterior and posterior lacrimal crests, runs to a site a little distal of the IOM and then disperses from the Whitnall tubercle to the lateral check ligament4. The Lockwood ligament corresponds to the Whitnall ligament in the upper eyelid5. The lower-positioned transverse ligament6,7) and intermuscular transverse ligament8) exist in the upper eyelid in addition to the Whitnall ligament. However, in the lower eyelid, no ligaments other than the Lockwood ligament have been reported to date.

In this study, we investigated the ligamentous structures in the lower eyelid. The Lockwood ligament plays the leading role in the lower eyelid, but other ligamentous structures exist around it that may serve to reinforce the lower eyelid.

Materials and Methods

Ten lower eyelids (right 5, left 5) of 5 Oriental post-mortems, ranging in age at death from 73 to 91 years, were dissected. All specimens were fixed with 10% buffered formalin. Photographs of the gross dissections were taken with a digital camera (RR1; Ricoh, Tokyo, Japan). All cadavers were registered in the cadaveric service of Aichi Medical University, with proper consent and approval for use for educational purposes and studies. All methods for securing the human tissue were humane, and complied with the tenets of the Declaration of Helsinki.

First, the skin of the lower eyelid was removed.

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from an area 5 mm wider than the orbital aperture and the orbicularis oculi muscle was exposed using a binocular loupe (HRP \times 3.5, 420 mm/16°; Heine, Herrsching, Germany). Next, the exposed orbicularis oculi muscle was incised with a No. 15 surgical blade around the inferior orbital rim. The orbital septum was directly incised with Steven scissors, blade around the inferior orbital rim. The orbital septum and attached to the periosteum of the lateral area, it ran on the posterior aspect of the orbital septum and the CPF (Figs. 1-A, C), and in the lateral area, it ran on the posterior aspect of the orbital septum and attached to the periosteum of the lateral orbital rim (Fig. 1-A). The CPF enveloped the Lockwood ligament rather than formed it.

Another ligament, which originated from the posterior lacrimal crest at almost the same site as the Lockwood ligament, was observed superior to the Lockwood ligament (superior ligament; Figs. 1-A, C). The ligament ran on the junction of the orbital septum and the CPF (Figs. 1-A, C), and in the lateral area, it ran on the posterior aspect of the orbital septum and attached to the periorbita. The incised edge of the periorbita was pulled superiorly with 3-0 nylon sutures. The orbital fat was exposed and removed as much as possible without injuring the ligamentous structures. The ligamentous structures in the lower eyelid were then investigated macroscopically.

Results

The Lockwood ligament was observed roughly in the middle between the junction of the orbital septum and the CPF, and the anterior margin of the IOM (Fig. 1-A). The Lockwood ligament originated from the posterior lacrimal crest, ran along the inferior margin of Horner’s muscle and then inferolaterally in the CPF, before dispersing from the Whitnall tubercle to the lateral check ligament (Figs. 1-A, B). The CPF enveloped the Lockwood ligament rather than formed it.

Another ligament, which originated from the posterior lacrimal crest at almost the same site as the Lockwood ligament, was observed superior to the Lockwood ligament (superior ligament; Figs. 1-A, C). The ligament ran on the junction of the orbital septum and the CPF (Figs. 1-A, C), and in the lateral area, it ran on the posterior aspect of the orbital septum and attached to the periorbita. The incised edge of the periorbita was pulled superiorly with 3-0 nylon sutures. The orbital fat was exposed and removed as much as possible without injuring the ligamentous structures. The ligamentous structures in the lower eyelid were then investigated macroscopically.

Discussion

The ligament in the lower eyelid is represented by the Lockwood ligament, and no other ligaments have been reported to date. However, we have revealed the presence of two other ligaments in addition to the Lockwood ligament. Both of these ligaments originated from the posterior lacrimal crest, similar to the Lockwood ligament, but went in different directions.

The Lockwood ligament is located centrally among these three ligaments, and does not attach to the anterior lacrimal crest. The Lockwood ligament is the structure that prevents globe ptosis, in cooperation with the medial and lateral check ligaments\(^9\). In addition to this supporting system, connective tissue septa have previously been reported to surround the globe, form the framework of the orbit, and enable free movement of the globe\(^9\). In the medial canthus, the Lockwood ligament is a supplemental structure for pulling the CPF laterally, and runs along the inferior aspect of Horner’s muscle before dispersing over the inferolateral aspect of the lacrimal sac\(^10\). Since the movement of the CPF contributes to the lacrimal drainage system\(^11\), the Lockwood ligament may indirectly contribute to lacrimal drainage. In the lateral canthus, the Lockwood ligament constitutes the inferior margin of the lateral retinaculum\(^4\) attaching from the Whitnall tubercle to the lateral check ligament, and is therefore thought to contribute to the stability of the lateral canthus.

The superior ligament resists intraorbital pressure in the lower eyelid. The orbital septum in the lower eyelid originates from 1 to 2 mm outside the orbital rim, such that a pocket is formed\(^12\), and at this site, the structure of the septum may be easy to elongate. However, the outside of the orbital rim in...
the lower eyelid contains the orbicularis retaining ligament\textsuperscript{13). This ligament connects firmly to the orbicularis oculi muscle and the periosteum. By fixing the orbicularis oculi muscle to the orbital rim, the orbicularis retaining ligament tenses the orbicularis oculi muscle and the orbital septum, which is thought to resist intraorbital pressure in the inferior part of the orbit. Since this ligamentous reinforcement alone cannot decrease the stress of the junction of the orbital septum and the CPF or directly support the orbital septum, the superior ligament may support the junction and the orbital septum in cooperation with the orbicularis retaining ligament.

The inferior ligament along the medial margin of the CPF is thought to represent the reinforcement structure of the CPF. The CPF disperses to the inferolateral aspect of the lacrimal sac and the lateral aspect of the nasolacrimal duct\textsuperscript{10,11). As the CPF pulls these aspects during eye opening and releases them during eye closing, the CPF contributes to the lacrimal drainage system of the lacrimal sac\textsuperscript{11). Since the CPF attenuates around Horner's muscle, and force is continuously added to the medial margin of the CPF with eyelid movement, this ligamentous reinforcement is logical.

We could not observe the ligamentous structures in the lateral area of the CPF. Since the Lockwood ligament is located in a slightly lower site laterally than medially, and constitutes the tenacious lateral retinaculum\textsuperscript{4}, the force added to the lateral margin of the CPF may be relieved by these structures.

References

1) Lockwood CB. The anatomy of the muscles, ligaments, and fasciae of the orbit, including an account of the capsule of Tennon, the check ligaments of the recti, and of the suspensory ligament of the eye. J Anat Physiol 1885; \textbf{20}:1–26.