Fatty degeneration of upper tarsal muscle as etiological factor of acquired upper eyelid ptosis


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Purpose — to study the histological structure of the upper tarsal muscle (Müller’s muscle of the upper eyelid) in patients with acquired ptosis and to confirm the presence of its fatty degeneration as an understudied etiological factor of upper eyelid ptosis. Material and methods. A retrospective analysis was performed covering 79 biopsy samples of Müller’s muscle of the upper eyelid obtained intraoperatively. Histological examination was performed with samples prepared by waxing. Planning the surgery included determination of basic parameters and the «transparency» symptom; the Müller’s muscle projection area was examined in the inverted upper eyelid, and ultrasound biomicroscopy (UBM) of the upper eyelid structures was performed. Results. Among the study subjects, a group of 11 patients with isolated fatty infiltration of the upper tarsal muscle was identified. At the preoperative stage, in the group of patients with upper eyelid eversion, visibly thickened Müller’s muscle advancing on the tarsus could be observed, as well as negative «transparency» symptom; UBM showed thickened «conjunctiva — Müller’s muscle» complex, and a large number of hypoechogetic inclusions in the muscle in comparison with the intact eye. The removed muscle was thickened, yellow, with increased density and rigidity. Microsection of the histological preparations revealed fat cells located among bundles of smooth muscle fibers of the upper tarsal muscle and dispersion of smooth myocytes on the background of fat infiltration. Conclusions. The presence of dystrophic changes in the upper tarsal muscle is proved with clinical, macromorphological and pathohistological methods; they can be one of the independent causes of acquired upper eyelid ptosis. Keywords: Müller’s muscle, upper tarsal muscle, upper lid ptosis, levator histology, fatty degeneration.

Ptosis is a common pathology in appendages of the eye and constitutes a malposition of the upper eyelid in the form of its drooping caused by insufficient or inadequate functioning of the muscles involved in its raising [1]. In the absence of treatment, acquired blepharoptosis is not only of a cosmetic complain, but also a limitation of the upper visual field [2].

The anatomical structures that support the upper eyelid in the correct position are the striated muscle that lifts the upper eyelid — the levator, smooth Müller’s muscle and connective tissue elements — the levator aponeurosis, and the superior transverse ligament of the orbit (Whitnall’s ligament) [1].

The deep muscle portion represented by the Müller’s muscle of the upper eyelid is of particular interest due to its unique structure, which consists of smooth muscle fibers branching directly from the striated muscle that lifts the upper eyelid at the level of Whitnall’s ligament, before its transformation into aponeurosis [3, 4]. Besides that, the exact embryological development of this muscle is not completely clear [5, 6].

The Müller’s muscle consists of myocytes containing contractile actin and myosin myofilaments. They are not organized by the clear cross-sectional pattern that is observed in skeletal muscles, and they have one central nucleus. Connective tissue surrounds individual smooth muscle fibers and muscle layers. This portion is innervated by sympathetic fibers [4].

A review of the literature on histological studies of Müller’s muscle of the upper eyelid yielded only occasional publications, mainly written by foreign authors describing anatomical, functional features and the structure of the superior tarsal muscle, its atrophy in congenital ptosis [4, 7–13]. Only two publications mentioned the involvement of the Müller’s muscle in the occurrence of acquired ptosis of the upper eyelid due to its fatty infiltration [14, 15].

This article is aimed at studying histological changes in Müller’s muscle of the upper eyelid in patients with acquired ptosis and to confirm the assumption that fatty infiltration of Müller’s muscle of the upper eyelid is an independent, poorly understood cause of acquired ptosis of the upper eyelid.

Material and methods

The study included 79 patients of both genders with acquired upper eyelid ptosis of varying severity. Mean age of female patients was 53±14 years (27–77), mean age of male patients — 54±14 years (24–84). Biopsy material from 79 specimens of the “conjunctiva — Müller’s muscle of the upper eyelid” complex was studied retrospectively. Clinical picture of ptosis was assessed using the following parameters: functionality of the levator, marginal reflex distance (MRD1) — the distance between
the upper lid margin and the corneal reflex, upper eyelid excursion, width of the palpebral aperture, height of the upper orbital–palpebral fold. In addition, the examination included the projection area of Müller’s muscle with inverted eyelid, as well as ultrasound biomicroscopy (UBM) of the upper lid structures, and assessment of the “transillumination” symptom. The study excluded patients with congenital upper lid ptosis, previously operated patients with acquired upper lid ptosis, as well as patients with traumatic, myogenic or neurogenic acquired ptosis.

After signing written informed consent, all patients underwent a transcutaneous access surgery for acquired upper lid ptosis. The incision was performed on the palpebral fold of the upper eyelid symmetrically to the intact eye. During levator visualization stage, straight Westcott scissors were used to separate the levator aponeurosis from the Müller’s muscle. Intraoperative examination revealed significant thickening of Müller’s muscle of the upper eyelid in 11 patients aged 29–77 years (8 female patients aged 56±17 years and 3 male patients aged 58±17 years old). Macroscopically, the changed muscle was resected with conjunctiva (height of resection was 8–10 mm). Aponeurosis of the levator was refixedated to the border of the tarsal plate, the incision was sutured. Biopsy specimen were initially put in 10% neutral formaldehyde solution and then sent to the laboratory for further histological examination with light microscopy. Semifine sections of the proximal segment of Müller’s muscle of the upper eyelid were prepared by waxing and with 3 different types of staining: hematoxylin and eosin, Van Gieson’s picro-fuchsin, and Mallory’s trichrome.

Results and discussion

The clinical picture in all patients seemed to correspond to acquired aponeurotic ptosis of the upper eyelid. However, upon a more detailed examination, some features were found that made it possible to separate 11 people into a special group. Their distinctive clinical sign was thickening of the tissue layer in the projection of the Müller’s muscle of the upper eyelid during its eversion with a visible «creeping» of the altered muscle onto the upper tarsal plate in the form of a roller. Negative «transillumination» symptom was found that consisted in the absence of transillumination of the cornea and underlying structures in the form of a dark rounded spot through the upper eyelid pulled downwards while the patient looked upwards. Patients with aponeurotic ptosis had positive “transillumination” — through the upper eyelid, when it is pulled downwards, the cornea showed through with the underlying structures in the form of a dark circle. On the UBM, fatty infiltration of the muscle was visualized as a thickening of the entire complex «conjunctiva — Müller’s muscle — upper eyelid levator aponeurosis» with a large number of hypoechogenic inclusions corresponding to fatty tissue in comparison with the intact eye.

Macroscopically, the intraoperative examination of the anatomical structures in 11 patients showed that Müller’s muscle was significantly increased in size between the levator aponeurosis and conjunctiva. The abnormal tissue was spread over the entire area of the superior tarsal muscle. To demonstrate the observed changes, the resected specimen was compared with macroscopically unchanged Müller’s muscle of the upper eyelid (Fig. 1). The most striking characteristic in light microscopy of biopsy specimen of Müller’s muscles of the upper eyelid in this group of patients was the presence of adipose tissue located among bundles of smooth muscle fibers, their dispersion against the background of fatty degeneration. The morphological picture was revealed to include partial replacement infiltration of smooth muscle tissue with fat (Fig. 2).

The Müller’s muscles in the other patients was healthy and consisted of compactly lying bundles of smooth muscle fibers covered with a thin layer of connective tissue containing blood vessels. Fat cells were completely absent in the muscle bundles (Fig. 3).

According to I.V. Blinova, in the proximal medial and median regions, the superior tarsal muscle from the conjunctival side is represented by compactly located smooth muscle fibers. The more massive outer layer is represented by individual smooth muscle bundles different in size and density. In the lateral part of the eyelid, smooth muscle fibers are located in a single conglomerate. Fat cells are absent in the thickness of the muscle, which coincided with our data [16].

Histological changes in Müller’s muscle in the form of fatty infiltration in patients with acquired ptosis have not been described in the Russian literature. The results of this study clearly demonstrate the changes in the structure of Müller’s muscle of the upper eyelid in patients with acquired ptosis. Among the bundles of unchanged smooth muscle cells, adipose tissue was found in large quantities, while in patients with acquired aponeurotic ptosis, myocytes had clear and pronounced structure, compact arrangement and the absence of fatty tissue among the bundles of smooth muscle fibers.

Interestingly, the structural changes seen in Müller’s muscle in patients with acquired upper eyelid ptosis were not associated with their age.
Fig. 2. Histological view of Müller’s muscle infiltrated by fat.
Hematoxylin and eosin staining. а, c, e — magn. 100; b, d, f — magn. 50. Among fatty tissue (2) are bundles of smooth muscle fiber (1) that go in lateral and axial directions. In figure 2e, the arrow shows a slice of the lacrimal gland. The fat between the muscle bundles is more pronounced (b, c, d, f).

Considering the changes that were found in the structure of the upper tarsal muscle in acquired ptosis of the upper eyelid, as well as the research data of K. Cahill et al. (1986) [14] and O. Gündisch et al. (2004) [15], who describe fatty infiltration of Müller’s muscle as a possible independent etiological factor of acquired ptosis of the upper eyelid not only due to dysfunction of smooth myocytes, but also as a mechanical obstacle due to a significant thickening and increase in the volume of the entire area of Müller’s muscle, it can be concluded that fatty infiltration of the upper tarsal muscle may be an independent cause of acquired ptosis of the upper eyelid.

**Conclusion**

The general classification used in the surgery of the eye and its appendages distinguishes congenital and acquired blepharoptosis. Acquired ptosis, in turn, may be either the result of an anatomical defect (aponeurotic, traumatic, myogenic), or the manifestation of certain systemic diseases (neurogenic ptosis, myasthenia, myopathy) [17].

This study focused only on the histological examination of Müller’s muscle of the upper eyelid in acquired ptosis. The changes found in the Müller’s muscle in patients of different ages and the severity of ptosis can be considered a new independent cause of ptosis of the up-
Removal of the dystrophic muscle during a surgery to eliminate ptosis of the upper eyelid provides lasting positive clinical effect. The results of this study helped reveal in more detail the pathogenesis of acquired ptosis. Further observation is required to determine the complete diagnostic algorithm and develop pathogenically specific treatment for this pathology.

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