



Anatomical Study and Clinical Observation of Retro-orbicularis Oculi Fat (ROOF)

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Abstract

Objective To study the anatomical location of retro-orbicularis oculi fat (ROOF) in the upper eyelid and to investigate how ROOF affects the appearance of the upper eyelid.

Methods Twenty-eight Chinese hemifacial cadaver specimens were used (14 male cadavers; age range 52–82 years). In 28 hemifaces, the eyelids were dissected from the superficial to deep layers, and the appearance, location, extent, and surrounding tissue of ROOF were observed. Additionally, we observed the relationship between the upper eyelid morphology and ROOF of the upper eyelid in surgical patients who were treated in the plastic surgery department of Tongji Hospital affiliated with Huazhong University of Science and Technology in 2018.

Results ROOF is a type of fascia adipose tissue that is located in a fat compartment between the muscles (the orbicularis oculi and frontalis muscles) and the orbital septum/frontalis fascia. In patients with hypertrophic ROOF, the upper eyelid appears as a heavy eyelid and as a drooping eyelid. And in patients with atrophic ROOF, the upper eyelid appears as a sunken eyelid.

Conclusion ROOF is located in the fat compartment between the orbicularis muscle and the orbital septum/frontalis fascia. ROOF covers the entire upper eyelid and

appears thinner medially and thicker laterally. It is continuous with the fat under the frontalis muscle and affects the appearance of the upper eyelid. It represents an important factor in upper eyelid surgery.

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Keywords Upper eyelid · Retro-orbicularis oculi fat (ROOF) · Heavy eyelid · Sunken eyelid · Fat compartment · Suborbicularis oculi fat (SOOF)

Background

There are many reports of ROOF in the anatomical literature. However, thus far, no scholars have systematically described ROOF as a pathological basis of heavy eyelids and sunken eyelids. The traditional description of the ROOF tissue layer has not considerably changed since a 1990 report, which described ROOF as “extending medially from the superior orbital nerve and laterally to a varying distance over the upper lateral orbit” [1].

The dimensions of ROOF were first quantified in 2007 by Korean experts [2]. However, these cadaver dissections did not extend beyond the upper eyelids; Blandford AD was the first one to describe the continuity between ROOF and the other deep fat compartments of the forehead [2]. To explore the etiology of ROOF for heavy eyelids, it is necessary to describe the anatomical location of ROOF, the relationship between ROOF and the surrounding tissues, and the physiological function of ROOF.

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Thus, the authors aimed to identify the location of ROOF and its relationship to the other fat compartments of the face.

Methods

Fourteen (28 sides) Chinese fresh-frozen adult head specimens were used. According to the designed anatomical planes, an incision was made in the hairline and the midline of the face, and the edges of the eyelid were dissected. The dissection was performed from the superficial to the deep level, according to the anatomical planes. The appearance, location, extent, and relationship of ROOF were observed.

We observed the relationship between upper eyelid morphology and ROOF of the upper eyelid in surgical patients who were treated in the plastic surgery department of Tongji Hospital affiliated with Huazhong University of Science and Technology in 2018.

All of the figures were created with Adobe Photoshop CC 2015.

Results

Twenty-eight hemifacial cadaver specimens were evaluated. ROOF was observed in all 28 hemifaces. ROOF is located deep to the orbicularis oculi muscle and the superficial layer of the orbital margin with the orbital septum (Fig. 1). ROOF mainly consists of fibrous adipose tissue rather than adipose tissue such as pre-aponeurosis fat. There is a physiological space between the deep muscle and the fascia. Inside the physical area referred to as fat, the compartment is known as ROOF.

After the removal of the orbicularis oculi and the frontalis muscles, the deep fat under the frontalis muscle and ROOF are exposed, which continues and appears to be the same tissue from the coronal and sagittal view. There are blood vessels and nerves running through it (Fig. 2). In a sagittal diagrammatic drawing (Fig. 3), the orbital septum continues upwards with the frontal fascia and separates ROOF from orbital fat. The lateral portions of ROOF and SOOF are continuous in the specimens (Fig. 4).

In operations that were performed in 2018, the appearance of ROOF in the upper eyelid of the patients was significantly different. We chose two examples, which are shown in Fig. 5. The patient with ROOF hypertrophy exhibited heavy eyelids, and the patient with ROOF atrophy exhibited sunken eyelids (Fig. 5).

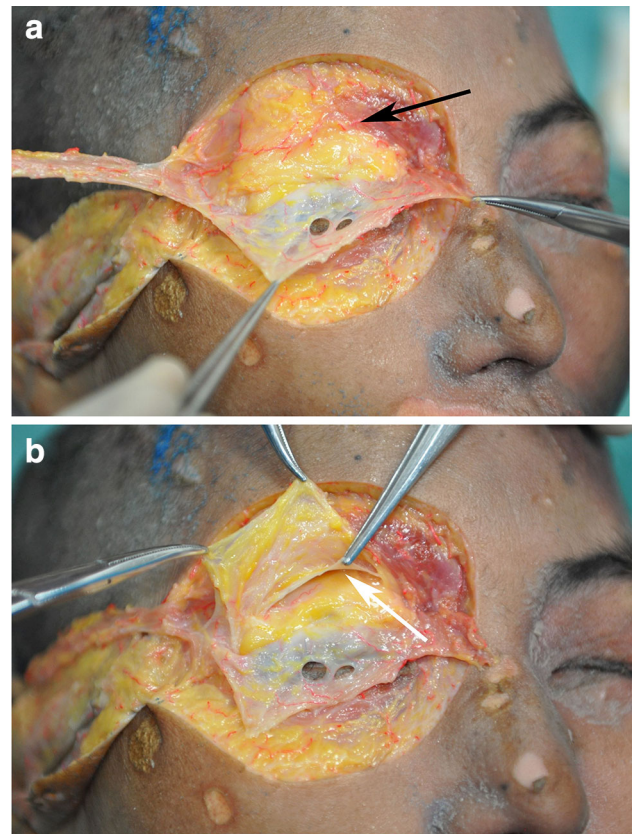


Fig. 1 ROOF. The black arrow in **a** refers to ROOF, and the white arrow in **b** indicates the orbital septal margin of the deep surface of the ROOF

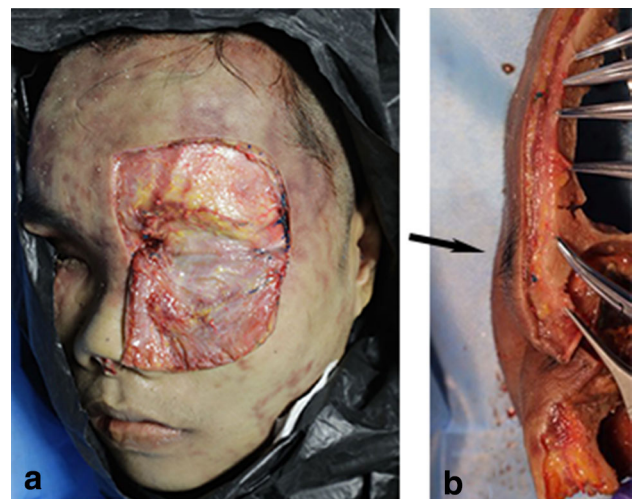


Fig. 2 The deep fat of the frontalis muscle and ROOF after removal of the orbicularis and the frontalis muscles, are shown in **a**. After the sagittal cut of the specimen, it can be observed that the ROOF and the deep fat of the frontalis muscle are continuous with each other, as seen in **b**

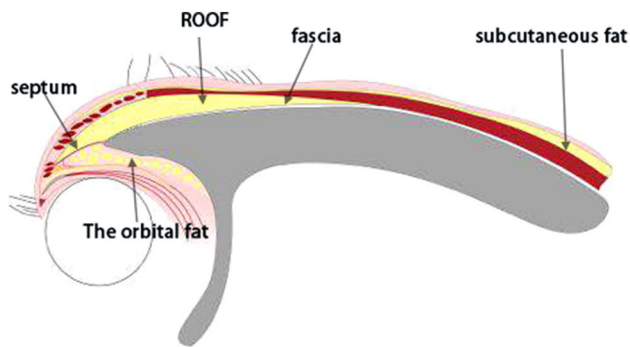


Fig. 3 This is a diagrammatic drawing of sagittal position. The orbital septum continues upwards with the frontal fascia, and separates ROOF from orbital fat

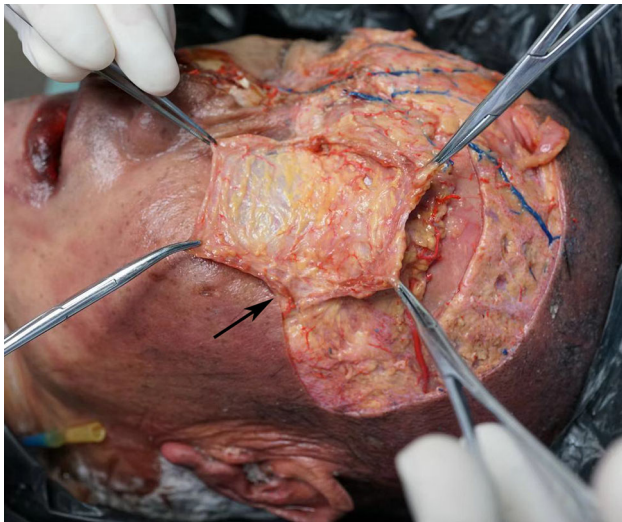


Fig. 4 This figure shows complete ROOF and SOOF anatomical images; the arrows indicate the connection between the ROOF and SOOF

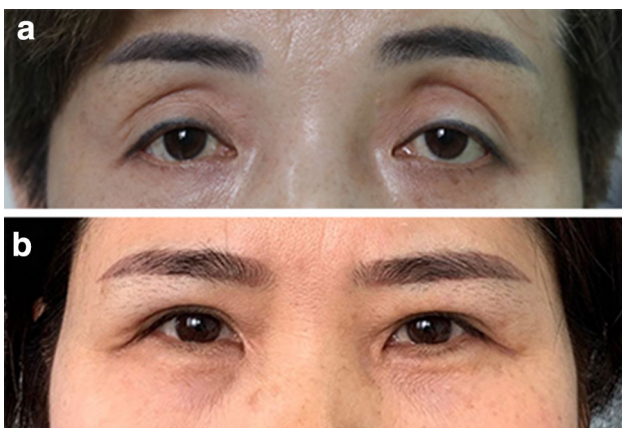


Fig. 5 **a** A picture of a clinical patient with ROOF atrophy, **b** a picture of a clinical patient with ROOF hypertrophy

Discussion

ROOF was first described three decades ago after careful observations during blepharoplasty. Because this description relied on the intraoperative findings that were identified during blepharoplasty, the limited operative field prevented the ability of exploring its anatomical extent [1]. It was only a decade ago that ROOF dimensions were quantified, and we do not currently know the boundaries and the neighboring areas of the fat pad [3].

The relationships of the ROOF layer to other important structures of the periorbital regions have only been recently elucidated, including lateral orbital thickening, deep temporal fascia and zygomatico-temporal nerve [5]. Moreover, Alexander D believed that the forehead region is an extension of the ROOF. ROOF represents an important structure that unites the eyelid and forehead regions. He proposed that traditional ROOF should be redefined as the retro-orbicularis oculi and frontalis muscle fat pad (ROOFF) [2]. Hwang et al. [3, 4] have reported that ROOF and SOOF are the fat types located behind the orbicularis oculi muscle and separated from the upper eyelid and the lower eyelid relatively independently. However, the lateral portions of ROOF and SOOF were connected in the specimens. Anatomical studies have demonstrated that facial fat is partitioned into distinct compartments [6]. ROOF is located in the compartment between the orbital septum and the orbicularis oculi muscle. As a fibrous fat pad, it consists of vessels and nerves, such as the supraorbital neurovascular bundle medially and the frontal branch of facial nerve laterally.

In general, young Asian women with heavy eyelids have a larger volume of ROOF. Certain diseases can cause the ROOF volume to increase. Thornton et al. [7] observed that patients with thyroid-associated orbitopathy had statistically significantly thicker retro-orbicularis and suborbicularis oculi fat pads. Some studies have even observed a prominence of the eyebrow fat pads in patients with thyroid-associated orbitopathy. Patients with pathological hypertrophy of ROOF, due to Grave's eye disease, can also have pathological hypertrophy of the eyebrows and SOOF [8–10]. It has been established that the fat volume in this space is variable. Additionally, this result indicates that there is a connection between ROOF and SOOF.

Hwang and other researchers [2] believe that ROOF and SOOF are separate. However, this is not an absolute in anatomical studies. ROOF is connected to SOOF in the specimens. A previous study reported that ROOF and SOOF are associated with the superficial temporal nerve [11]. The upper part of ROOF is the deep fat of the frontalis muscle, which is separated by the dense fibrous

connective tissue of the eyebrow. These tissues are all located in the same layer.

ROOF and SOOF are known to contain large amounts of fascia, which indicates that they are closely related to the muscle and fascia. The aging of the upper eyelids in Asian individuals is mainly manifested as a laxity of the upper eyelids. Tower J et al. demonstrated that volumetric changes to facial fat occur with aging [12]. This also applies to the upper eyelids.

As an ethnic feature of Asian individuals, ROOF participates in the formation of the upper eyelid. ROOF is located between the orbicularis muscle and the septum, which acts as a lubricant to reduce the tissue linkage of muscle movement. During hypertrophy, the upper side of the upper eyelid is heavy and promotes upper eyelid skin sagging. When ROOF undergoes atrophy, the upper eyelid is sunken. ROOF tissue whether it is too thick or too thin will result in an aged appearance. Therefore, to achieve a younger appearance of the upper eyelid, the volume of ROOF should be appropriate. If the ROOF is too thick, then partial resection should be performed. If the ROOF is too thin, then filler should be used. The fat compartment between the orbicularis oculi muscle and the orbital septum is the most suitable region for augmentation.

There are limitations. The number of specimens in this article was insufficient, and individuals were relatively old. Furthermore, measurements and statistical analyses of ROOF data indicators have not yet been performed. Finally, the specific relationship between the volume and appearance of the upper eyelid needs to be further studied.

Conclusion

ROOF, as a structural fat, widely exists in the upper eyelids of adults. Additionally, it is located in the fat compartment between the orbicularis oculi muscle and the orbital septum. ROOF extends to the brow and forehead, and it connects SOOF. ROOF is involved in the formation of a heavy and sunken upper eyelid appearance in Asian individuals. ROOF lubricates and cushions the muscles during muscle movement. The proliferation or atrophy of ROOF can lead to a poor appearance of the upper eyelid. Eyelid surgery should involve the careful evaluation of ROOF to properly guide the operation and to rejuvenate the appearance of the upper eyelid.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflicts of interest to disclose.

Human and Animal Rights This article does not contain any studies with human participants or animals that were performed by any of the authors.

Informed Consent For this type of study, informed consent is not required.

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