

Updates on the Theory of Upper Eyelid Crease Formation in Eastern Asians

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ABSTRACT

Surgical theories serve as a guide for surgical techniques and reflect our understanding of anatomical structures and functions. Among Eastern Asians, double eyelid surgery is the most common cosmetic procedure. The hypothesis of upper eyelid crease creation has evolved throughout time, from the quest for a fixed crease to the reconstruction of an elastic crease that corresponds with ethnic traits. The background, content and surgical significance of these beliefs are summed up in this review.

Keywords: Surgical theories; Eyelid crease; Hypothesis; Anatomical structures

INTRODUCTION

Due to the lack of a widely accepted hypothesis on the formation of upper eyelid creases, double eyelid surgery is the most common procedure among Eastern Asians; yet, the satisfaction rate is not as high as anticipated. All of the crease phenomena should be explained by a comprehensive theory that also offers helpful surgical assistance. Crease formation theory has evolved over the past few decades due to anatomical knowledge, aesthetic demands, and feedback on surgical outcomes. Clarifying the pretarsal fascia's structure and function is at the heart of this evolution [1].

LITERATURE REVIEW

Aponeurosis extension theory

Whitnall thought that the aponeurosis sending fan-shaped branches *via* the orbicularis oculi muscle to the subcutaneous tissue was the cause of the upper eyelid crease based on Western anatomy. Sayoc, however, thought that monolids in Eastern Asians were caused by the absence of terminal perforating branches. Under electron microscopy, Cheng found aponeurotic branches behind the double eyelid line. Under the influence of the aponeurosis extension theory and Western aesthetic concepts, a surgical method focusing on dermal-aponeurosis connections was developed. Representatives of this method include Sayoc, Fernandez, Khoo Boo-chai, whose methods still

have a significant impact. Unfortunately, although this surgery, which emphasizes tissue removal, can form a stable double eyelid, it has obvious drawbacks: Scar depression, stiff folds, and an unnatural appearance. Many patients, who were dissatisfied with the stiff folds, returned to the operating table in pursuit of a more natural result. In fact, this theory has been questioned for a long time. For example, many Eastern Asian surgeons have not consistently found branches of the aponeurosis directly entering the skin. Some surgical techniques can still form crease without suturing the aponeurosis, presenting a significant challenge to the theory. Many natural creases, such as the variability and asymmetry in the same individual, cannot be explained by the theory [2-4].

Conjoined fascia theory

The conjoined fascia theory emphasizes various fascial structures, including Retro-Oculi Orbicularis Fat (ROOF), orbital septum and aponeurosis, extending toward the tarsus and ultimately converging. In addition to the sagittal fan-shaped aponeurotic branches, the theory adds the continuation of fascia in the coronal position. Meyer believed that the fibrofatty tissue between the orbital septum and orbicularis oculi muscle is a continuation of the ROOF. Eastern Asians have thicker sub-orbicularis oculi fascia, and it is currently believed that this continuation extends to the pretarsal area. Hwang and Reid proposed that the fascia belongs to the superficial layer of the orbital septum extending to the pretarsal area. The conjoined

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fascia theory is closer to the fascial observations of Eastern Asians, yet remains vague. How the continuation in the coronal position and the aponeurotic branches in the sagittal position weave into the pretarsal fascia is still unclear. As Siegal noted, if aponeurotic fibers within the fascia are responsible for inducing upper eyelid creases, why would excising these fascial structures increase the likelihood of crease formation [3-6].

Buffering and conduction theory

The abundant pretarsal fascia in Eastern Asians, along with the use of a sub-orbicularis oculi muscle approach in surgery, has greatly facilitated the study of the pretarsal fascia. Based on this, Wang systematically analyzed the structure of the pretarsal fascia and proposed the buffering-conduction theory. The content is as follows:

The true aponeurosis extension is divided into three parts. The levator aponeurosis, near the tarsus, splits into deep and superficial fascia. The superficial layer merges with the orbital septum, known as aponeurosis extension to orbital septum, whose function is to lift the orbital fat during eyelid opening. The deep layer, known as aponeurosis extension to tarsus, extends along Müller's muscle surface to the tarsal region, helping to elevate the tarsus. The orbital fat capsule, known as aponeurosis extension to orbital fat, is formed within the orbital septum by a thin layer of fascia that aids in lifting the orbital fat during eyelid opening. The creation of creases at various heights is driven by these three aponeurosis extensions [7,8].

The distal end of the aponeurosis extension and its bifurcation are covered by the pretarsal fascia, which is the downward extension of the ROOF in the coronal position and is connected to them by collagen fiber crosslinking. At the distal end of aponeurosis, this link is especially thick. The aponeurosis extensions stretch the fascia, causing the tiny fibers to clump together and grow stiffer and thicker, which can be misinterpreted for tendon-like structures. The so-called "fan-shaped aponeurosis branches" seen under a light microscope are likewise explained by this. In ROOF, Collin and Meyer discovered a comparable extensive linkage at the supraorbital border.

The buffering effect is demonstrated by the fiber bundles in the pretarsal fascia, which typically buffer the stresses from the aponeurosis extension and reduce the likelihood of crease formation. Conversely, the conduction effect can be demonstrated by the creation of a crease if the fiber bundles' tension and direction are suitable. The result of the buffering-conduction effect determines whether a crease forms and how deep it is. While extremely elastic fibers are less likely to cause creases, coarse, stiff, and sagittal-oriented fibers can cause deeper wrinkles.

Both surgical creases and hereditary upper eyelid folds can be explained by the buffering-conduction idea. An inelastic connection between the dermis and the distal aponeurosis is the most efficient approach for buried-suture surgery to create quick paths within the buffering fascia. By avoiding the buffered fascia, the Kiss approach and the turn-over orbital septum flap procedure recreate a new buffering-conduction system that more

readily causes a crease. The buffering fascia is directly shortened using the bridge procedure. The buffering-conduction system's dual function is crucial to the development of Eastern Asians' natural crease. In fact, correcting for fascia loss can mimic elastic wrinkles, and those with "over-stable" double eyelids are thought to be abnormal [9].

DISCUSSION

The formation of the upper eyelid crease has long been a subject of debate, with evolving theories reflecting advances in anatomical understanding, aesthetic expectations, and surgical experience. The Aponeurosis Extension theory has historically dominated the field, establishing the foundational concept that extension of the levator aponeurosis toward the skin is essential for crease formation. While this framework has significantly influenced surgical techniques, particularly those emphasizing dermal-aponeurotic fixation, its limitations are increasingly evident. Inconsistent identification of direct aponeurotic insertions into the dermis in Eastern Asian eyelids, along with the ability to create creases without such fixation, challenges its universality. Moreover, the theory does not adequately explain natural variations such as asymmetry, multiple crease heights, or dynamic changes over time. Clinically, procedures based solely on this concept have often resulted in rigid, unnatural folds and visible scarring, highlighting a disconnect between theoretical assumptions and aesthetic outcomes.

In response to these shortcomings, the Conjoined Fascia theory expanded the anatomical framework by incorporating a broader range of fascial structures, including the retro-orbicularis oculi fat, orbital septum, and associated connective tissues. This model better reflects the complex, multilayered anatomy of the upper eyelid, particularly in Eastern Asian populations where fascial thickness and continuity differ from Western descriptions. By proposing both sagittal and coronal extensions of fascial planes, it offers a more comprehensive structural perspective. However, despite its improved anatomical relevance, the Conjoined Fascia theory remains largely descriptive and does not sufficiently address the mechanical processes underlying crease formation. Notably, it fails to reconcile paradoxical observations, such as the increased likelihood of crease formation following excision of certain fascial components, thereby limiting its explanatory power in surgical contexts.

The Buffering-Conduction theory represents a significant conceptual advancement by integrating anatomical structure with biomechanical function. Central to this theory is the role of the pretarsal fascia as both a buffer and a conductor of forces generated by the levator aponeurosis. The buffering function dissipates mechanical stress, reducing the likelihood of crease formation, whereas the conduction function facilitates the transmission of force when fiber orientation, stiffness, and tension are favorable. This dual mechanism provides a unified explanation for the presence, absence, and variability of eyelid creases. It also accounts for differences in crease depth and stability, as well as the dynamic nature of eyelid morphology. Importantly, the theory clarifies previously misunderstood histological findings, such as the appearance of tendon-like

structures, by attributing them to localized stiffening of collagen fiber networks under tension.

From a surgical perspective, this paradigm shift has important implications. Traditional techniques that prioritize firm dermal-aponeurotic attachment and tissue excision may inadvertently disrupt the buffering-conduction balance, leading to over-stable or artificial-appearing folds. In contrast, approaches informed by the buffering-conduction framework emphasize preservation and modulation of fascial integrity, aiming to optimize force transmission pathways rather than impose rigid structural connections. This perspective supports the development of more refined, minimally invasive techniques that produce natural, dynamic outcomes and reduce the risk of complications such as scarring and stiffness.

Despite these advances, several challenges remain. Current understanding of pretarsal fascia biomechanics is largely qualitative, with limited quantitative data on tissue elasticity, fiber orientation, and force distribution. Variability among individuals, influenced by genetic, developmental, and age-related factors, further complicates the establishment of a universal model. Additionally, in vivo visualization of fascial dynamics remains technically challenging, restricting the ability to directly validate theoretical assumptions. Future research incorporating high-resolution imaging, biomechanical modeling, and longitudinal clinical studies will be essential to address these gaps.

In summary, while the aponeurosis extension theory and conjoined fascia theory have each contributed valuable insights, the buffering-conduction theory offers a more comprehensive and functionally relevant framework for understanding upper eyelid crease formation. Rather than supplanting earlier models, it integrates their key elements into a cohesive system that emphasizes the interplay between anatomical structure and mechanical behavior. This integrated perspective not only enhances theoretical understanding but also provides a more rational basis for surgical innovation and individualized patient care.

CONCLUSION

The aponeurosis extension theory remains the most influential view, clarifying the concept that without aponeurosis extension,

no crease can form. The conjoined fascia theory emphasizes the involvement of various fascia in double eyelid formation. The buffering-conduction theory explains various double eyelid phenomena from an anatomical, mechanical, and surgical practice, supplementing the previous two theories.

CONFLICT OF INTEREST

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

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