The Asian Eyelid: Relevant Anatomy

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Semin Plast Surg 2015;29:158–164.

Abstract

Keywords

- ▶ Asian eyelid anatomy
- ▶ Asian eyelid
- ▶ eyelid anatomy
- ▶ Asian eyelid morphology
- ▶ Asian blepharoplasty
- ▶ Asian double crease

The eyelid of Asians has its own unique characteristics. If the surgeon does not acknowledge this, aesthetically pleasing results will seldom be achieved. Here the authors review and summarize important up-to-date anatomical and relevant clinical studies of the Asian upper eyelid, aiming to help surgeons thoroughly understand its unique features, including Asian eyelid morphology, anatomical details, and the mechanisms of upper eyelid crease formation. Hopefully, an in-depth understanding of the Asian eyelid will aid surgeons to accomplish their work and lead to novel new techniques in this field.

“Asian” refers to anything related to the continent of Asia. Therefore, the Asian eyelid includes the varied eyelid morphologies present in Asia. The Asian population is composed of various races—Chinese, Indian, Middle Eastern, Southeast Asian, as well as others. Most of the published literature on the “Asian eyelid” describes the morphology of eyelids found in native Chinese and those of Chinese descent; this morphology has its own unique characteristics. (Other terms used to describe the Asian eyelid are the Mongoloid eye and the Oriental eye.) Because the proper correction/change of Asian eyelid structures leads to a dramatic improvement in the aesthetic appearance of patients, Asian eyelid periorbital surgery has emerged as a new area of interest in plastic and reconstructive surgery.

“Know the ideal beautiful normal,” as stated by D. Ralph Millard, Jr., MD, is still the most important principle in both cosmetic and reconstructive surgery.¹ Therefore, it is a must for all surgeons to fully understand Asian periorbital structures. The ideal beautiful normal Asian woman’s eye is difficult to define. First, it needs to be normal: The morphology should be common and typically found. Second, the ideal beautiful normal Asian eye is not a single type or particular morphology, but a range or spectrum. If surgeons try to change all the women in the world to obtain similar fixed standard measurements, there will be many women with similar looks; hence, they will be not considered beautiful

anymore. Third, beauty like fashion changes over time. Last, even the most beautiful eyes in the world may not be able to make a woman look good, the surgeon and patient have to discuss and adjust their goals together to get the results that will satisfy both.

In the past, for patients and surgeons the goal of Asian eyelid surgery was the Caucasian look. However, over time, people realized that Caucasian-like eyelids make Asian patients look quite unnatural. As a result, the trend shifted toward unique beautiful normal ideals of Asians, particularly Asiatic Asians. To create a beautiful normal Asian eyelid, a thorough understanding of Asian eyelid anatomy is imperative. Because there is not much difference in the anatomy of the lower eyelid between Asians and Caucasians, in this chapter we will focus only in the anatomy of structures in Asian upper eyelids, which are relevant to everyday practice.

Anatomy

Upper Eyelid Morphology of the Chinese and Chinese Descendants

People from many Asian countries who have Chinese ancestry are very easy to recognize. Upper eyelid morphology is the most obvious part in the face that contributes to this fact. The unique characteristics are as follows: The upper eyelid crease is not as apparent as the crease of a Caucasian eye; the upper

lid looks puffier and has more fullness; the palpebral fissure is narrower and gives the look of slit-like eyes; mild ptosis is commonly seen; there is an upward lateral canthal tilting with a look of slant eyes; an epicanthal fold is common; and the soft tissue intercanthal distance is wider around 5 to 7 mm compared with that in Caucasians.²

The upper lid crease can be divided into three types: (1) a single eyelid (no visible lid crease), (2) a low eyelid crease (low-seated, nasally tapered, including hidden fold), and (3) a double eyelid (well-formed supratarsal crease).^{2,3} We prefer to subdivide the double eyelid morphology into three subtypes, related to the height of the crease and epicanthal fold: (1) Infold: the height of the upper lid crease is lower than epicanthal fold; (2) on-fold: the height of the crease is right on epicanthal fold; and (3) outfold: the height of the crease is higher than the epicanthal fold (►Fig. 1). With this classification, we found it easier to fine-tune the goal of surgery during a preoperative discussion with the patients. Of note, in

a patient who does not have an epicanthal fold, only the outfold type can be offered.

Skin

Similar to Caucasians, the eyelid skin of Asians is also the thinnest skin in the body.^{4,5} The thinnest part is just the area near the ciliary margin (0.3 mm). Upper eyelid skin gradually thickens closer to the eyebrow. The skin thickness at the upper tarsal area is around 0.8 mm. At the level just below the eyebrow, the skin thickness is around 1 to 1.3 mm.⁵ As Asian upper eyelid skin is generally thicker than Caucasian's, the thickness difference between the supratarsal area and the area closer to the brow becomes more significant. This fact explains the unnatural results created by a traditional blepharoplasty in the Asian elderly, a population that needs a lot of skin removal due to the newly created supratarsal fold formed by thick skin as shown in ►Fig. 2. Therefore, many surgeons prefer the infrabrow skin excision instead.^{6,7} An infrabrow

Fig. 1 Asian eyelid morphologies are categorized into six types. (A) Single eyelid (no visible lid crease). (B) Low eyelid crease (low-seated, nasally tapered, including hidden fold). (C) Double eyelid crease, infold type: the height of the upper lid crease is lower than the epicanthal fold. (D) Double eyelid crease, on fold type: the height of the crease is right on the epicanthal fold. (E) Double eyelid crease, outfold type: the height of the crease is higher than the epicanthal fold (*asterisk*). (F) Double eyelid crease, outfold type without an epicanthal fold.

Fig. 2 Unnatural result caused by a traditional upper blepharoplasty in the elderly with supratarsal skin removal. The upper lid fold is formed by thick skin.

excision blepharoplasty or sub-brow lift has become a very popular technique in Asia because it can provide a natural younger look in patients without changing the supratarsal crease of the patient. ▶**Fig. 3** demonstrates the intraoperative procedure and the 1-month results after a sub-brow lift in an Asian patient with tattooed brows. ▶**Fig. 4** shows the 2-year results after a sub-brow lift in a patient without tattooed brows.

Fig. 3 An Asian woman with a brow tattoo. (A) Preoperative photo. (B) Intraoperative photo after infrabrow skin was excised. (C) Postoperative photo 1 month after surgery.

Fig. 4 An Asian lady without a brow tattoo. (A) Preoperative photo. (B) Two-year results after sub-brow lift in a patient without brow tattoo. The scars are not visible and the upper lid creases look natural.

Orbicularis Oculi Muscle

In the Asian population, the orbicularis oculi muscle (OOM) is also a fast-twitch muscle similar to what is found in Caucasians. The OOM is divided into palpebral and orbital parts. The palpebral OOM is composed of pretarsal and preseptal parts. The palpebral part originates from the medial canthal tendon and is responsible for the involuntary blinking of the eyelid, while the orbital part functions as forceful lid closure.² The OOM is innervated by the zygomatic and recurrent buccal branches of the facial nerve. Injury of these nerves may interfere with eyelid closure and blinking mechanism, or may even change the position of the lower lid margin, creating unfavorable results such as scleral show and ectropion.

Fat Pads

In 1962, Uchida first described the four types of fat pads found in the Asian eyelid: subcutaneous, pretarsal, submuscular or preseptal, and orbital or preaponeurotic fat pads.⁸ Submuscular or preseptal fat is now known as submuscular fibroadipose tissue (SMFAT). Submuscular fibroadipose tissue is a superficial fat located between the OOM and the orbital septum. It continues superiorly as the retro-orbicularis oculi fat (ROOF) above the arcus marginalis. Superior to that, it extends underneath the frontalis muscle as the galeal fat pad. Subcutaneously, pretarsal fat and SMFAT are more prominent in Asians,^{2,3} and can cause a puffy appearance. This is thought to be one of the factors in the single eyelid morphology. Preaponeurotic fat will be described later with the orbital septum because of their close relationship.

Orbital Septum and Preaponeurotic Fat

In Caucasians, the orbital septum originates from the peri-orbita and separates into two layers distally. The posterior layer reflects and attaches with the anterior layer of the levator aponeurosis. The anterior layer extends to the lid

margin as septal extension as described by Ried et al.⁹ This septal extension lies between pretarsal and preseptal OOM and levator aponeurosis. It extends to cover the whole tarsal plate and terminates near the ciliary margin. Extensions of dermal fibers of the levator aponeurosis pierce through the septal extension and OOM to insert into the dermis of pretarsal skin, creating a strong dermal attachment as a complex in the pretarsal area. The orbital septum normally fuses to the levator aponeurosis around 3.7 mm higher than the superior tarsal border in Caucasians.² This prevents preaponeurotic fat descent and interference with upper lid crease formation during eye opening in Caucasians.

In Asians, most of these structures are similar to Caucasians. The most important difference is that the preaponeurotic fat is found to be lower than that in Caucasians. Preaponeurotic fat is commonly found as low as the upper tarsal border.^{3,10,11} Furthermore, in many of our cases, the preaponeurotic fat descends even lower and covers part of the tarsal plate. The mechanism of preaponeurotic fat descent is still unclear. Jeong et al demonstrated that the fusion point between the orbital septum and the levator aponeurosis was below the superior tarsal border in nine Korean cadavers.³ Whereas Kakizaki et al showed that the point of fusion of the orbital septum and levator aponeurosis was higher than the superior tarsal border, similar to Western eyelids, but attenuation of the inferior portion of the orbital septum in the Asian eyelid allows anterior-inferior herniation of the preaponeurotic fat pad instead.^{10,11}

Upper Eyelid Retractors

The upper eyelid retractors of both Asians and Caucasians are composed of three major structures: the levator palpebrae superioris (LPS) muscle, the levator aponeurosis, and Müller's muscle.¹² ▶**Fig. 5** demonstrates and intraoperative view of the LPS muscle, the levator aponeurosis, and adjacent structures. A diagram of the sagittal cross section across the center of the pupil of an Asian upper eyelid is shown in ▶**Fig. 6**.

The LPS muscle originates from the annulus of Zinn. Distally the LPS muscle usually divides into two branches.

Fig. 5 Intraoperative photo (surgeon's view) demonstrates the levator palpebrae superioris, levator aponeurosis, and adjacent structures. OOM, orbicularis oculi muscle.

Fig. 6 A diagram of sagittal cross section across the center of the pupil of an Asian upper eyelid.

The superior branch of LPS muscle is thicker and continues distally as the levator aponeurosis. The thinner inferior branch serves as the origin of Müller's muscle.¹³

The levator aponeurosis originates from the LPS muscle slightly distal to the Whitnall ligament. It separates into two layers. The anterior layer is a thick, robust fibrous tissue, which is distally fused to the posterior layer of the orbital septum. Part of the anterior layer pierces through the OOM and attaches to the subcuticular tissue as a levator extension. The posterior layer is a thinner fibrous tissue, which is located in front of the Müller's muscle and inserted into the anterior-inferior one-third of the tarsus.¹⁴

Müller's muscle is the smooth muscle with a tendon, which either originates from the inferior branch of the LPS muscle or orbital smooth muscle network underneath the LPS muscle or both.^{13,15} It inserts via a tendinous portion in the superior aspect of the tarsal plate.¹² Müller's muscle also has transverse extensions to the medial rectus capsulopalpebral fascia and the lateral rectus capsulopalpebral fascia. In the past, Müller's muscle was thought to be weaker and smaller in Asians, but a recent study showed a similar shape and thickness compared with Caucasians.¹⁶

Tarsus

The tarsal plate of the upper eyelid is generally narrower in Asians than in Caucasians, whereas the tarsal plate height of the lower eyelid is not significantly different between two ethnicities. Goold et al and Kakizaki microscopically measured the midportion of the upper and lower tarsal plates in Japanese cadavers compared with Caucasian cadavers. The average height at the central part of the tarsal plate of the upper eyelid was found to be 11.3 mm and 9.2 mm in Caucasian and Japanese, respectively. The average tarsal plate height of the lower lid was found to be 5.1 mm in both groups.¹⁷ Nagasao et al classified the tarsal plate of the upper eyelid of Japanese into three morphologic categories, which are sickle (55%), triangular (29%), and trapezoid types (16%).¹⁸ Understanding the tarsus in detail is very helpful in the selection of a proper plan and techniques in an Asian blepharoplasty.

Eyelid Crease and Fold

The most popular theory for lid crease formation is the levator expansion theory, which was introduced by Sayoc in 1956.¹⁹

The posterior levator aponeurosis penetrates the orbital septum and OOM and then gives rise to small fibers that insert into the dermis of the upper lid skin. During eye opening, the levator muscle will not only pull the tarsus and upper lid margin up, but also create the upper lid crease by the force transmitting through the dermal extension fibers.

Many studies have been done to explain the relationship of the upper lid structures that create the single eyelid or low eyelid crease.^{3,20,21} However, the true mechanism remains controversial due to the fact that most of the studies were done on static structures, such as cadaveric cross-sectional microscopic examination, whereas the true upper eyelid opening mechanism is dynamic. In the past, it was believed that the cause of the single eyelid was the absence of a lower seated levator extension only.²⁰ Later, Jeong et al introduced additional possible reasons from their cadaveric study, apart from the levator extension issue: the orbital septum fuses to the levator aponeurosis at variable distances below the superior tarsal border, and preaponeurotic fat pad protrusion and thick subcutaneous fat layer prevent levator fibers from extending toward the skin near the superior tarsal border.³ In 2012, Kakizaki et al found from a Japanese cadaveric study that the OOM and skin at the crease are significantly thinner,²¹ whereas the latest review by Saonanon² concludes that multiple factors are responsible for eyelid crease formation. The width and tightness of the skin–OOM–tarsus complex (formed by posterior aponeurosis) is one of the most important components (–Fig. 7). When a double eyelid opens, this complex is lifted higher as a single tight unit and the crease then forms at the thinnest area parallel to the force vector. In the single eyelid, this complex is weak or too narrow and does not extend above the eyelid crease. When the levator muscle pulls upward, the skin and OOM simply slip down along the rising tarsal plate.

Because the average eyelid crease of Asians is around 2 mm lower than Caucasians and the upper lid crease in male Asians is lower than female Asians (4–6 mm and 6–8 mm, respectively),²² surgeons should aim to create a

beautiful normal Asian look rather than create a Caucasian-type lid crease on Asian faces. Normally we prefer an on-fold type for females and infold or on-fold types for males.

Epicanthal Fold

The epicanthal fold is a semilunar flap of skin that descends along the side of the nose from the upper eyelid to the medial aspect of the lower eyelid. Its concavity is directed toward the inner canthus.²³ The epicanthal fold is one of the characteristics commonly found in the Asian eyelid; it is seldom found in other ethnicities. When the epicanthal fold presents, the soft tissue intercanthal distance is wide²⁴ the eye looks round, short, small, and not bright, leading to an unfavorable appearance. The four types of epicanthal fold according to Johnson's classification²⁵ are illustrated in –Fig. 8. The etiology of the epicanthal fold has been described by several theories such as the Z-shaped kinking of orbicularis muscle fibers, an excess of underlying orbicularis muscle and fibroadipose tissue, no or little attachment of the medial levator aponeurosis, and so on.²³ So far, there has been only one histological study on the epicanthal fold, which was done by Kakizaki.²⁶ The study included 10 postmortem eyelids of elderly subjects with epicanthus tarsalis (average age 73 years old). The study confirms that the levator aponeurosis does not extend its fibers into the medial canthal skin area. Subcutaneous tissue with rich fibroadipose tissue was situated between the skin and the OOM, and the Z-shaped kinking of hypertrophy of the orbicularis muscle was not present. The study concludes that epicanthal fold formation depended on the intermuscular fibers of the obliquely directed preseptal orbicularis muscle. Therefore, it is important to manipulate the interaction between intermuscular fibers of the OOM and the skin, while doing medial epicanthoplasty regardless of the technique being used.

Canthi

Both the medial and lateral canthal regions are small and are composed of complicated structures. Knowledge of structures in these areas is not well established, but is continually

Fig. 7 The right eye of a patient with a low crease. (A) The upper eyelid skin is stretched by pulling the eyebrow upward. The dense skin–orbicularis oculi muscle–(OOM–) tarsus complex (asterisk) is visible from eyelashes to the upper lid crease. (B) When the brow is pushed downward, the skin over the dense complex does not move, but the skin above the crease moves downward and folds over the dense complex creating upper eyelid crease and fold.

Fig. 8 The four types of epicanthal fold according to Johnson's classification.²⁵ (A) Epicanthus tarsalis. (B) Epicanthus supraciliaris. (C) Epicanthus palpebralis. (D) Epicanthus inversus.

expanded. In the past, it has been thought that the only attachments of the eyelid to the bone are medial and lateral canthal tendons. They have even been called medial and lateral canthal ligaments. Later it was found that they were not ligaments, but rather tendons of the OOM.²⁷ The medial canthal tendon was thought to be composed of two limbs— anterior and posterior attachments. Several studies in the past 5 years have reported an absence of the posterior limb, but the presence of Horner's muscle and medial rectus capsulopalpebral fascia instead.^{28,29} Lately, Kang et al³⁰ reviewed the literature and named all the supportive structures in the medial canthal area as “medial retinaculum,” composed of medial canthal tendons, Horner's muscle, medial rectus capsulopalpebral fascia including the medial check ligament, medial horn of the levator aponeurosis, the medial horn supporting ligament, the medial horn of the lower eyelid retractors, the preseptal OOM, and three variations of Lockwood's ligament. For lateral tarsal fixation, Kakizaki found that the “lateral retinaculum” is formed by not only the lateral canthal tendon, but also by the lateral rectus capsulopalpebral fascia and muscle of Riolan.³¹

Conclusion

There are some distinct differences between the anatomy of the Asian eyelid and periorbital structures that impact the phenotypic appearance, function, as well as the development of correct approaches to the Asian eyes. These changes have, within the past 10 to 15 years, changed some of the ways we approach double eyelid surgery, as well as brow aesthetics and the lower eyelid. We have highlighted some of these newer developments for consideration.

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