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Iatrogenic Keratoconus Secondary to Long-term Excessive Bleb Massage Following Bilateral Glaucoma Drainage Device Implantation: A Case Report

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Case Report

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Abstract

Background: Keratoconus (KC) is a bilateral corneal ectatic disorder characterized by progressive corneal thinning and protrusion, with chronic eye rubbing being its most important non-genetic risk factor. Iatrogenic KC caused by bleb massage is rare. We report a case of bilateral iatrogenic KC in a patient with bilateral primary open-angle glaucoma (POAG) following bilateral Ex-PRESS glaucoma drainage device implantation, secondary to long-term excessive bleb massage (more than 5 times per day for approximately 7 years), in order to raise clinicians' awareness of this rare complication.

Case presentation: A 41-year-old woman with bilateral POAG underwent bilateral Ex-PRESS glaucoma drainage device implantation at our hospital in 2017. Postoperative intraocular pressure (IOP) was approximately 10 mmHg, and regular bleb massage was advised. After 2019, the patient did not return for scheduled follow-up visits and performed self-administered massage approximately 5 times daily with considerable force. In January 2024, astigmatism of -10.00 DC developed in the left eye. In November 2024, visual acuity declined markedly in both eyes (0.1 in the right eye and 0.02 in the left eye). Corneal topography and anterior segment OCT revealed typical KC changes in both eyes, with a Kmax of 71.3 D in the left eye, accompanied by corneal scarring and central epithelial erosion. The patient was diagnosed with bilateral iatrogenic KC. After massage was discontinued, IOP remained stable at 10 mmHg. The patient is currently awaiting corneal transplantation, with the left eye prioritized.

Conclusions: Non-standard or excessive bleb massage may induce iatrogenic KC through long-term repetitive mechanical stress and transient IOP elevation. Standardized postoperative patient education, regular corneal topography monitoring, and vigilance for unexplained progressive myopia or worsening astigmatism are essential to prevent this serious complication.

1 Background

Keratoconus (KC) is a bilateral, non-inflammatory corneal ectatic disorder characterized by progressive thinning and protrusion of the central or paracentral cornea, with a global prevalence of approximately 0.05%–0.23% [1], and it most commonly has its onset during adolescence. Its pathogenesis involves the combined effects of genetic and environmental factors: genetic factors include mutations in genes such as VSX1 and SOD1 as well as a tendency toward familial clustering [1, 2]; among environmental factors, eye rubbing is the most important non-genetic risk factor [3].

The association between eye rubbing and KC has been clearly established by evidence-based medicine. A meta-analysis by Sahebjada et al. [4] (8 case-control studies) showed that eye rubbing significantly increased the risk of KC (OR = 6.46, 95% CI 4.12–10.1). Liu Xiaoyu et al. [5] found that the proportion of eye rubbing in the KC group (67.98%) was significantly higher than that in the control group (24.87%), and that the more severe the disease, the higher the rate of eye rubbing; Guo Xinghan et al. [6] and Ye et al. [7] reported eye rubbing rates of 61.4% and 91.3% among 202 and 391 Chinese patients with KC, respectively.

The mechanisms by which eye rubbing induces KC involve multiple pathways. In a non-human primate model, Turner et al. [8] quantitatively measured transient intraocular pressure (IOP) elevations induced by eye rubbing, with a mean of 109 mmHg and a peak of 310 mmHg, which induces corneal ectasia through a vicious cycle of "corneal deformation–IOP elevation–stromal collagen remodeling" [3, 9]. Meanwhile, eye rubbing can cause microdamage to the corneal epithelium and induce elevated levels of tear matrix metalloproteinases (MMP-1, MMP-13) and inflammatory cytokines (IL-6, TNF-α) [10, 11], thereby accelerating stromal degradation [12, 13].

Iatrogenic KC is rare and is mostly observed in the context of long-term contact lens wear, refractive surgery, or ocular mechanical trauma [1, 2, 14]. KC caused by massage after filtering surgery has been reported only sporadically: Lin Tao et al. [15] reported one case of KC following compound trabeculectomy due to high-intensity massage (approximately once per hour), and Fakhraie et al. [16] reported a similar case. However, bilateral iatrogenic KC following long-term massage after bilateral Ex-PRESS implantation has not been reported previously, either domestically or internationally.

This article reports the diagnosis and treatment course of a 41-year-old female patient with POAG who developed bilateral iatrogenic KC after bilateral Ex-PRESS implantation secondary to long-term excessive bleb massage (> 5 times per day for approximately 7 years). aiming to improve awareness of this rare iatrogenic complication.

2 Case presentation

2.1 Basic information and initial presentation

A 41-year-old woman presented on August 7, 2017 with a 5-year history of blurred vision in both eyes and occasional ocular distension. She denied any family history of KC, allergic rhinitis, asthma, atopic dermatitis, ocular trauma, long-term eye rubbing habits, or contact lens wear. Her general medical history was unremarkable.

Findings at initial examination:

Initial visual acuity: 0.3 in the right eye (-0.75 DS/-0.50 DC × 120°, corrected to 0.5) and 0.6 in the left eye (-0.75 DS/-0.75 DC × 160°, no improvement with correction); IOP was 57 mmHg in the right eye and 58 mmHg in the left eye (Goldmann). Slit-lamp examination: mild corneal edema in both eyes, adequate anterior chamber depth, no iris atrophy, round pupils (approximately 3.5 mm in diameter) with sluggish light reflex, and increased lens density. Fundus examination: pale optic discs with a cup-to-disc ratio of approximately 0.8. Tubular visual fields were present in both eyes, and the anterior chamber angles were open circumferentially (Shaffer grade IV). RNFL OCT showed marked thinning in all quadrants of both eyes, which was more severe in the left eye. Diagnoses: bilateral POAG, bilateral refractive error, and bilateral optic nerve atrophy.

2.2 Surgical treatment

Because the IOP was extremely high (> 55 mmHg) and optic nerve atrophy was severe, and the target IOP could not be achieved with medication, surgery was decided upon. On August 9, 2017, implantation of a glaucoma micro-drainage device (Ex-PRESS glaucoma drainage device, model P50) was performed in the right eye, with a postoperative IOP of 14 mmHg; on September 2, 2017, the same procedure was performed in the left eye, with a postoperative IOP of 10 mmHg.

2.3 Postoperative follow-up and massage management

Postoperatively, the patient was instructed to apply pressure to the filtering bleb through the lower eyelid while gazing upward, with the force titrated to "slight softening of the eyeball," and a recommended frequency of 1–2 times per day for approximately 10 seconds each time [17, 18].

During the first 2 years after surgery (August 2017 to August 2019), the patient attended regular follow-up visits, and IOP remained stable in both eyes (10–11 mmHg in the right eye and 7–12 mmHg in the left eye), with good bleb morphology. After 2019, she did not return for scheduled follow-up visits because of the COVID-19 pandemic, but she continued to perform self-administered massage approximately 5 times daily (far exceeding the recommended frequency) with considerable force, reporting that she "could feel the eyeball becoming softer." This excessive massage persisted for approximately 5 years, during which she received no professional medical guidance.

2.4 Disease progression and diagnosis

Follow-up in January 2024:

At the follow-up visit in January 2024, visual acuity was 0.4 in the right eye (-0.00/-4.50 × 140°) and 0.12 in the left eye (+ 0.25/-10.00 × 30°); IOP was 11 mmHg in the right eye and 10 mmHg in the left eye. Slit-lamp examination: the filtering blebs in the superior region of both eyes were diffuse and elevated, the corneas were clear, and the drainage tubes were in place and patent without leakage. At this point, -10.00 DC astigmatism had already developed in the left eye, but it did not receive sufficient attention, and corneal topography was not performed.

Follow-up in November 2024 (diagnosis established):

The patient reported a marked decline in visual acuity in both eyes. Visual acuity was 0.1 in the right eye (+ 1.50/-5.50 × 145°) and 0.02 in the left eye (no improvement with refraction); IOP was 6 mmHg in the right eye and 11 mmHg in the left eye. The right cornea was clear; in the left eye, corneal scarring was visible, with "hurricane-like" punctate epithelial erosion in the central region (Fig. 1). Corneal topography (PentaCam) showed a Kmax of 50.5 D and a maximum anterior surface elevation of + 51 μm in the right eye, and a Kmax of 71.3 D and + 77 μm in the left eye (Fig. 2). Anterior segment OCT (PachyMetryWide) showed a thinnest corneal thickness of 474 μm in the right eye, and 454 μm in the left eye with focal thinning and altered stromal density in the inferotemporal region (Fig. 3).

Considering the patient's history of long-term excessive bleb massage (> 5 times daily for approximately 5 years), the typical corneal signs, and the characteristic changes on corneal topography and anterior

segment OCT, she was diagnosed with bilateral iatrogenic keratoconus. She was immediately instructed to discontinue massage, and IOP monitoring and close follow-up were continued.

2.5 Follow-up (December 2024)

At the follow-up visit in December 2024, visual acuity was 0.15 in the right eye (+ 0.50/-7.25 × 145°) and 0.02 in the left eye (no improvement with refraction); IOP was 10 mmHg in both eyes. The right cornea was clear; in the left eye, corneal scarring and epithelial erosion persisted, and the drainage tube was in place and patent (Fig. 4). After discontinuation of massage, IOP remained stable, suggesting intact function of the drainage device. The patient is under close follow-up and awaiting a corneal donor for corneal transplantation, with the left eye prioritized.

3 Discussion

3.1 Etiology of keratoconus and the particularity of this case

This patient had no family history of KC, no history of allergy, no eye rubbing habit, and no history of contact lens use; her preoperative corneal morphology was normal, and KC developed approximately 7 years after glaucoma drainage device implantation and was directly associated with long-term excessive massage. This represents a typical iatrogenic injury with important clinical warning significance.

The particularity of this case lies in the following aspects: (1) bilateral involvement—Ex-PRESS implantation was performed sequentially in both eyes, and both eyes received excessive massage in the same manner, suggesting a key role of mechanical stress in the development of KC; (2) a clear predisposing factor—the development of KC showed a direct temporal, regional, and intensity-related association with massage, consistent with the diagnostic criteria for iatrogenic KC; (3) a long latency period—approximately 5 years elapsed from excessive massage to diagnosis, consistent with a "long-term cumulative pathogenesis" pattern [3, 4, 9]; (4) rarity of reporting—bilateral KC following long-term massage after bilateral Ex-PRESS implantation has not been previously reported in China or internationally [15, 16].

3.2 Mechanisms of corneal injury induced by bleb massage

Bleb massage is a routine adjunctive measure for maintaining a functional filtering bleb and ensuring long-term IOP-lowering efficacy [17, 18]. Guidelines recommend gentle massage through the lower eyelid, approximately 10 seconds each time, 1–2 times per day [17, 19]. However, excessive or non-standard massage may become a trigger for corneal injury.

The present patient had the following high-risk factors: (1) excessively high massage frequency—the patient performed massage more than 5 times daily, far exceeding the recommended 1–2 times per day,

resulting in cumulative long-term repetitive mechanical stress; (2) excessive massage force—the patient reported that she "could feel the eyeball becoming softer," suggesting that the pressure applied to the cornea and filtering bleb may have exceeded the safe range; (3) corneal biomechanical vulnerability—long-term elevated IOP or long-term use of anti-glaucoma medications in patients with glaucoma may have already impaired corneal endothelial function and stromal biomechanical properties [20]; in addition, after Ex-PRESS glaucoma drainage device implantation, the local tissue structure in the filtering bleb region is relatively weak, reducing its resistance to mechanical stress.

From a pathophysiological perspective, excessive bleb massage may induce KC through the following multiple mechanisms:

(1) Direct mechanical stress injury: Turner et al. [8] found that eye rubbing can cause transient IOP elevations of up to 109–310 mmHg; McMonnies [3] pointed out that repetitive mechanical stress can lead to fatigue and disorganization of corneal collagen fibers and microtears of Descemet's membrane; and Luce [9] confirmed that repetitive stress can reduce corneal hysteresis (CH) and the corneal resistance factor (CRF).

(2) Indirect injury from IOP fluctuation: each massage episode induces a transient IOP elevation [8], and long-term fluctuation accelerates stromal collagen degradation and remodeling. Pahuja et al. [12] found differential expression of extracellular matrix remodeling genes (LOX, MMP-9) and inflammatory genes at the cone apex in KC, suggesting a vicious cycle among mechanical stress, IOP fluctuation, and stromal remodeling.

(3) Inflammatory cytokine-mediated injury: Balasubramanian et al. [10] found that tear levels of MMP-13, IL-6, and TNF-α were significantly elevated 60 seconds after eye rubbing; Ionescu et al. [11] further confirmed that multiple inflammatory cytokines in the tears of patients with KC (IL-1, IL-4, IL-6, IL-10, IL-17, TNF-α, and IFN-γ) are overexpressed, which can promote stromal collagen degradation and apoptosis. Luo Qiting et al. [21] also pointed out that the mechanical stimulation–inflammatory activation–stromal remodeling cascade is an important mechanism in VKC complicated by KC.

It is worth noting that the severity of disease differed markedly between the two eyes in this case (Kmax 71.3 D in the left eye vs. 50.5 D in the right eye, with scarring and epithelial erosion already present in the left eye); the reasons for this are detailed in Section 3.6.

3.3 Comparison with previous literature

KC secondary to massage after filtering surgery has rarely been reported. Lin Tao et al. [15] reported a 28-year-old woman who underwent compound trabeculectomy and performed massage as often as once per hour, developing KC in the right eye approximately 2.5 years after surgery, with no progression during 9 months after the massage frequency was reduced; Fakhraie et al. [16] also reported a similar case. The present case is characterized by: (1) Ex-PRESS implantation rather than conventional trabeculectomy; (2) involvement of both eyes; (3) a longer latency period (approximately 5–7 years); (4) a relatively lower massage frequency but a longer duration; (5) more severe disease, with the left eye

having reached the indication for corneal transplantation. This suggests that regardless of the surgical procedure, long-term excessive massage can induce KC.

KC caused by other mechanical factors has also been reported. Chen Tingting et al. [22] reported a case of thyroid-associated ophthalmopathy complicated by bilateral KC, suggesting the involvement of immune inflammation and the regulatory effects of thyroid hormones (T3, T4) on stromal collagen metabolism in the pathogenesis; Luo Qiting et al. [21] reviewed and pointed out that chronic ocular surface allergy–eye rubbing–mechanical injury–corneal ectasia is a key pathway in VKC-related KC. The above evidence provides indirect support for the present case.

3.4 Importance of postoperative follow-up and patient education

Bleb massage is an important means of improving the long-term success rate of filtering surgery; however, because of considerable interpatient variability, there are still no unified standards for massage frequency, force, or location, and insufficient doctor–patient communication is the main reason for excessive massage [15, 19, 23]. Drawing on this case, the following lessons and experiences are summarized:

1. Standardizing postoperative patient education: postoperatively, patients should be informed in detail of the correct massage technique (frequency, force, and location), with emphasis on the harms of excessive massage (such as corneal injury and filtering bleb leakage). Patients should be asked to demonstrate the technique in person so that their mastery can be verified, and illustrated instruction manuals should be provided. A study by Zhao Han et al. [19] showed that a professional massage strategy implemented by dedicated medical and nursing staff significantly increased the rate of functional filtering bleb formation (94.24% vs. 80.00%) and reduced the incidence of adverse reactions (7.68% vs. 24.00%) compared with self-administered massage by patients. A dedicated massage device developed by Lee et al. [23]can emit an auditory signal when the applied force reaches the target level, enabling individualized and quantifiable massage management, and merits attention.

- (2) Strengthening corneal monitoring during long-term follow-up: in patients with glaucoma undergoing long-term follow-up, in addition to monitoring IOP, visual acuity, and visual fields, the corneal status should be evaluated regularly, especially in the region adjacent to the filtering bleb. For patients with poor adherence to massage or improper force, routine corneal topography and corneal biomechanical examinations (Corvis ST, ORA) are recommended starting from 1 year after surgery to facilitate early detection of abnormalities. This case also underscores that a comprehensive long-term postoperative follow-up management system should be established.
- (3)Increasing vigilance for iatrogenic complications: when postoperative patients present with unexplained visual decline or progressive worsening of myopia or astigmatism, examinations such as corneal topography and anterior segment OCT should be performed promptly to rule out iatrogenic corneal injury, and patients should be asked in detail about their massage habits

(frequency, force, location, and duration) so that high-risk patients can be identified in a timely manner.

- (4) Balancing the IOP target with massage intensity: the goal of glaucoma drainage device surgery is to maintain a functional filtering bleb and a stable target IOP level [17, 18]; however, excessively pursuing IOP reduction while neglecting the safety of massage may lead to serious complications. The target IOP should be individualized, and filtering bleb function and corneal health should be weighed against each other during follow-up. The massage intensity required after Ex-PRESS implantation is usually lower than that after conventional trabeculectomy [18], and educational content should be adjusted accordingly.

3.5 Limitations and prospects

- This case has the following limitations: (1) it is a single case report with a limited level of evidence; (2) preoperative corneal topography and corneal biomechanical baseline data were lacking, making it impossible to accurately assess the longitudinal changes in the cornea; and (3) genetic testing was not performed to exclude genetic susceptibility, and handedness and sleeping position preferences were not systematically evaluated. In the future, more cases and prospective studies are needed to clarify the dose–response relationship between bleb massage and KC, and to explore the value of corneal biomechanical monitoring in the early detection of this complication.

3.6 Analysis of the causes of intereye asymmetry in disease severity

- In this case, KC was significantly more severe in the left eye than in the right eye (Kmax 71.3 D vs. 50.5 D; thinnest corneal thickness 454 μm vs. 474 μm; scarring and "hurricane-like" epithelial erosion had already developed in the left eye). KC is essentially a bilateral but asymmetric disease. Dienes et al. [24]confirmed that intereye asymmetry increases exponentially with disease progression (correlation between posterior surface elevation asymmetry and disease severity: $r = 0.80$, $P < 0.001$); in a 2024 review in Nature Reviews Disease Primers, Singh et al. [25] also pointed out that the intereye asymmetry of KC results from the combined effects of multiple factors. Based on this case and the literature, the reasons why the left eye was more severely affected are analyzed below.

1. Asymmetry in handedness and massage force: Jafri et al. [26] were the first to systematically report, in 2004, the relationship between asymmetric KC and eye rubbing habits, finding that patients often rub the contralateral eye with their dominant hand, causing the contralateral eye to bear greater mechanical stress; McMonnies et al. [3] also pointed out that handedness determines which eye is rubbed more frequently and with greater force. In this case, the patient was right-handed (accounting for approximately 90% of the population), and when she massaged the filtering bleb of the left eye with her right hand, the left eye may have borne greater mechanical stress, which partially explains the more severe ectasia in the left eye.

- (2) Sleeping position preference and nocturnal mechanical compression: a cross-sectional study by Corrêa et al. [27] (50 patients with KC) showed that the corneal parameters of the "dependent eye" positioned inferiorly during sleep were significantly worse (steepest K 47.89 vs. 45.78 D, P = 0.0047; thinnest thickness 445.84 vs. 460.34 μm, P = 0.0057), whereas no differences were found between the two eyes in normal controls, suggesting that continuous mechanical compression of the inferiorly positioned eye during sleep may be a modifiable risk factor for asymmetric KC progression. Singh et al. [25]also pointed out that floppy eyelid syndrome (FES) is associated with KC, and the affected eye is consistent with the preferred sleeping side. Although sleeping position was not evaluated in this case, if the patient habitually slept in the left lateral decubitus position, the left eye, as the "dependent eye," would be subjected to prolonged compression, which, superimposed on excessive daytime massage, may have led to greater cumulative injury.
- (3) Greater baseline disease severity and corneal biomechanical "vulnerability" of the left eye: at the initial visit in this case, RNFL thinning and optic nerve atrophy were both more severe in the left eye than in the right eye, suggesting more severe glaucomatous damage in the left eye. Long-term elevated IOP can cause a reduction in and impaired function of corneal endothelial cells [20], affecting stromal hydration and biomechanical stability, and rendering the baseline corneal mechanical strength of the left eye lower than that of the right eye. Roberts et al. [28]pointed out that corneal ectasia is essentially a positive feedback loop driven by biomechanical weakening—once local mechanical strength decreases, deformation becomes more likely, and deformation further exacerbates mechanical weakening; therefore, the left eye was more prone to entering and amplifying this vicious cycle.
- (4) Surgical sequence and differences in filtering bleb function: in this case, the right eye was operated on first on August 9, 2017, and the left eye underwent the same procedure on September 2, 2017 (an interval of 24 days). Postoperatively, the left eye had a lower IOP (10 vs. 14 mmHg) and a wider range of fluctuation during follow-up (7–12 vs. 10–11 mmHg), suggesting that the left eye had a more patent filtration pathway or a more diffuse filtering bleb, and that each massage episode may have produced a greater transient IOP impact; moreover, large IOP fluctuations are themselves a risk factor for corneal stromal collagen degradation [12].
- (5) Natural intereye asymmetry in corneal biomechanics: even between eyes that appear normal, there is a certain natural difference in corneal biomechanical parameters (CH, CRF) [9, 25]. Dienes et al. [24] found that intereye asymmetry in the thinnest corneal thickness was the best parameter for characterizing intereye asymmetry in patients with KC (AUROC = 0.99, sensitivity 98%, specificity 95%), and proposed a warning threshold of > 12 μm. In this case, the difference in thinnest corneal thickness between the two eyes was 20 μm, far exceeding this threshold, suggesting that the left eye may have had an unfavorable deviation in corneal thickness from an early stage, which was then amplified under long-term mechanical stress.
- (6) "Second-eye effect" and psychological/behavioral factors: as the second eye to undergo surgery, the left eye may have received more attention and caused more anxiety for the patient, leading her to unconsciously increase the frequency or force of massage on the left eye. In addition, because

the patient already had experience with the first eye's surgery when the second eye was operated on, she may have developed overconfidence in the "feel" of massage, causing the actual massage force applied to the left eye to exceed the recommended range. Although no psychological assessment was performed in this case, this behavioral factor deserves attention in clinical practice.

- In summary, the greater disease severity in the left eye may have resulted from the combined effects of multiple factors: asymmetry in massage force due to handedness, possible compression related to sleeping position preference, corneal biomechanical "vulnerability" resulting from more severe baseline glaucomatous damage in the left eye, greater IOP fluctuation due to differences in filtering bleb function, and amplification of the natural intereye asymmetry in corneal parameters. Clinically, attention should be paid to assessing the symmetry of massage between the two eyes, inquiring about sleeping position preferences, and strengthening corneal morphological monitoring for the eye with greater baseline disease severity. The lack of systematic evaluation of handedness and sleeping position preferences in this case is one of the limitations of this retrospective analysis; in similar cases in the future, such information should be routinely collected to refine the etiological analysis.

4 Conclusions

- Although bleb massage after anti-glaucoma drainage device surgery is a routine therapeutic measure, non-standard or excessive manipulation can induce iatrogenic keratoconus through long-term repetitive mechanical stress and transient IOP elevation. Ophthalmologists should standardize postoperative patient education by clearly specifying the frequency, force, and location of massage; strengthen corneal morphological and biomechanical monitoring during long-term follow-up, with particular attention to unexplained progressive myopia or worsening astigmatism; promptly intervene in patients with poor adherence to massage or pre-existing corneal morphological abnormalities, including adjusting the massage regimen, intensifying follow-up, and considering prophylactic corneal cross-linking [29]when necessary. Through these measures, it is hoped that this rare but serious iatrogenic complication can be avoided.

Declarations

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“Not applicable” in this section.

Author contributions

Xiao Yang and Guangfu Dang were major contributor in writing the manuscript. Yang Yang and Tong Wang prepared figures and refrences, Yuanzhi Chen and Guangfu Dang revised the case report. All authors read and approved the final manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Ethical approval

This study was performed in compliance with the principles of the Declaration of Helsinki and was approved by the Institutional Ethics Committee of Jinan Mingshui Eye Hospital (Protocol number:2022016). Informed consent form was obtained the patient included in the study.

Consent for publication

we confirm that the patient has signed a written informed consent form, agreeing to the public release of the personal or clinical information and any identifiable images in this study.

Competing interests

The authors declare no competing interests.

References

1. Rabinowitz YS, Keratoconus. Surv Ophthalmol. 1998;42(4):297–319. 10.1016/S0039-6257(97)00119-7.
2. Romero-Jiménez M, Santodomingo-Rubido J, Wolffsohn JS. Keratoconus: a review. Cont Lens Anterior Eye. 2010;33(4):157–66. 10.1016/j.clae.2010.04.006.
3. McMonnies CW. Mechanisms of rubbing-related corneal trauma in keratoconus. Cornea. 2009;28(6):607–15. 10.1097/ICO.0b013e318198384f.
4. Sahebjada S, Al-Mahrouqi HH, Moshegov S, et al. Eye rubbing in the aetiology of keratoconus: a systematic review and meta-analysis. Graefes Arch Clin Exp Ophthalmol. 2021;259(8):2057–67. 10.1007/s00417-021-05081-8.
5. Liu XY, Guo XH, Liu XX, et al. Correlation analysis between eye rubbing, sleeping position and keratoconus. Recent Adv Ophthalmol. 2024;44(11):868–71. 10.13389/j.cnki.rao.2024.0164.
6. Guo XH, Lin X, Sun Y et al. Correlation analysis of keratoconus and eye rubbing. J Clin Ophthalmol. 2024;32(3):193-7. Chinese. 10.3969/j.issn.1006-8422.2024.03.001
7. Ye Y, Chen A, Zhang F, et al. Mediating roles of corneal biomechanical and topographic parameters in eye rubbing and keratoconus based on the Chinese keratoconus cohort study. Front Bioeng Biotechnol. 2025;13:1595671. 10.3389/fbioe.2025.1595671.
8. Turner DC, Girkin CA, Downs JC. The magnitude of IOP elevation associated with eye rubbing. Ophthalmology. 2019;126(1):171–2. 10.1016/j.ophtha.2018.08.025.

9. Luce DA. Determining in vivo biomechanical properties of the cornea with an ocular response analyzer. J Cataract Refract Surg. 2005;31(1):156–62. 10.1016/j.jcrs.2004.10.044.
10. Balasubramanian SA, Pye DC, Willcox MD. Effects of eye rubbing on the levels of protease, protease activity and cytokines in tears: relevance in keratoconus. Clin Exp Optom. 2013;96(2):214–8. 10.1111/cxo.12038.
11. Ionescu IC, Corbu CG, Tanase C, et al. Overexpression of tear inflammatory cytokines as additional finding in keratoconus patients and their first degree family members. Mediators Inflamm. 2018;2018:4285268. 10.1155/2018/4285268.
12. Pahuja N, Kumar NR, Shroff R, et al. Differential molecular expression of extracellular matrix and inflammatory genes at the corneal cone apex drives focal weakening in keratoconus. Invest Ophthalmol Vis Sci. 2016;57(14):6172–80. 10.1167/iovs.16-19897.
13. Ben-Eli H, Erdinest N, Solomon A. Pathogenesis and complications of chronic eye rubbing in ocular allergy. Curr Opin Allergy Clin Immunol. 2019;19(5):526–34. 10.1097/ACI.0000000000000571.
14. Sugar J, Macsai MS. What causes keratoconus? Cornea. 2012;31(6):716–9. 10.1097/ICO.0b013e31823f8d9d.
15. Lin T, Guo Q, Zhang H et al. Keratoconus secondary to eyeball massage after trabeculectomy: a case report. Ophthalmology. 2023;32(1):64 – 5. Chinese. 10.13281/j.cnki.issn.1004-4469.2023.01.012
16. Fakhraie G, Vahedian Z. Post filtering surgery globe massage-induced keratoconus. J Ophthalmol. 2016;2016:3915403. 10.1155/2016/3915403.
17. Khaw PT, Chiang M, Shah P, et al. Enhanced trabeculectomy: the Moorfields Safer Surgery System. Dev Ophthalmol. 2012;50:1–28. 10.1159/000334776.
18. Nguyen DQ, Niyadurupola N, Tapp RJ, et al. Effect of digital ocular massage on intraocular pressure after bleb forming surgery. Clin Exp Ophthalmol. 2012;40(5):473–9. 10.1111/j.1442-9071.2011.02699.x.
19. Zhao H, Gao F, Liu HF. Exploration of the improvement effects of different eyeball massage strategies on intraocular pressure control and functional filtering bleb formation in patients after glaucoma filtration surgery based on intraocular pressure control level. Pract Prev Blindness Technol. 2025;20(1):43–7. 10.3969/j.issn.1673-3835.2025.01.013.
20. Park HM, Choi J, Lee WJ, et al. Rate of central corneal thickness changes in primary angle closure eyes: long-term follow-up results. BMC Ophthalmol. 2021;21(1):145. 10.1186/s12886-021-01908-4.
21. Luo QT, Zhang CR. Research progress on the mechanisms of keratoconus in vernal keratoconjunctivitis. Int Eye Sci. 2024;24(7):1084-7. Chinese. 10.3980/j.issn.1672-5123.2024.7.14
22. Chen TT, Chen YX, Fu CR et al. Thyroid-associated ophthalmopathy complicated by bilateral keratoconus: a case report. Ophthalmology. 2024;33(2):104-6. Chinese. 10.13281/j.cnki.issn.1004-4469.2024.02.015
23. Lee GA, Sit AJ. A novel post-trabeculectomy massage device. J Glaucoma. 2012;21(7):461–5. 10.1097/IJG.0b013e31821040d2.

24. Dienes L, Kránitz K, Juhász É, et al. Evaluation of intereye corneal asymmetry in patients with keratoconus. A Scheimpflug imaging study. PLoS ONE. 2014;9(10):e108882. 10.1371/journal.pone.0108882.
25. Singh RB, Koh S, Sharma N, et al. Keratoconus Nat Rev Dis Primers. 2024;10(1):81. 10.1038/s41572-024-00565-3.
26. Jafri B, Lichter H, Stulting RD. Asymmetric keratoconus attributed to eye rubbing. Cornea. 2004;23(6):560–4. 10.1097/01.ico.0000121711.58571.8d.
27. Corrêa DC, Dantas DO, Amaral DC, et al. Evaluation of the preferred sleeping position as a risk factor for keratoconus asymmetry. Optom Vis Sci. 2024;101(8):462–9. 10.1097/OPX.0000000000002261.
28. Roberts CJ, Dupps WJ Jr. Biomechanics of corneal ectasia and biomechanically targeted treatments. Curr Opin Ophthalmol. 2012;23(4):316–22. 10.1097/ICU.0b013e328355a0a4.
29. Wang XQ, Zhi HM, Hao HY. Experience in the treatment of secondary keratoconus after anti-glaucoma surgery. Gansu Med J. 2013;32(10):778–9. Chinese.

Figures

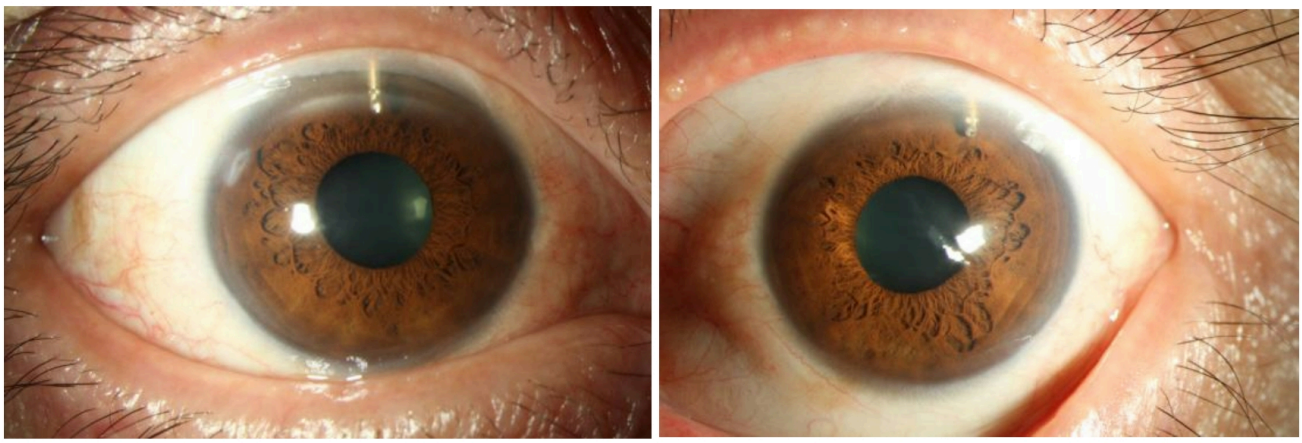


Figure 1

Both eyes: the Ex-PRESS drainage tube was in place with a patent tube opening. Right eye: the cornea was generally clear (A). Left eye: patchy grayish-white corneal scarring and "hurricane-like" punctate epithelial erosion were visible in the central cornea, indicating advanced changes of corneal ectasia(B).

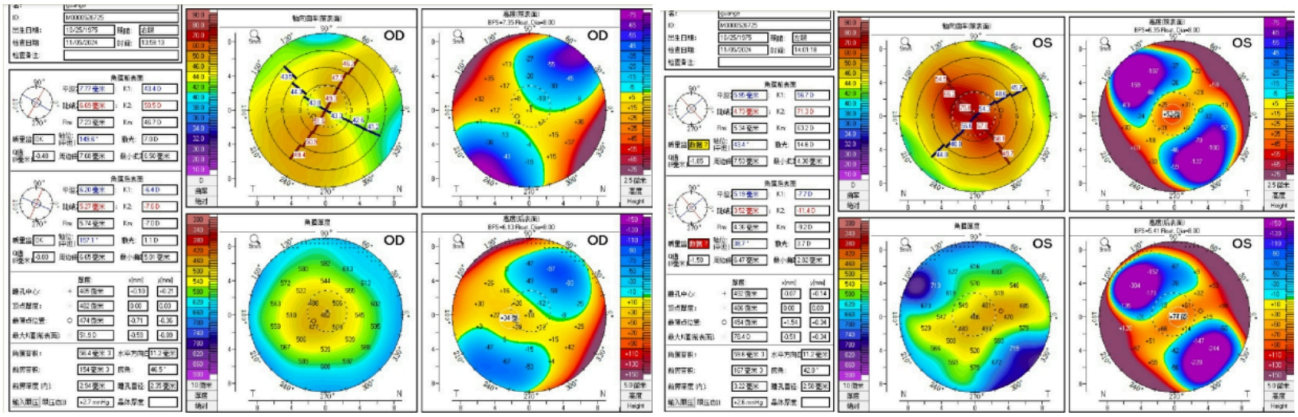


Figure 2

Corneal topography of both eyes (PentaCam four-map refractive display). Right eye: the axial curvature map showed irregular astigmatism and mild steepening (K1 = 43.4 D, K2 = 50.5 D, Kmax = 50.5 D), with a maximum anterior surface elevation of +51 μm and a thinnest corneal thickness of 474 μm, consistent with early KC changes(A). Left eye: the axial curvature map showed marked steepening and a typical cone configuration (K1 = 56.7 D, K2 = 71.3 D, Kmax = 71.3 D), with a maximum anterior surface elevation of +77 μm and a thinnest corneal thickness of 454 μm, meeting the diagnostic criteria for advanced KC(B).

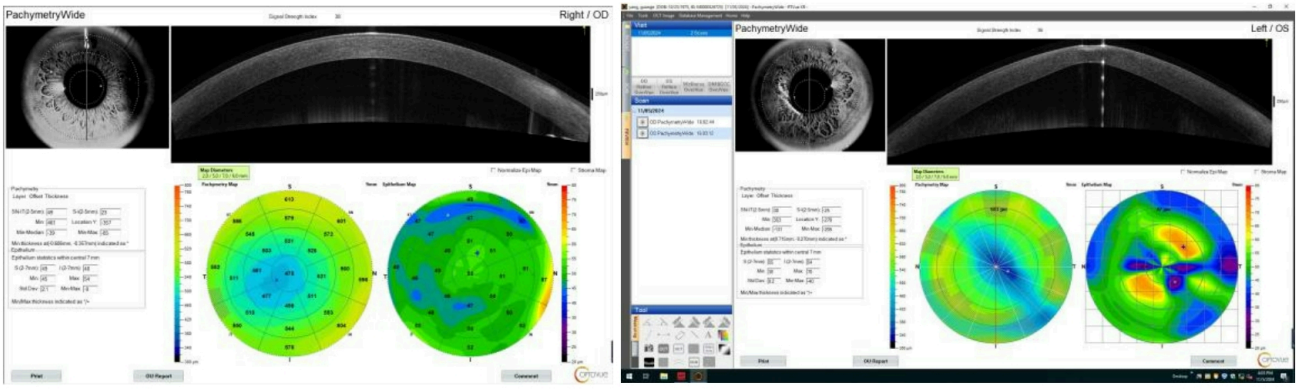


Figure 3

Anterior segment OCT (PachyMetryWide) of both eyes. (A) Right eye: corneal thickness map and cross-sectional image showing a relatively uniform corneal thickness distribution, with the thinnest point at approximately 474 μm and no obvious focal thinning. (B) Left eye: the corneal thickness map showed

focal thinning in the inferotemporal region (thinnest point approximately 454 μm), and the cross-sectional image revealed focal corneal thinning and altered stromal density, suggesting disorganization of stromal collagen arrangement.

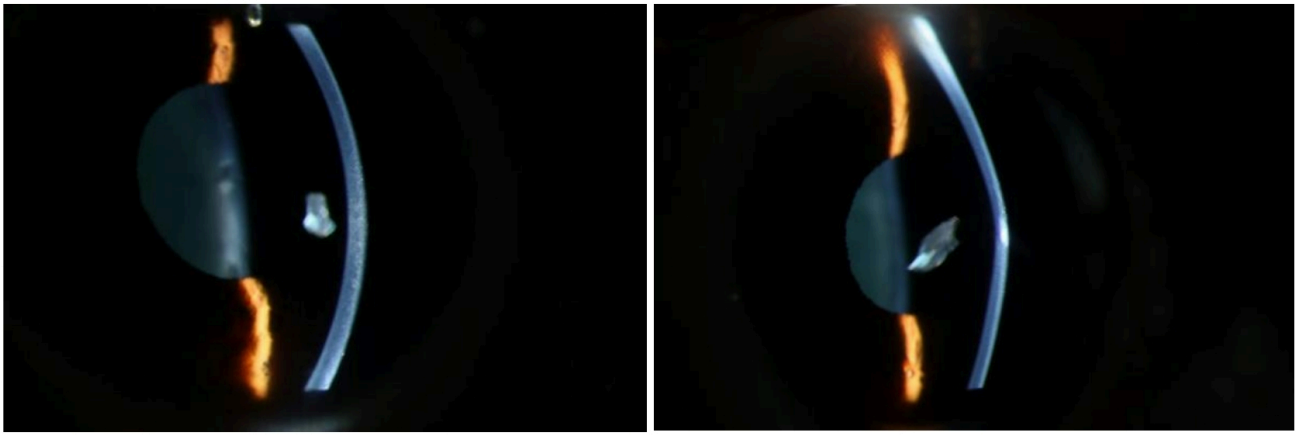


Figure 4

Slit-lamp slit-beam images of both eyes at follow-up after discontinuation of massage (December 2024). The right cornea was clear (A), whereas in the left eye, "hurricane-like" punctate epithelial erosion and superficial scar formation were visible in the central cornea, which are typical signs of advanced keratoconus (B). At 1 month of follow-up after discontinuation of massage, IOP remained stable at 10 mmHg in both eyes, but corneal ectasia as well as left corneal scarring and epithelial erosion showed no obvious improvement. The patient is currently awaiting a corneal donor for corneal transplantation, with the left eye prioritized.