Microbial Keratitis–Related Corneal Scar in a Keratoconic Eye: Aberrations, Refraction, and Visual Rehabilitation

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ABSTRACT

To report a case of keratoconus complicated by post-infectious corneal scarring and to discuss visual rehabilitation guided by refraction and higher-order aberrations (HOAs). A 33-year-old male with bilateral keratoconus, previously treated with corneal collagen cross-linking (CXL), developed microbial keratitis in the right eye resulting in anterior stromal scarring. Spectacle correction improved best-corrected visual acuity (BCVA) to 6/12; however, rigid gas-permeable (RGP) contact lens fitting restored vision to near 6/6. Pentacam imaging revealed vertical coma and trefoil, in the affected eye. (Mannis et al., 2016; Mountford et al., 2018). The patient was managed with culture-guided topical antibiotics followed by corticosteroid therapy for scar modulation and ocular surface optimization. Visual rehabilitation included RGP contact lens fitting. Surgical options such as phototherapeutic keratectomy (PTK) or deep anterior lamellar keratoplasty (DALK) were reserved for future consideration if optical rehabilitation failed (Zarei-Ghanavati et al., 2017; Anwar et al., 2018). Spectacle correction alone may underestimate visual impairment in keratoconic eyes with post-infectious scarring. Corneal aberrometry and tomography are essential for assessing residual optical quality and guiding visual rehabilitation options or surgical intervention (Dart et al., 2020; Pflugfelder et al., 2017).

Keywords: Keratoconus; microbial keratitis; corneal scar; higher-order aberrations; rigid gas-permeable contact lens; PTK; DALK

INTRODUCTION

Keratoconus is a progressive, non-inflammatory ectatic corneal disorder characterized by asymmetric corneal thinning, steepening, irregular astigmatism, and increased higher-order aberrations (HOAs), most notably vertical coma[1,2]. Visual impairment in keratoconus is frequently disproportionate to refractive error, as conventional spectacle correction is unable to compensate for irregular astigmatism and HOAs that degrade retinal image quality.

Microbial keratitis can further compromise visual function by inducing corneal scarring, particularly when involving the anterior stroma or visual axis. Post-infectious corneal scars introduce localized surface irregularities that exacerbate existing ectatic changes, leading to increased HOAs, glare, reduced contrast sensitivity, and persistent visual distortion despite apparently improved refraction[4]. In keratoconic eyes, such scarring presents a unique rehabilitative challenge, as both ectasia-related and scar-induced optical aberrations contribute to visual loss.

Comprehensive evaluation using corneal tomography and aberrometry is therefore essential to assess residual optical quality and guide individualized visual rehabilitation strategies, including contact lens fitting and surgical intervention when necessary[5,3]. We report a case of microbial keratitis caused by *Pseudomonas stutzeri* in a keratoconic eye following corneal cross-linking, highlighting the impact of post-infectious anterior stromal scarring on HOAs and visual rehabilitation.

CASE REPORT

A 33-year-old male with known bilateral keratoconus presented with redness and reduced vision in the right eye. He had undergone uncomplicated bilateral corneal collagen cross-linking one month prior to presentation. His ocular history was significant for adenoviral epidemic keratoconjunctivitis five months before CXL. The left eye remained asymptomatic.

Clinical timeline: The patient presented on (**day 5) of symptoms** with redness and decreased vision in the right eye. He was reviewed on (**day 1, day 2, day 5, and day 15)** following presentation. Initial treatment elsewhere for presumed herpetic keratitis resulted in no improvement.

Clinical course of microbial keratitis: A 25-year-old male with known bilateral keratoconus presented with redness and reduced vision in the right eye for five days. He had undergone uncomplicated bilateral corneal collagen cross-linking one month prior to presentation and had a history of adenoviral epidemic keratoconjunctivitis five months before cross-linking. Prior to presentation, the patient had been treated elsewhere for presumed herpetic keratitis without clinical improvement.

At presentation (day 1), visual acuity was 6/60 in the right eye and 6/6.7 in the left eye, with intraocular pressure of 12 mmHg in both eyes. Slit-lamp examination of the right eye revealed ciliary injection, corneal haze, and multiple superior stromal infiltrates at the 10 o'clock position with fluorescein uptake, along with a superior inactive subepithelial triangular opacity. Corneal cultures were obtained.

Given the recent history of corneal cross-linking and prior adenoviral keratitis, an immune-mediated reaction triggered by ultraviolet exposure was considered; however, fungal keratitis was initially ruled out. The patient was admitted and started on intensive topical fortified

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vancomycin and fortified tobramycin administered hourly, along with atropine three times daily.

At day 2 of follow-up, visual acuity showed no improvement and initial cultures demonstrated no growth. The patient was discharged on fortified vancomycin and fortified tobramycin administered every three hours.

At day 5, the patient reported no subjective improvement; however, visual acuity in the right eye improved to 6/36 without pinhole improvement. Slit-lamp examination revealed no significant clinical change. Repeat culture results at this visit grew *Pseudomonas stutzeri*. Fortified vancomycin was discontinued, fortified tobramycin was continued three times daily, and topical moxifloxacin was added four times daily.

At the one-week follow-up (day 15), the patient reported mild subjective improvement. Slit-lamp examination demonstrated reduced density of the stromal infiltrate, consistent with resolving infection. Visual acuity remained 6/36, improving to 6/15 with pinhole.

Post-infectious assessment: On examination, BCVA in the right eye was **20/40** with a refraction of **+1.00 / –2.00 × 35**, while the left eye achieved **20/20** with **+1.00 / –0.75 × 140 (**Table 1). Slit-lamp examination of the right eye revealed multiple anterior stromal scars involving the visual axis (**Figure 1**). The left eye showed mild sub epithelial haze without visual axis involvement (**Figure 2**).

Anterior segment optical coherence tomography demonstrated a hyperreflective anterior stromal scar with an estimated depth of approximately **150 µm** (**Figure 5**).

Corneal tomography of the right eye demonstrated a steep K of 47.6 D with elevated HOAs, including increased vertical coma and trefoil on a 6-mm pupil (**Figure 3**). The left eye remained stable post-CXL with relatively low HOAs (**Figure 4**).

Over the follow up period, subjective refraction and visual acuity in the right eye showed gradual improvement, but spectacle correction failed to provide satisfactory visual quality due to irregular astigmatism. On 25 August 2025, an RGP contact lens trial in the right eye restored visual acuity to approximately (20/40+2) indicating effective masking of corneal surface irregularities and higher order abberrations (HOAs). Lens parameters were selected based on corneal topography, and final over-refraction achieved near-normal visual acuity. Scleral and hybrid lenses were discussed as alternatives if RGP intolerance developed[5].

MANAGEMENT

During the acute phase of microbial keratitis, the patient was treated with culture-guided topical fortified antibiotics, including tobramycin and ceftazidime, aimed at eradicating Pseudomonas stutzeri, a pathogen known for rapid corneal destruction and risk of stromal melting if inadequately treated[2]. After epithelial healing, topical corticosteroids (loteprednol) were introduced to modulate stromal inflammation and reduce scarring, while minimizing the risk of recurrent infection[4]. Adjunctive ocular surface optimization included preservative-free lubricants, lid hygiene, warm compresses, and omega-3 supplementation. Cycloplegics were used transiently during the acute phase[1].

Rigid gas-permeable (RGP) contact lenses were fitted to correct irregular astigmatism and mask higher-order aberrations (HOA),

Table 1. Visual acuity and refraction over time are summarized.

Date	Refraction (OD)	VA (OD)	Refraction (OS)	VA (OS)	Notes
22/05/25	+0.75 / –2.25 × 40	20/50	+1.00 / –0.75 × 140	20/20	Post-healed ulcer
19/06/25	+1.00 / –2.00 × 35	20/50	+1.00 / –0.75 × 140	20/20	Steroid taper
25/08/25	+1.00 / –2.00 × 35	20/40+	+1.00 / –0.75 × 140	20/20	RGP trial

Figure 1. Slit-lamp photograph of the right eye showing multiple anterior stromal corneal scars (arrows) involving the visual axis following resolved microbial keratitis.

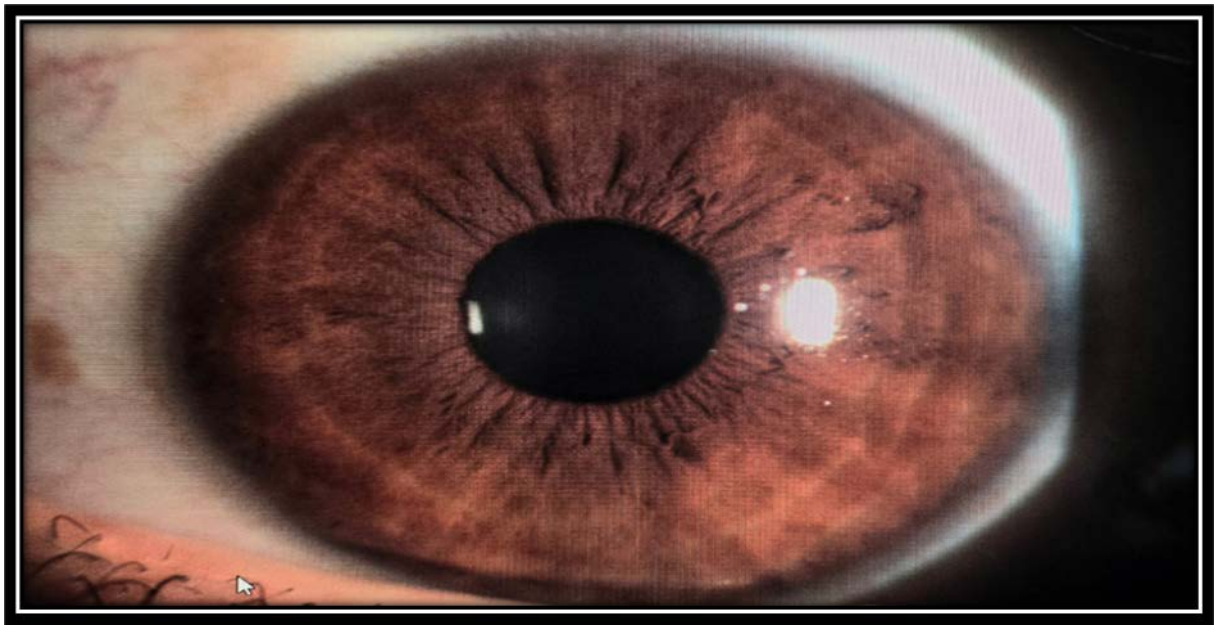

Figure 2. Slit-lamp photograph of the left eye showing mild subepithelial haze without involvement of the visual axis in a post–corneal cross-linking keratoconic eye.

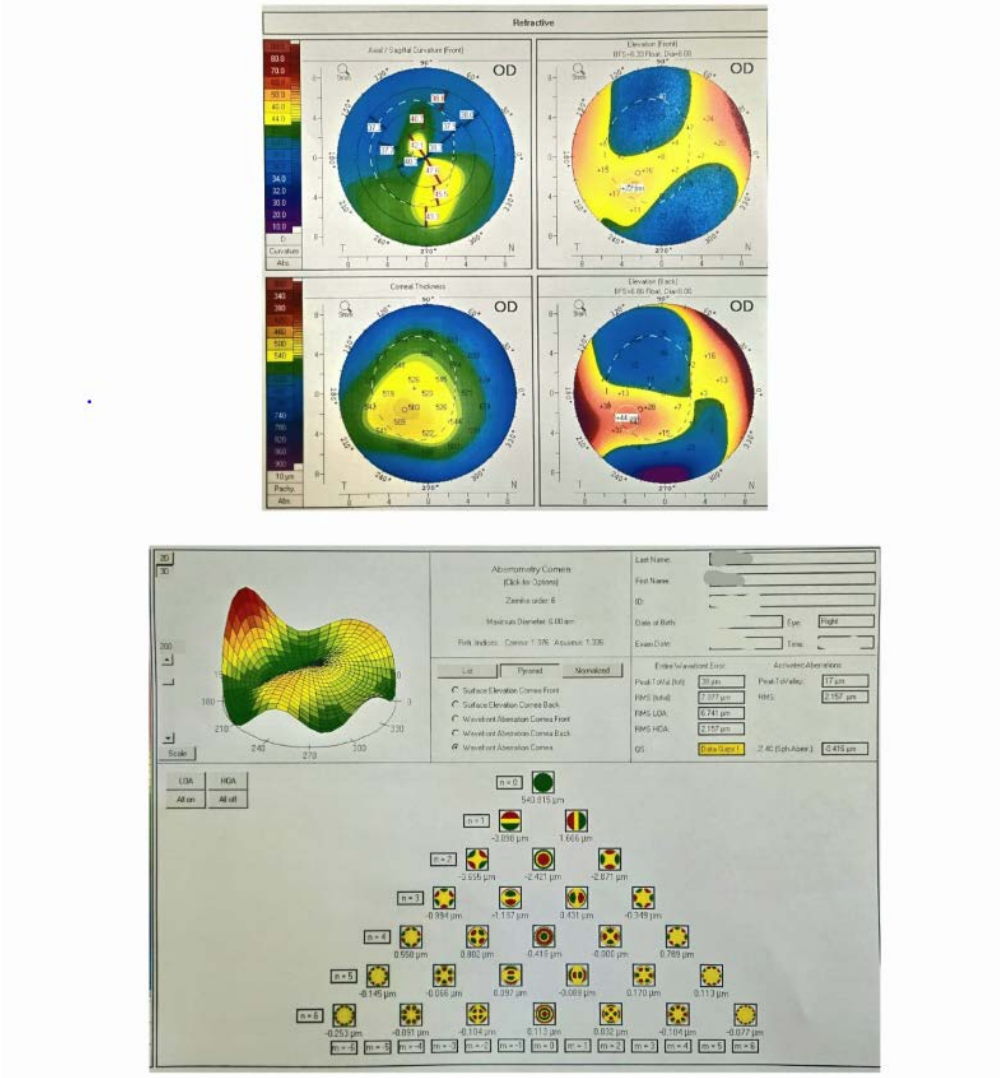

Figure 3. Pentacam tomography and higher-order aberration maps of the right eye demonstrating corneal steepening and elevated higher-order aberrations, including increased vertical coma and trefoil.

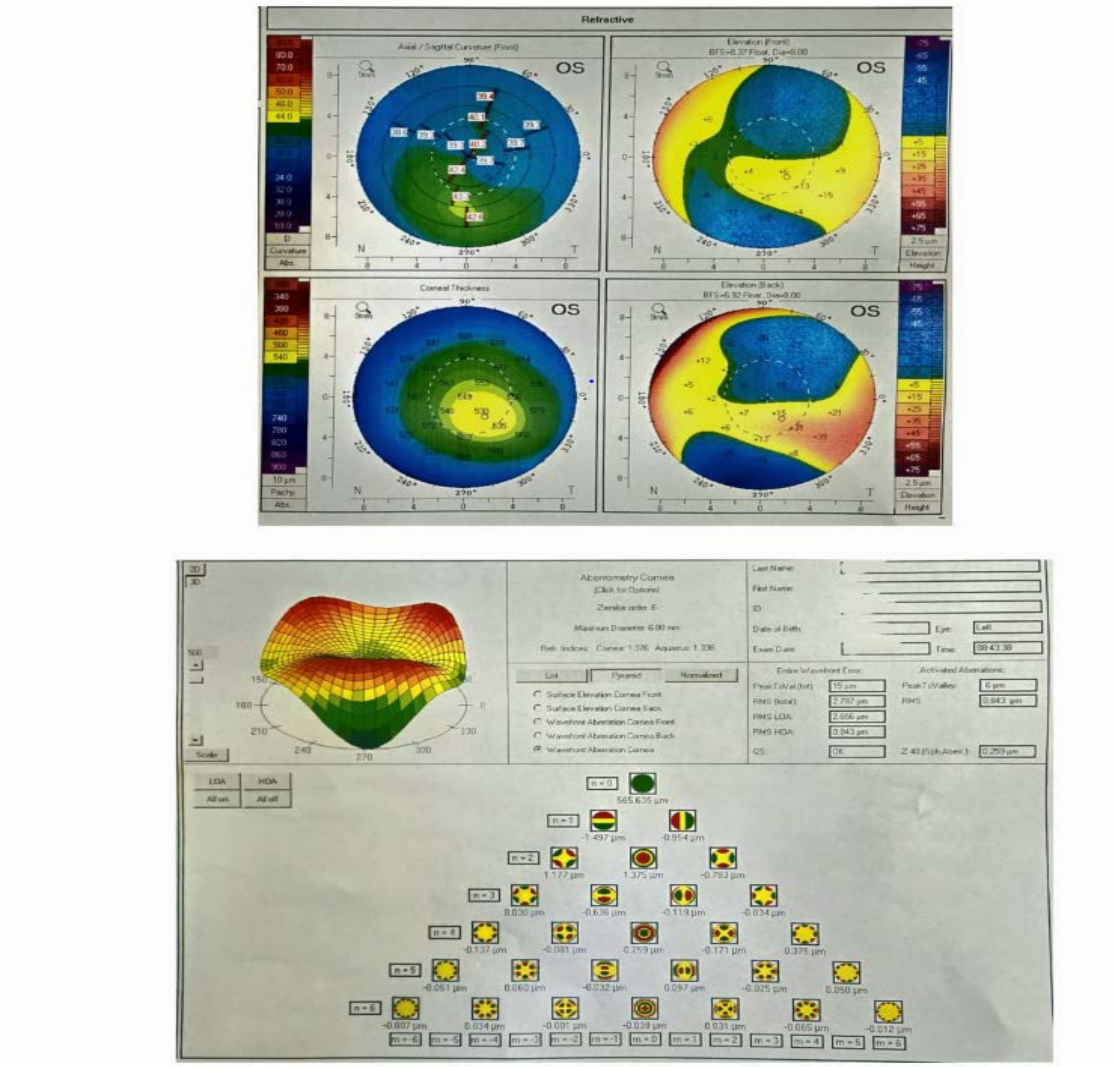

Figure 4. Pentacam tomography and higher-order aberration maps of the left eye showing stable post–corneal cross-linking keratoconus with relatively low higher-order aberrations.

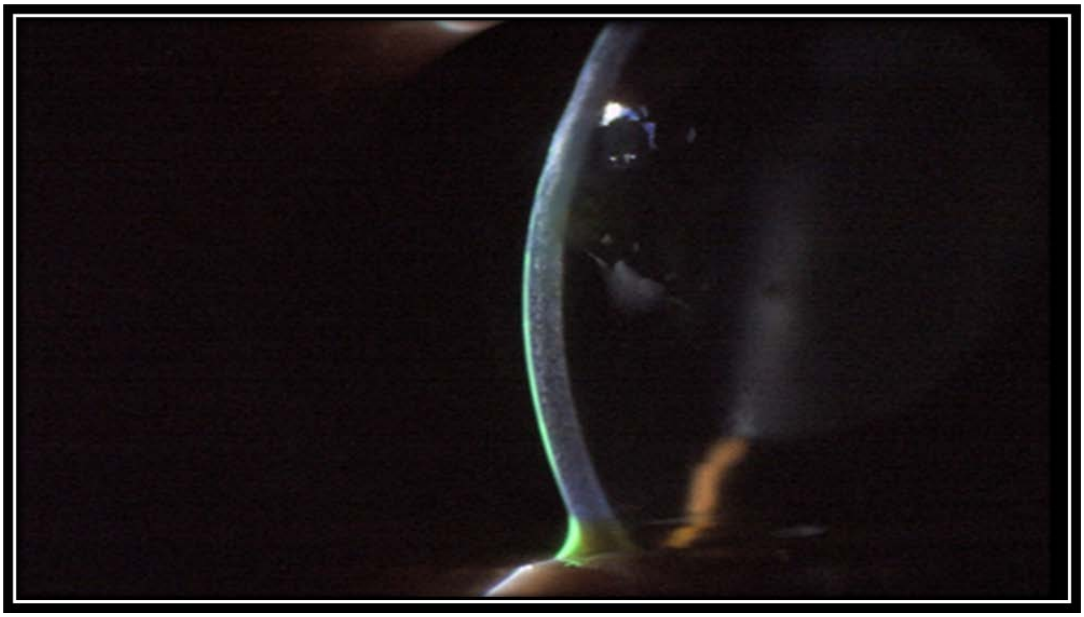

Figure 5. Anterior segment optical coherence tomography of the right eye demonstrating a hyperreflective anterior stromal scar (arrow) with an estimated depth of approximately 150 µm, consistent with post-infectious corneal scarring.

successfully restoring near-normal visual acuity[3]. In cases of RGP intolerance, scleral lenses provide a tear reservoir over the scarred cornea and a smooth optical surface, while hybrid lenses are considered when RGP fitting is suboptimal[5]. Surgical options such as PTK for superficial scars and DALK for deeper stromal involvement were reserved for future consideration[6,7].

DISCUSSION

Post-infectious corneal scarring in keratoconic eyes exacerbates irregular astigmatism and higher-order aberrations, often resulting in blurred or distorted vision despite conventional spectacle correction[2,4]. In this case, anterior stromal scarring in the right eye following Pseudomonas stutzeri keratitis was associated with increased Kmax and vertical coma on Pentacam imaging, correlating with functional visual impairment. Slit-lamp examination revealed multiple nummular elevated opacities within the visual axis, corresponding to areas of high corneal irregularity[1].

Contact lens rehabilitation played a pivotal role in functional visual recovery. RGP lenses masked corneal surface irregularities and reduced higher-order aberrations, restoring near-normal visual acuity[10,11]. Scleral lenses provided an alternative in cases of RGP intolerance, maintaining a tear reservoir over the scarred cornea, while hybrid lenses offered solutions for suboptimal fits[3,5]. Aberrometry-guided fitting ensures precise correction of higher-order aberrations, improving visual quality beyond conventional refraction[3].

Pseudomonas stutzeri is an uncommon cause of microbial keratitis but has been reported in eyes with pre-existing corneal pathology or prior surgery[8,9]. Prompt culture-guided therapy in this case limited stromal damage and preserved visual potential.

Multimodal imaging combining slit-lamp examination, corneal tomography, and AS-OCT enabled accurate localization and depth estimation of the scar, guiding optical rehabilitation and surgical planning[6,7].

Limitations

The main limitation of this case report is the short duration of follow up. This rare case of Pseudomonas stutzeri keratitis resulted in corneal scarring that might benefit from extended follow up, including repeated refraction and corneal topography to assess potential long term visual and refractive changes. Additionally, further medical or surgical interventions, such as phototherapeutic keratectomy or anterior lamellar keratoplasty may be required for visual rehabilitation. The impact of these interventions on visual acuity and refractive outcomes should be evaluated in future follow up.

CONCLUSION

Spectacle correction alone may underestimate visual impairment in keratoconic eyes with post-infectious corneal scarring. Corneal aberrometry and tomography are essential for comprehensive assessment and guidance of visual rehabilitation. RGP lenses remain the first-line option, followed by surgical intervention.

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Competing Interest: None

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