Case report

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Excimer laser-assisted phototherapeutic keratectomies combined to EDTA chelation for the treatment of calcific band keratopathy

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Abstract

Introduction: Calcific band keratopathy (CBK) is a relatively common chronic corneal degeneration and various forms of treatment are mentioned in the literature.

Cases description: Two patients (89 and 37 yo, respectively) affected by diffuse long-standing CBK in one eye and complaining of ocular pain, foreign body sensation and decreased visual acuity are reported. An ethylenediaminetetraacetic acid (EDTA) application on the ocular surface was performed associated with a customized no-touch transepithelial phototherapeutic corneal remodeling in one patient and a standard phototherapeutic keratectomy (PTK) in the second patient. Corneal transparency progressively improved in both cases since the early follow-up visits and the cornea became clear 2 weeks after surgery. In both cases, a significant reduction of ocular discomfort was reported.

Conclusions: Combining EDTA chelation and excimer laser-assisted PTK represents an useful treatment of band keratopathy even in challenging cases and may help regularize corneal surface and improve corneal clarity.

Keywords

Corneal degenerations, cornea/external disease, examination techniques: Corneal topography/Keratometry, Optics/Refraction/Instruments, optics/refraction/instruments, corneal topography/imaging systems, refractive surgery, diseases of the ocular surface

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Introduction

Calcific band keratopathy (CBK) was first described by Dixon in 1848 and by his assistant Bowman 1 year later. It is a relatively common, chronic corneal degeneration that is composed of band-shaped fine calcium deposits in the sub-epithelium, Bowman's layer and the anterior stroma.[1] Chronic ocular diseases, chemical exposure, hypercalcemia, hereditary disorders, and other systemic or traumatic diseases may result in CBK. Surgical approach to CBK is indicated after the treatment of any other concomitant systemic or ocular pathologies. Medical management of band keratopathy consists in the use of a bandage contact lens with antimicrobial topical eye drops to avoid infections and artificial tears. Surgical mechanical debridement was the first technique ever performed for this disease and it is still widespread today. However, this often leads to an irregular surface post-debridement as the depth of the treated area is not predictable. Other techniques have been previously reported, including the use of a diamond burr,[2] Nd:YAG laser,[3] lamellar keratoplasty,[4] amniotic membrane transplantation[5] and phototherapeutic keratectomy (PTK) assisted by excimer laser.[6] Currently, the most common treatment includes the use of a metal ion chelator, such as ethylendiaminetetraacetic acid (EDTA). After

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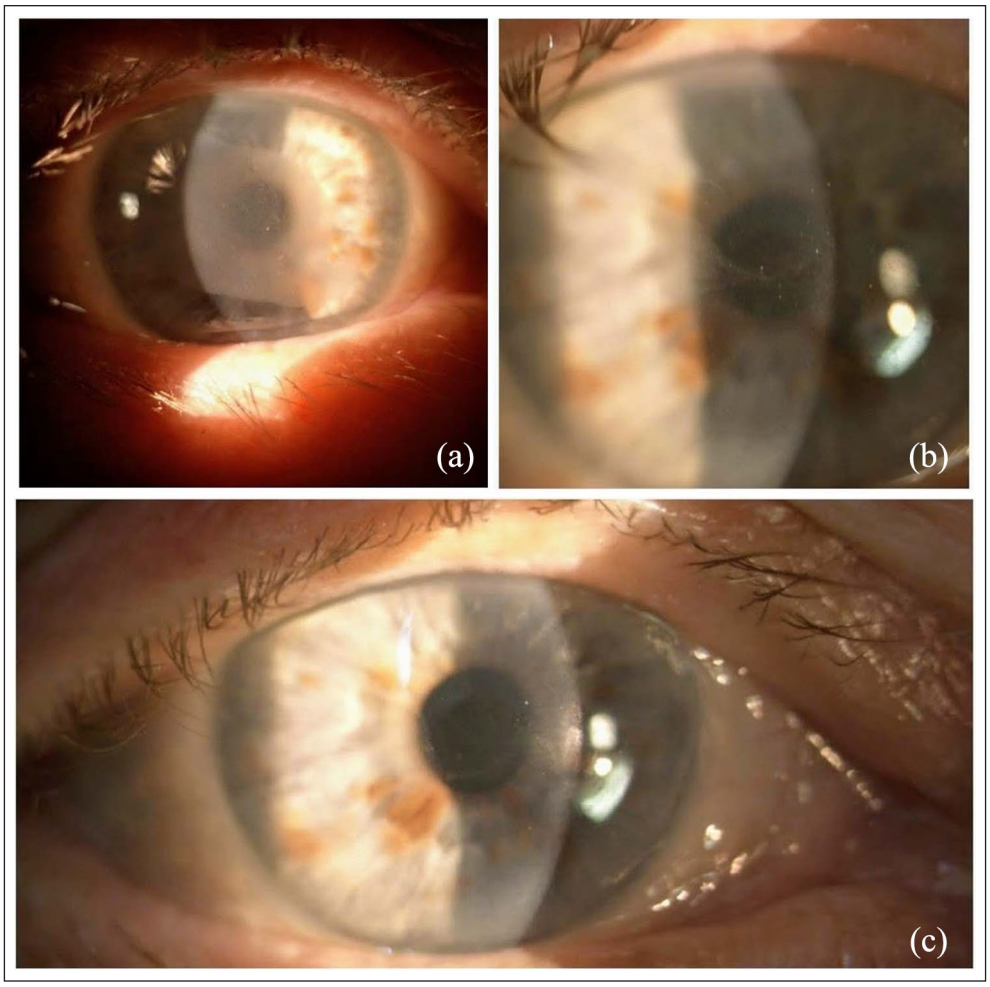

Figure 1. Case #1: (a) calcific band keratopathy (CBK) before excimer laser phototherapeutic keratectomy (PTK). A diffuse cloudy cornea affects particularly the central optical zone, (b) 14 days after surgery, corneal transparency is significantly improved, and (c) 6 months postoperatively, cornea is almost clear.

EDTA application, the corneal surface needs to be smoothed with a manual superficial keratectomy or a standard PTK.[7] In this paper, two types of PTK treatments for CBKs of different degrees are presented.

Cases description

The first case subject was an 89-years-old man with a long-standing for unknown causes CBK in the right eye (RE). At the end of June 2019, the patient came to the Corneal Service of our Eye Clinic, complaining of a progressive decrease in visual acuity and ocular discomfort in the right eye (RE). The patient referred to 2 previous excimer laser PTK procedures in 2015 and 2016 in the RE, always to treat a CBK. Corrected distance visual acuity (CDVA) was counting fingers in the RE and 20/20

(-1sph -1cyl@130°) in the left eye (LE), respectively. Diagnosis of dense CBK recurrence involving the visual axis was made (Figure 1(a)). Fundus examination was not possible. The anterior segment OCT showed a thickness of the calcium deposit ranging from 70 µm to 85 µm. A customized trans-epithelial no-touch (cTen™) photorefractive keratectomy was planned to remodel the corneal shape, in order to correct second order and higher order aberrations and contextually remove the CBK from the right eye. After detailed counseling about the treatment, the patient signed the informed consent. The customization of the laser treatment was based on the morphological and refractive data acquired by Precisio2™, a high-resolution tomographer for customized refractive surgery (iVis Technologies S.r.l.).

Figure 2(a), the customized treatment plan to remodel the corneal shape in order to correct second-order and high-order aberrations was executed by means of the "Corneal Interactive Programmed Topographic Ablation" software (iVis Technologies S.r.l.) using the Precisio2™ corneal elevation data and ray-racing refractive data. The attempted refractive correction was equal to - 2.68cyl @128°. The maximum ablation of the customized refractive treatment for corneal remodeling was equal to 56 µm

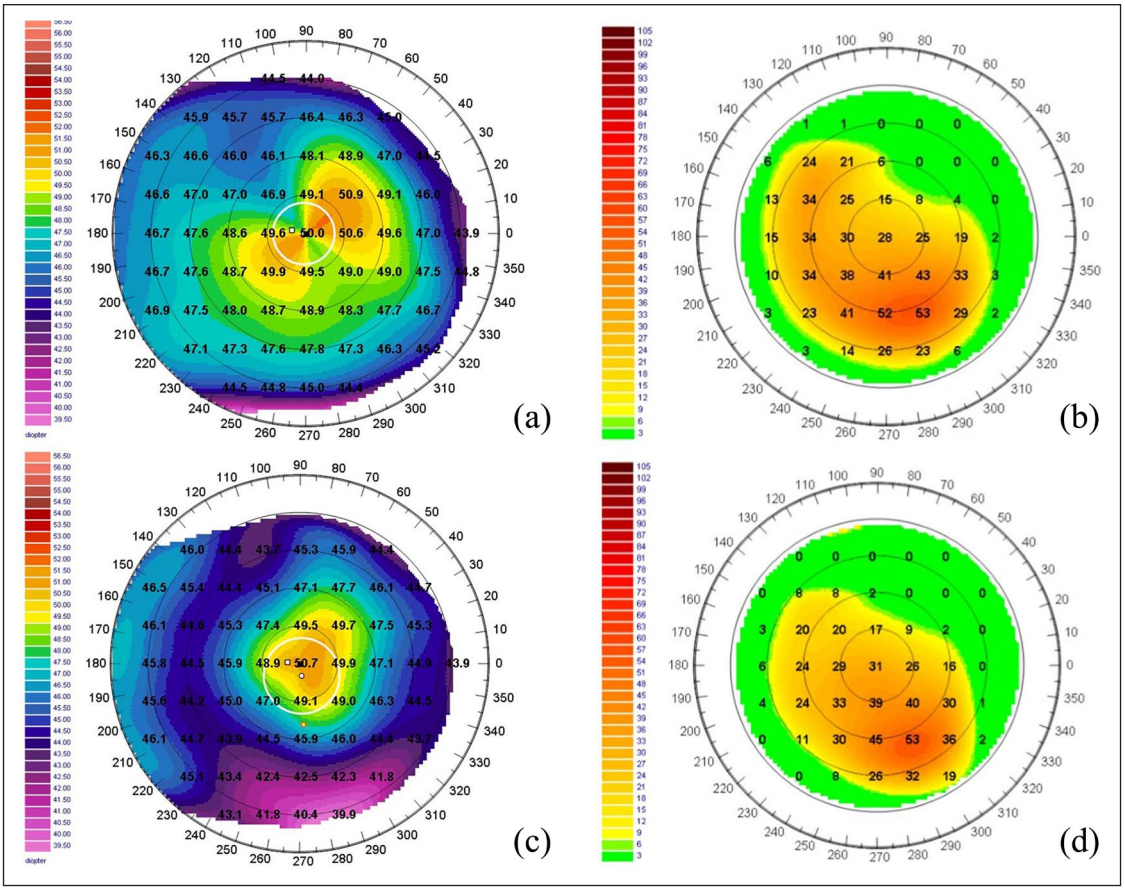

Figure 2. Computerized tomographic images of case #1: (a) pre-op corneal map (relative scale, axial algorithm), (b) planned customized transepithelial treatment (shot file). This represents the expected ablation depth map, (c) 6 months post-op corneal map (relative scale, axial algorithm). Topographic astigmatism is significantly reduced, and cornea morphology appears more regular, and (d) 6 months post-op achieved ablation depth map. The comparison of this image with the expected one (shot file) highlights a great similarity; this is a sign that the ablation was conducted as planned.

added of 54 µm to remove epithelium and corneal opacities. The maximum width of the connecting zone was consequently calculated equal to 7.70 mm (Figure 2(b)). The treatment started under topical anesthesia (oxybuprocaine eye drops, Benoxinato Cloridrato, Alfa Intes S.r.l.) and a lid speculum placement with the application for 5 minutes of an EDTA 2% solution in a 9 mm cylindrical marker to confine the chelating solution to the central cornea and induce calcium deposits chelation, with the aim not to completely remove the calcium but to soften it and then to be able to perform the laser treatment. The no-touch customized transepithelial surgical treatment was executed while the iRes™ excimer laser was having a Gaussian flying-spot of 650 µm at 1000 Hz, (iVis Technologies S.r.l.).

The second case subject was a 37-years-old man presenting with an extremely thick calcium plaque on the cornea in the RE and complaining of ocular pain, photophobia and discomfort (Figure 3(a)). The internal structures of the eye were not detectable but an inferior iris coloboma seemed to be present. The patient referred a previous pars plana vitrectomy 20 years before due to retinal detachment for high myopic retinocoroidosis. Silicone oil was still in the vitreous chamber, as evidenced by the ultrasound examination. Corrected distance visual acuity was light perception in the RE and 20/50 (-25sph -2cyl@160°) in the LE, respectively. The calcium plaque ranged from 1 mm to 3.5 mm of thickness, therefore the anterior segment OCT was not reliable due to the artifacts from the rear shadow cone. After an informed consent was signed by the patient, following an explanation of the nature and possible consequences of the treatment, the surgical procedure was performed under topical anesthesia (oxybuprocaine eye drops, Benoxinato Cloridrato, Alfa Intes S.r.l.) and a lid speculum was placed. The treatment started with the application for 5 minutes of an EDTA 2% solution in a 9 mm cylindrical marker to confine the chelating solution to the central cornea and induce calcium deposits chelation; this allowed to get a cleavage plan between the calcium deposit and the cornea. The dense and very thick calcific deposits removal required a long and careful procedure, until a cleavage plane in the anterior stroma was

Figure 3. Case #2: (a) dense and rough CBK involving the interpalpebral zone before surgery, (b) 1 week after PTK, the cornea appears smooth and slightly cloudy. An inferior iris coloboma is present, (c) 2 weeks after surgery, corneal clarity is increased, fine and deep neovessels are detected in the nasal quadrant, and (d) 6 months of follow-up, the cornea appears smooth and details of the anterior segment can be seen.

found. At this point, using a forceps and a blunt spatula, the thick fibrous pannus of the superficial scar plaque was completely removed. Then, the corneal surface was submitted to an excimer laser-assisted PTK procedure with masking fluid hyaluronic acid 0.4% (Dompé Farmaceutici S.p.A.), in order to obtain a regular corneal surface. The excimer laser PTK was performed executing a standard PTK procedure by means of the iRES™ excimer laser system (iVis Technologies S.r.l.). The ablation zone was set selecting 7.5 mm diameter and 50 µm ablation depth.

At the end of the surgical procedures, a bandage contact lens was applied and topical antibiotic therapy was administered to both patients. Postoperative treatment included ofloxacin eye drops (Monoflox Ofta, Sooft Italia S.p.a.) 3 times a day, artificial tears 6 times a day for 1 week and oral analgesics for the first 48 hours. Both patients were examined the day after surgery and further follow-up visits were performed at 1 week, 2 weeks, 1, 3 and 6 months, respectively. The contact lens was removed after 7 days, with a complete epithelial healing and then medical therapy with 0.1% fluorometholone (Fluaton, Bausch & Lomb) eye drops 3 times a day was started and tapered for 1 month.

In the first case, corneal clarity progressively improved since the early follow-up visits. Two weeks after surgery, the opacity almost disappeared (Figure 1(b)). Six months after performing the customized corneal remodeling the cornea was completely clear (Figure 1(c)). At 6 months the UDVA was 20/32 and the CDVA was 20/20 -0.50cyl@45°) in the RE and the patient was fully satisfied. The 6 months post-op map shows a much more regular profile with almost no residual astigmatism, with an almost perfect compliance between the expected post-op data and the achieved post-op data. (Figure 2(c)) The achieved ablation depth map evidenced a very good correspondence with the expected one (shot file), confirming that the ablation was conducted as planned. (Figure 2(d))

In the second case, a significant improvement in corneal transparency was appreciated one week postoperatively, a complete epithelial healing was noted and the contact lens was removed (Figure 3(b)). The anterior segment structures could be detected as well as a fine and deep corneal neovascularization (Figure 3(c)). These vessels started to regress 1 week later and almost completely disappeared 1 month after the laser procedure (Figure 3(d)). The detection of an improvement in visual acuity was not possible due to the retinal conditions. However, the patient was satisfied about the aesthetic outcome. No symptoms of ocular discomfort were reported. The cornea remained clear during the 6 months follow-up.

Conclusions

The aim of treatment for CBK is to obtain a smooth and regular corneal surface with a clear cornea, with an improvement of the ocular comfort. The solution of disodium EDTA produces a chemical chelation of the calcium that induces the removal of the deposits from Bowman's layer and from the anterior stromal lamellae. The treatment using EDTA mainly aims the removal of calcium plaques in the superficial corneal layers, and therefore some deposits could persist after treatment, causing an irregular and rough corneal surface.[2] Therefore, EDTA chelation needs additional procedures, such as PTK.[5]

The success of excimer laser PTK is due to its high precision in ablating the desired layers of anterior stroma instead of superficial keratectomy performed manually. In the last two decades, various superficial corneal disorders have been effectively treated by PTK, such as bullous keratopathy, corneal opacity, and recurrent corneal erosion.[6] A major complication of the PTK procedure is a hyperopic shift, probably due to very deep central ablations.[8,9] Moreover, 73 and 56 % of patients after PTK evidenced a central islands formation, respectively 3 months and 1 year after the treatment, significantly affecting the postoperative visual recovery.[10] Therefore, the use of a dedicated no-touch, transepithelial customized ablation to simultaneously obtain the corneal remodeling in order to compensate for second and higher order aberrations and the therapeutic removal of the corneal opacities is highly recommendable. In fact, in our patient #1 using the trans-epithelial customized PTK ablation a hyperopic shift was not observed, secondary to an ablation profile considering the real corneal morphology, always in association with a satisfactory corneal transparency.

In conclusion, the combined treatment of EDTA and customized PTK ablation seems to be a new safe and effective technique in treating CBK. When customized ablation is not possible secondary to a total corneal opacity, the combined treatment of EDTA, surgical removal of the calcific/fibrotic plaque and subsequent manual PTK for the regularization of the corneal surface is however a valid therapeutic option.

Declaration of conflicting interests

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