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Anterior stromal puncture for treatment of contact lens-intolerant keratoconus patients

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Abstract
Purpose To report the results and effectiveness of anterior stromal puncture for contact lens-intolerant keratoconus patients with subepithelial fibrotic nodules.
Methods Nine eyes of nine keratoconus patients who were rigid gas-permeable contact lenses (RGP)-intolerant due to subepithelial nodular scars were included in this study. The nine patients were enrolled in the study between March 2008 and December 2008. After confirming nodular elevation from slit-lamp biomicroscopy, the area where the epithelium of nodular scars had sloughed was punctured by anterior stromal puncture using a 26-gauge needle attached to a 1-ml syringe under slit-lamp biomicroscopy. The RGPs of all patients were refitted around 4 weeks after the puncture.
Results Five of the nine patients were male, and the average patient age was 29.6 years (SD±5.22 years). Mean follow-up time was 13.7 months (SD±4.8 months), and the epithelial defect healed in 1.4 days on average. After the puncture, four of nine patients presented with a recurrent erosion of the nodule during follow-up and needed a second puncture. All the patients showed good contact lens tolerance and satisfactory contact lens fit. No complications such as corneal perforation or keratitis developed.
Conclusions Anterior stromal puncture using a 26-gauge needle can be a successful and effective method to induce corneal epithelium and Bowman's layer reattachment. It can be used as an outpatient procedure to improve RGP tolerance in patients with keratoconus with elevated subepithelial nodules.

Keywords Anterior stromal puncture · Keratoconus · Keratoconus nodules · Contact lens intolerant

Keratoconus is a noninflammatory condition where the cornea assumes a conical shape because of thinning and protrusion of the corneal stroma [1]. The corneal thinning induces irregular astigmatism, myopia, and protrusion, leading to mild to marked impairment in the quality of vision. Symptoms are highly variable and, in part, depend on the stage of progression of the disorder [1]. Early in the disease, there may be no symptoms, but in advanced disease there is significant distortion of vision accompanied by profound visual loss [1]. The management of keratoconus varies depending on the stage of progression of the disease. In very early keratoconus cases, spectacles may provide adequate visual correction, but because spectacles do not conform to the unusual shape of the cornea and the resultant induced irregular astigmatism, contact lenses provide better correction, and are therefore the mainstay of therapy in keratoconus [1]. About 80% of all patients with keratoconus use spectacles, soft toric contact lenses, or rigid gas-permeable contact lenses (RGPs; the majority of patients) to successfully correct their vision [2].

However, contact lens intolerance in keratoconus sometimes occurs due to the formation of raised subepithelial nodular scars [3, 4]. These subepithelial nodular scars, which are also referred to as "proud nebulae" [3], are

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typically at or near the apex of the cone [5]. These nodules can result in contact lens intolerance because of recurrent erosions and discomfort [6]. Although the erosions heal after a period without contact lens wear, the nodules remain elevated and may persist even after prolonged periods without lens wear [7]. Patients with these nodules often require more invasive procedures, including corneal transplantation, to correct their vision.

Various treatment options have been used to treat these nodular scars successfully, including manual superficial keratectomy and excimer laser phototherapeutic keratectomy (PTK) [4, 6, 8, 9]. Although successful, these techniques require expensive equipment in an operative setting. In this study, we investigated the efficacy of anterior stromal puncture under slit-lamp biomicroscopy for treatment of recurrent corneal erosions, with the rationale that the puncture would enhance adherence of the epithelium to the basement membrane [10]. To the best of our knowledge, this is the first report of successful treatment of subepithelial nodules in keratoconus using anterior stromal puncture.

Materials and methods

Patients were referred from the keratoconus clinic of Dr. Lee&Park's clinic to the the contact lens and cornea department of Ophthalmology, Korea University College of Medicine, Seoul. A total of nine eyes from nine referred keratoconus patients who were RGP-intolerant due to the presence of subepithelial nodules were treated using anterior stromal puncture between March 2008 and December 2008. In all patients, the subepithelial nodules were slightly down to the visual axis, and had failed to flatten either on refitting or discontinuing contact lens wear. Contact lenses were fitted according to the three-point touch technique with a light apical touch.

All patients had previously worn RGP lenses and had achieved good visual acuity with these lenses. On slit-lamp examination, we confirmed the presence of an elevated subepithelial nodule with sloughed epithelium near the apex of the cone in all patients (Fig. 1a, b). Corneal topography (ORBScan, Orbttek Inc.) was performed for all cases. However, useful data was not obtained in some patients because of the irregularity of the tear film and epithelium.

Informed consent was provided by all study participants, and the principles outlined in the Declaration of Helsinki were followed in this study.

Procedure for anterior stromal puncture

A topical anesthetic eyedrop (Alcaine®, proparacaine hydrochloride 0.5%, Alcon) was instilled. After confirming the sloughed epithelium of the elevated nodular scars, multiple anterior stromal punctures were made to the elevated nodular scar area under slit-lamp biomicroscopy while the patient was in a seated position. The number of punctures varied according to the size of the area. We used a bent 26-gauge (0.1–0.2 mm turned end) needle attached to a 1-ml disposable syringe. After the treatment, an antibiotic eyedrop (Cravit®, levofloxacin 0.5%, Santen) was instilled, and an eye patch was worn until the day after the procedure. The patients were instructed to follow-up daily until the epithelium had healed, and to use antibiotic eyedrops every 6 hours for 1 week for prophylaxis. All the patients were refitted with RGPs approximately 4 to 6 weeks after the procedure, which is when we expected surgical healing to be complete and the scar to have formed.

Results

We investigated nine eyes from five men and four women (Table 1). The mean age of the patients was 29.6 years ±5.22 (SD) (range 22 to 36 years). The mean follow-up time was 13.7 months ±4.8 (SD). Patients experienced no pain during the procedure, and reported minimal discomfort for up to 24 hours after the procedure, with no requests for analgesics. The epithelial defects healed in 1.4 days on average (range 1–2 days), and four of the nine eyes had an epithelial defect on the first post-procedure day.

In all cases, successful anterior stromal punctures were performed; no complications such as corneal perforation or keratitis developed. Approximately 4 to 6 weeks after the procedure, all patients were refitted with RGPs and achieved corrected visual acuity. However, four of nine patients developed a recurrent erosion of subepithelial nodule after RGP refitting, and required a second puncture. The procedure was reported in all these patients as described above, and no further recurrences were observed during the follow-up period. No patients underwent penetrating keratoplasty during the follow-up period.

Discussion

To remove keratoconus subepithelial nodules and to improve contact lens intolerance, several treatment options have been reported, including manual superficial keratectomy and excimer laser phototherapeutic keratectomy (PTK) [3, 6–9]. Excimer laser PTK is a successful treatment procedure for anterior corneal pathology, and has several advantages over surgical excision [3, 6]. Laser patients experience much less postoperative pain, and the resultant wound is much smaller and more regular than that made during surgical excision [3]. An early report by

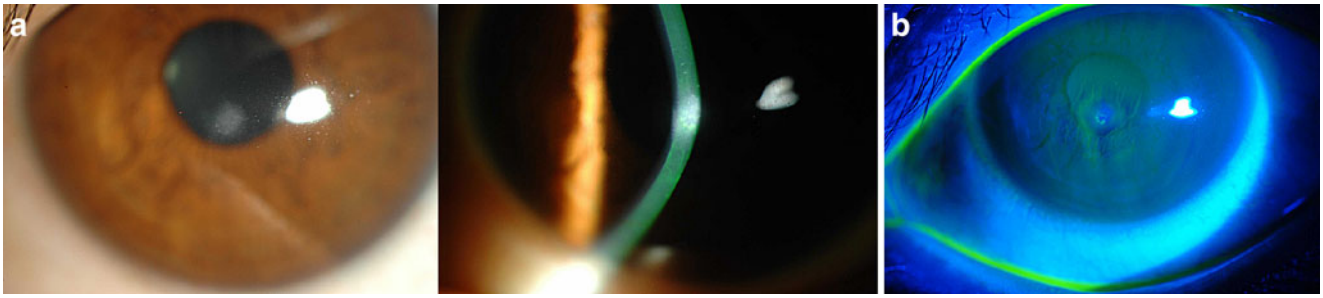

Fig. 1 **a**. Slit-lamp photographs of a subepithelial nodule in a patient with keratoconus before anterior stromal puncture. Note the elevated nodule at the apex of cone (slit lamp; slit view, ×16). **b** Fluorescein staining in the subepithelial scar area due to elevated epithelium of the nodule

Steinert and Puliafito [9] stated that PTK could be used to successfully remove keratoconus nodules. These authors reported that the patient was able to refit his/her contact lens 2 weeks after the procedure, with a visual acuity of 20/25; this visual acuity remained stable for the entire 6-week follow-up period. In another study by Moodaley et al. [3],. excimer laser PTK was used to remove keratoconus nodules in ten patients, and seven patients were able to resume regular contact lens wear within 1 month of completion of treatment. All patients achieved a postoperative visual acuity of 6/12 or better with a contact lens at the end of the 8-month follow-up period. Elsahn et al. [6]. recently reported on a larger series of 15 patients with a longer follow-up period of 23 months who underwent successful PTK for keratoconus nodules.

However, several investigators have reported a variety of complications after PTK procedures. Lahners et al. [5]. reported a case of keratolysis following PTK for a subepithelial nodule in a patient with keratoconus; progressive keratolysis led to a central descemetocele. Infections such as bacterial keratitis [11] and herpes simplex keratitis [12] have also been reported, though the incidence of these is low. In some patients, a hyperopic shift induced by PTK has been observed [13, 14]. Other possible complications after the PTK procedure include delayed reepithelialization and recurrent erosions, scarring, and irregular astigmatism [15, 16].

In this study, we report the successful treatment of subepithelial nodules in the eyes of nine keratoconus patients, using anterior stromal puncture with a 26-gauge needle. Anterior stromal puncture is a treatment used for recurrent corneal erosions, as the punctures enhance epithelium adhesion to the basement membrane due to scar formation [10]. Anterior stromal puncture has some advantages over PTK for treating recurrent corneal erosion. It can be performed in an outpatient and office setting without the requirement for expensive equipment like an excimer laser; there is a very low risk of inducing visually significant corneal scarring and hyperopic shifts, and the epithelial healing time is much shorter [17]. In keratoconus patients, contact lens wear usually abrades the epithelium of the subepithelial nodule, and the patient may be unable to wear the contact lens because of discomfort [3]. In all cases in this study, we confirmed that sloughed epithelium from the subepithelial nodule made contact lens intolerable, and made anterior stromal punctures to ensure more secure bonding of the epithelium, similar to the treatment used for recurrent corneal erosion patients.

In conclusion, anterior stromal puncture using a 26-gauge needle is a successful and effective method for inducing corneal epithelium and Bowman's layer reattachment. This procedure can improve RGP tolerance in patients with keratoconus with elevated subepithelial nodules in an outpatient office setting.

Table 1 Preoperative patient data

Patient No	Age (years)	Sex	Eye	K1	Axis	K2	Axis	VA[a] (with RGP)
1	33	M	OS	59.2	140	53.7	50	20/25
2	30	F	OD	71.1	5	65.6	95	20/25
3	30	F	OS	Not[b]	-	-	-	20/25
4	36	F	OD	64.0	4	59.1	94	20/40
5	23	M	OS	Not	-	-	-	20/30
6	26	M	OD	51.7	109	47.4	19	20/20
7	22	M	OS	Not	-	-	-	20/25
8	31	M	OS	65.9	106	56.0	16	20/25
9	25	F	OS	Not	-	-	-	20/25

[a] VA, visual acuity
[b] Not applicable due to irregular corneal surface

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