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TAILORED ATONAL EXPANSION WITH REFRACTIVE LENTICULE FOR CORNEAL CROSS-LINKING- FOLLOW UP STUDY

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ABSTRACT

Background: During CXL (collagen crosslinking), the refractive lenticule obtained from the SMILE (small incision lenticule extraction) operation is utilized for intraoperative stromal augmentation. This method's early outcomes are encouraging. Long-term data, however, is hard to come by.

Aim: The purpose of this study was to evaluate the long-term stability and safety of visual outcomes following CXL (modified technique of collagen crosslinking) utilizing refractive lenticule in eyes with thin corneas (<400 µ m) and progressive keratoconus.

Methods: Twenty-eight eyes with progressive keratoconus and thin corneas (<400 µ m) that underwent CXL with intraoperative stromal augmentation using a refractive lenticule harvested from SMILE (small incision lenticule extraction) were evaluated. Preoperative and postoperative evaluations were conducted at three months, and corneal tomography was performed annually after that any negative outcome, evident refraction, UDVA and CDVA (uncorrected and corrected distance visual acuity), and specular microscopy for endothelial cell count. For five years, the subjects were evaluated.

Results: 14 eyes were evaluated in this study, and preoperative maximal keratometry revealed a mean corneal flattening of -4.27 D with p=0.01. Five years after surgery, CDVA and UDVA showed improvements of 0.34 logMAR and 0.36 logMAR (logarithm of minimum angle of resolution), respectively. The gain of two lines in CDVA was shown by eight eyes. At five years after surgery, the mean spherical equivalent improved from -6.83 D to -6.03 D. On the anterior segment optical coherence tomography, a clear demarcation was observed between 230 and 270 m. No endothelial cell loss occurred after surgery, according to study findings.

Conclusions: The current study leads to the conclusion that a long-term evaluation of results after a modified collagen crosslinking technique revealed disease stability and safety supporting the usage of CXL.

Keywords: corneal crosslinking, CXL, keratoconus, SMILE, thin cornea

INTRODUCTION

The cause of keratoconus, a progressive, non-inflammatory corneal ectasia, remains unknown. It causes corneal thinning with uneven astigmatism, increasing myopia, and corneal scarring, all of which result in less than ideal visual acuity. Corneal collagen crosslinking, or CXL, is the only therapy option that can stop the illness from progressing.1,2 The standard Dresden technique results in a minimum corneal pachymetry of 400 µm to prevent UV-A (ultraviolet-A) from penetrating the corneal epithelium and crystalline lens. Since many people with corneal ectasia have thinner corneas, corneal thickness is typically a limiting issue. Numerous methods, such as lenticule-assisted CXL, have been reported to get around these restrictions.[3,4]

During CXL, the refractive lenticule obtained from the SMILE surgery is used for intraoperative stromal augmentation. However, there is a dearth of long-term outcome data in the literature.5, 6 Therefore, the goal of the current study was to evaluate the long-term stability and safety of visual outcomes following CXL (modified technique of collagen crosslinking) utilizing refractive lenticule in eyes with thin corneas (<400 μ m) and progressive keratoconus.

MATERIALS AND METHODS

The goal of the current prospective interventional study was to evaluate the long-term stability and safety of visual outcomes following CXL (modified technique of collagen crosslinking) utilizing refractive lenticule in eyes with thin corneas (<400 μ m) and progressive keratoconus. The Institute's Department of Ophthalmology provided the study participants. Prior to participation, each subject provided both written and verbal informed consent.

The current study used SMILE to evaluate every patient getting CXL. The study finally comprised eyes with progressive keratoconus undergoing treatment during the specified study time and the narrowest pachymetry of less than 400 μm. Disease progression was defined as the difference of at least two lines of CDVA (corrected distance visual acuity) attributable to keratotic alterations and at least one of the following over the previous year: increased astigmatism, as determined by either increased Kmax (steepest keratometry) value of 1D or manifesting subjective refraction of at least 1 D. The study excluded participants with preoperative endothelial cell density of 2000 cells/mm2, prior intracorneal ring segment implantation, other ocular infections, axial corneal scarring, herpetic keratosis, severe dry eye syndrome, pregnancy, or failure to follow up.

Specular microscopy, corneal tomography, dilated fundus assessment, slit-lamp biomicroscopy, UDVA (uncorrected distance visual acuity) and CDVA (corrected distance visual acuity) assessment as logMAR (logarithm of minimum angle of resolution), and manifest refraction were among the preoperative and postoperative evaluations conducted at one month, three months, and annually following final inclusion. Three tomography scans were obtained prior to surgery in order to reduce repeatability errors in steep corneas, and the mean value was utilized for evaluation in subsequent postoperative visits. Additionally, a single, subject-matter expert examiner documented each reading. Soft and rigid gas-permeable contact lenses were stopped one and three weeks prior to tomography, respectively. Refractive lenticules were surgically removed from patients receiving SMILE for myopia without astigmatism using a femtosecond laser while they were under topical anesthetic.

The quantity of stromal thickness augmentation required determined lenticule thickness. No corneal storage agent was required, and related corneal tissue was avoided because the lenticule was used for CXL right away during the same session. Prior hepatitis B and HIV (human immunodeficiency virus) serological testing was performed on SMILE subjects.

Because 0.5% proparacaine and alcaine were administered three times at intervals of five minutes, fifteen minutes before to the surgery, the CXL treatment was performed under topical anesthesia without any aseptic measures. The required thickness of the refractive lenticule was determined using surgical pachymetry at the thinnest corneal spot following central 8mm manual corneal epithelial debridement. The predefined region of the cone apex was covered by the middle portion of a 6.2mm lenticule.

Using intraoperative ultrasonic pachymetry, an increased stromal thickness of >400μm was verified, enabling CXL to be performed in accordance with the necessary safety procedure standards. For thirty minutes, one drop of a 0.1% solution containing ten milligrams of riboflavin was administered every five minutes; for the following thirty minutes, one drop was administered every five minutes under UV-A radiation. At a distance of 5 cm, UV-A light with a wavelength of 365 nm and a desired irradiance of 3 mW/cm2 was employed. After the treatment was finished, the refractive lenticule was removed from the stromal bed and disposed away, and surface irrigation was carried out using regular saline. After epithelial healing was complete, the bandage contact lens was put on and taken off on the fifth postoperative day. For six weeks following surgery, 0.1% sodium hyaluronate eyedrops were administered four times a day, 1% prednisolone acetate eyedrops slowly tapered over a month, and 0.5% moxifloxacin eyedrops four times daily for 1 week. Pachymetry and keratometry evaluation, side effects, endothelial cell count, spherical equivalent, and UDVA and CDVA (visual acuity) were used to evaluate the results.

The collected data was statistically evaluated using the Student t-test, Chi-square test, ANOVA (analysis of variance), and SPSS (Statistical Package for the Social Sciences) software version 24.0 (IBM Corp., Armonk, NY, USA). The mean, standard deviation, frequency, and percentages were used to express the results. A p-value of less than 0.05 was taken into account.

RESULTS

The goal of the current prospective interventional study was to evaluate the long-term stability and safety of visual outcomes following CXL (modified technique of collagen crosslinking) utilizing refractive lenticule in eyes with thin corneas (<400 μ m) and progressive keratoconus. Twenty-eight eyes with progressive keratoconus and thin corneas (less than 400 μm) who underwent CXL with intraoperative stromal augmentation utilizing a refractive lenticule taken from SMILE (small incision lenticule extraction) were evaluated. The study included 100% male participants between the ages of 10 and 32, with a mean age of 21.69±8.7.

On evaluating the results of the refractive lenticule-based modified CXL approach as customized stromal expansion in ultrathin corneas. The thinnest corneal point before surgery, one year after surgery, and five years after surgery showed a non-significant difference (p=0.08).

Corneal thickness at the apex, endothelial cell count, and spherical equivalent all showed comparable non-significant differences (p=0.09, 0.08, and 0.07, respectively). The mean keratometry was significantly lower before surgery, one year after surgery, and five years after surgery (p=0.04). Steepest keratometry, CDVA (logMAR), and UDVA (logMAR) all showed a similar significant decrease with p=0.01, 0.02, and 0.04, respectively (Table 1).

The study's findings also showed that none of the eyes evaluated had any intraoperative or postoperative complications. In every case, complete epithelial healing was observed three to five days after the surgery was finished, at which point the contact lens bandage was taken off. The ongoing haze did not cause any loss of visual acuity.

There were no instances of fungal, viral, microbial, or corneal melting among the research participants. Additionally, none of the eyes showed signs of disease development.

DISCUSSION

Twenty-eight eyes with thin corneas (less than 400 μm) and progressive keratoconus that underwent CXL with intraoperative stromal augmentation using a refractive lenticule taken from SMILE (small incision lenticule extraction) were evaluated in this study. The study included 100% male participants between the ages of 10 and 32, with a mean age of 21.69±8.7. These demographics were similar to those of earlier studies conducted by Mazzota C et al. in 2013 and Sachdev GS et al. in 2017, in which the authors evaluated participants whose demographic information was similar to that of the current study.

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The outcomes of the current investigation were similar to those of the authors' studies on customized stromal expansion employing refractive lenticules. The study's findings also showed that no intraoperative or postoperative complications were evaluated in any of the eyes. In every case, complete epithelial healing was observed three to five days after the surgery was finished, at which point the contact lens bandage was taken off. The ongoing haze did not cause any loss of visual acuity. There were no instances of fungal, viral, microbial, or corneal melting among the research participants. Additionally, none of the eyes showed signs of disease development. These results were consistent with those of Kanellopoulos AJ12 in 2009 and Kaya V et al in 2011.

CONCLUSION

The current study indicates, taking into account its limitations, that long-term evaluation of results after a modified collagen crosslinking technique found disease stability and safety supporting the use of CXL. A lower sample size, shorter monitoring, and single-institutional design were some of the study's shortcomings, though. To achieve a definitive conclusion, further prospective studies with larger sample sizes, longer monitoring periods, and varied geographic backgrounds are therefore required.

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S. No	Parameter	Preoperative	Postoperative 1-year	Postoperative 5-years	p-value
1.	**Thinnest corneal point (µm)**	374.12±12.52	376.69±10.45	375.69±9.87	0.08
2.	**Corneal thickness at apex (µm)**	382.84±8.26	384±8.74	383.69±9.96	0.09
3.	**Endothelial cell count (cells/mm$^{2)}$**	2442.38±311.10	2440.08±325.72	2388.08±326.46	0.08
4.	**Mean keratometry (D)**	64.39±8.53	62.48±8.23	61.88±8.10	**0.04**
5.	**Steepest keratometry(D)**	78.34±9.48	74.64±9.85	74.05±9.87	**0.01**
6.	**Spherical equivalent (D)**	-6.83±6.10	-6.89±4.41	-6.03±3.16	0.07
7.	**CDVA (logMAR)**	0.87±0.76	0.68±0.67	0.51±0.43	**0.02**
8.	**UDVA (logMAR)**	1.25±0.51	1.01±0.49	0.87±0.25	**0.04**

Table 1: Results of tailored stromal expansion (modified technique of collagen crosslinking) using refractive lenticule in study subjects with ultrathin corneas