The Change in Corneal and Conjunctival Sensation Following Pterygium Surgery

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ABSTRACT **Background:** The cornea is one of the most densely innervated in the body. Pterygium surgery includes removal of the pterygium tissue from the cornea and conjunctiva followed by autologous conjunctival grafting.

Objectives: To examine the change in corneal and conjunctival sensation post-pterygium surgery.

Methods: This prospective study included patients with primary pterygium. We collected and analyzed demographic data, visual acuity (VA), refraction, quantified sensation, and corneal tomography. Comparison in sensation in the cornea, conjunctiva, and conjunctival autograft was recorded the day of surgery and at least 6 months postoperatively.

Results: Nine patients participated in the study. Mean follow-up time was 9 months (9 ± 3.3, 6–12.4). No complications were documented during or following surgery and no recurrences were found. Statistically significant increases in corneal sensation in the nasal corneal and in the nasal conjunctival areas were noted by the end of follow-up compared to before surgery (P = 0.05, paired samples t-test). There was a significant correlation between the increase in nasal corneal and conjunctival sensation with improved Schirmer testing outcomes and tear break-up time after surgery (P = 0.05, P = 0.01, Pearson correlation). There was a positive correlation between the changes in nasal corneal sensation after surgery and improved changes in VA (P = 0.02, Pearson correlation).

Conclusions: We found improvement in sensation 9 months after pterygium surgery, which may be due to reinnervation of the cornea and conjunctival autograft from the neighboring non-injured nerve fibers. Larger studies with confocal microscopy should be conducted for further analysis.

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The cornea is one of the most densely innervated and sensitive tissues in the body [1]. It is considered 300 to 600 times more sensitive than skin, having a nerve density of approximately 7000 nociceptors per square millimeter in the center [2,3]. The trigeminal ganglion provides sensory innervation to the cornea for perception of stimuli (touch, temperature, and pain). Corneal sensation is also important for the blink reflex, tear formation, maintenance of hydration, wound healing, and avoidance of injury [4]. Corneal sensitivity changes have been extensively described after corneal surgeries such as laser-assisted in situ keratomileusis (LASIK), photorefractive keratectomy (PRK) [5-7], repeated intravitreal anti-vascular endothelial growth factor injections [8], cataract surgery [9], and vitrectomy [10]. Corneal nerve regeneration occurs over several years after surgical transection, but the nerve density never returns to pre-surgery levels [4,11].

Pterygium (Latin for *little wing*) is an abnormal fibrovascular proliferative tissue that extends over the cornea in the interpalpebral area [12]. It is usually located on the nasal side. Surgical removal is the treatment of choice [12]. The common surgery includes removal of the pterygium tissue from the cornea and conjunctiva followed by autologous conjunctival grafting [13]. The autologous limbal conjunctival autograft can be attached to the exposed scleral bed either by sutures or fibrin glue [14].

To the best of our knowledge, only two studies have examined changes in sensation after pterygium surgery with conjunctival autograft. Both studies found some decrease in sensation in the short-term following surgery [15,16]. However, the long-term changes in corneal and conjunctival sensation as well as the association between clinical factors and diagnostic imaging to change in sensation were not described.

The purpose of this study was to examine the changes in corneal and conjunctival sensation at least 6 months post-surgery and to examine the correlation between those changes and demographic, refractive, clinical, and imaging factors.

PATIENTS AND METHODS

PATIENT SELECTION

This prospective study was conducted between September 2019 and March 2020. Adult patients with primary pterygium and for whom surgery was advised participated in the study. Patients with other ocular disease, history of a systemic disease that could affect ocular surface, history of contact lens use, history of ocular or orbital surgeries, and prior corneal or conjunctival surgery were excluded from the study.

The following data were collected and analyzed on the day of surgery as well as at least 6 months after surgery: age, sex, visual acuity (VA), refraction, sensation measurements, ocular surface evaluation, and imaging.

The study was approved by the local institutional review board at Sheba Medical Center. The surgical procedure complied with the tenets of the Declaration of Helsinki, and the participants provided informed consent.

REFRACTION MEASUREMENTS

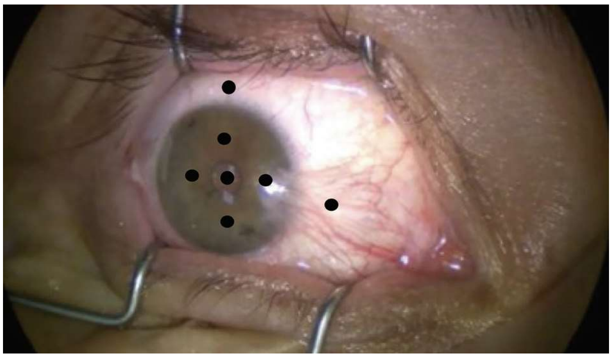
All patients underwent comprehensive eye examinations, including VA, intraocular pressure, and assessments of anterior and posterior segments. Snellen VA was converted to a log minimum angle of resolution (logMAR) value.

To evaluate the surgically induced refractive changes (SIRCs) between the preoperative and minimal 6-month postoperative examinations, the difference between each postoperative and respective preoperative refraction was calculated for both eyes using double-angle mathematical methods for subtraction of refractions, as described by Holladay et al. [17].

SENSATION MEASUREMENTS

The patients underwent evaluation of corneal and conjunctival sensation by Cochet–Bonnet esthesiometer with a 0.12 mm diameter filament. Five corneal points (one in each quadrant and the center of the cornea) and two conjunctival (nasal and upper area of the flap) were evaluated [Figure 1]. Each area was tested three times with each filament length, which was sequentially reduced in 5 mm steps starting from 60 mm. Two positive responses in three attempts at each filament length was regarded as a positive result. Results are presented as length of the nylon filament in centimeters, 6.0 cm being the maximum sensitivity of the cornea, and 0 cm signifying corneal anesthesia at the point tested. Corneal sensation was evaluated immediately prior to surgery and at least 6 months after surgery.

Figure 1. Corneal and conjunctival points of assessment by Cochet–Bonnet esthesiometer. Five corneal points and two conjunctival points (black circle) were evaluated



OCULAR SURFACE EVALUATION: SUBJECTIVE SCORE

The Ocular Surface Disease Index (OSDI) was administered at the first and last visits. The questionnaire has three subscales: ocular symptoms, vision-related function, and environmental triggers. Patients rate their responses on a Likert-type scale from 0 to 4, with 0 corresponding to *none of the time* and 4 corresponding to *all of the time*. A final score was calculated.

OBJECTIVE EVOLUTION

Schirmer's test: Performed with Schirmer tear test strips (Ophthalmos, São Paulo, Brazil) without anesthetic instillation. A result ≥ 10 mm after 5 minutes was considered normal.

Tear break-up time (TBUT): Calculated as the number of seconds between the last blink and the appearance of the first superficial punctate keratitis (SPK). A TBUT over 10 seconds is considered normal.

IMAGING (CORNEAL TOMOGRAPHY)

Maximal keratometry (K-max) and corneal thickness were evaluated before surgery using the CSO SIRIS (Costruzione Strumenti Oftalmici, Firenze, Italy).

SURGICAL TECHNIQUE

After instillation of topical oxybuprocaine hydrochloride (Bausch + Lomb UK Ltd., Surrey, UK), under sterile conditions, lidocaine 2% was injected subconjunctival into the pterygium head and the superior bulbar conjunctiva. The length and width of corneal pterygium involvement were measured. The pterygium was separated from the underlying sclera and surrounding conjunctiva by blunt dissection. The pterygium head was excised and the sclera was exposed. A limbal conjunctival autograft was formed from the superior limbus and placed on top of the cornea and kept moist. The graft was glued to the bare sclera area with Tisseel (Baxter Corp., Deerfield, IL, USA). Neomycin sulfate/ polymyxin B sulfate/ dexamethasone ointment (Maxitrol ointment; Alcon Laboratories, Fort Worth, TX, USA) was applied to the operated eye and a pressure patch and an eye shield were kept in place for 24 hours.

STATISTICAL ANALYSIS

Quantitative variables were described as mean, range, and standard deviation. Categorical variables were described as absolute and relative frequencies. Matched paired samples *t*-test analysis was conducted to compare clinical characteristics before surgery to at least 6 months after surgery. Pearson correlation was conducted to find correlation between change in sensation and clinical factors.

The statistical analyses were performed using Microsoft Excel™ 2017 (Microsoft Corporation, Redmond, WA, USA) and IBM Statistical Package for the Social Sciences statistics software, version 24 (SPSS, IBM Corp, Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

RESULTS

DEMOGRAPHICS

In total, one eye from each of nine patients underwent pterygium surgery. The study included four men (44.44%) and five women (55.56%). The mean age at the time of the procedure was 65.6 years (65.64 ± 12.44 years, range 50.1–85.8).

SURGERY

In four (44.44%) eyes, the pterygium occurred in the right eye and five (55.56%) in the left eye. In all cases, the pterygium was on the nasal side. The pterygium was diagnosed 1.62 years (1.62 ± 0.47, 1–2) before surgery. Mean width of the pterygium was 2.25 mm (2.25 ± 0.5, 2–3). The mean length of pterygium was 5.16 mm (5.16 ± 2.36, 2.5–7). No complication were documented during or following surgery. Mean follow-up time was 9 months (9 ± 3.3, 6–12.4). No recurrences were found by the end of the follow-up period.

DRY EYE EVALUATION

Mean TBUT before surgery was 6.55 seconds. At the end of the follow-up period, TBUT was 10.14 seconds ($P < 0.01$, paired samples *t*-test). Mean Schirmer test was 18.11 mm before surgery and 20.55 mm at the end of follow-up ($P = 0.42$, paired samples *t*-test). Mean OSDI score before surgery was 18.84, improving to 11.11 ($P = 0.10$, paired samples *t*- test) at the end of follow-up [Table 1].

REFRACTION

Mean LogMAR before surgery was 0.17 and 0.15 at the end of follow-up ($t = 0.15$, paired samples *t*- test). The mean SIRC was -0.5 + 2.3 × 85.1. Mean spherical equivalent was 0.7. Mean K-max before surgery was 45.08 (45.08 ± 0.70, 43.24–46.40) and changed to 44.87 (44.87 ± 0.70, 44.83–46.02) at the end of the follow-up period. Mean corneal thickness measured 556 microns (556 ± 50, 487–567) before surgery and 571 microns (571 ± 80, 546–628) at the end of the follow-up period.

CORNEAL SENSATION AND RISK FACTORS

There was a statistically significant increase in corneal sensation in the nasal corneal area and in the nasal conjunctival area at the end of follow-up compared to before surgery ($P = 0.05$ accordingly, paired samples t- test). Table 2 shows the mean change.

There was a significant correlation between the increase in nasal sensation of the cornea and conjunctiva and increase in Schirmer test value and TBUT after surgery ($P = 0.05$, $P = 0.01$, Pearson correlation). There was also a positive correlation between the change in nasal sensation of the cornea after surgery and the change VA ($P = 0.02$, Pearson correlation). Age, sex, other dry eye tests, and size of the pterygium were not correlated to change in corneal sensation. In addition, no correlation was found between age, sex, Schirmer test, and the size of the pterygium.

Table 1. Dry eye evaluation

Variables	Before pterygium surgery	After pterygium surgery	*P*-value (paired samples *t*-test)
TBUT (seconds)	6.55	10.14	**< 0.01**
Schirmer test (mm)	18.11	20.55	0.42
OSDI Score	18.84	11.11	0.10

TBUT = tear breakup time, OSDI = Ocular Surface Disease Index
Bold signifies significance

Table 2. Corneal sensation

Corneal/ conjunctival area	Corneal sensation before pterygium surgery	Corneal sensation after pterygium surgery	*P*-value (paired samples *t*-test)
Cornea nasal area (cm)	3.16	4.10	**0.05**
Cornea temporal area (cm)	3.61	3.50	0.72
Cornea upper area (cm)	3.44	3.66	0.10
Cornea lower area (cm)	3.50	3.94	0.32
Cornea center area (cm)	4.42	5.18	0.14
Conjunctiva nasal area (cm)	3.50	5.17	**0.05**
Conjunctiva upper area (cm)	5.33	5.77	0.12

Bold signifies significance

DISCUSSION

In this study we examined the change in corneal and conjunctival sensation following pterygium surgery and examined the factors that may correlate with this change. We found hypoesthesia in the area of the pterygium before surgery that improved following surgery. Moreover, we found a positive correlation between the change in sensation of the nasal corneal area and the change in VA and Schirmer testing. There was also a positive correlation between the change in sensation of the nasal corneal area and the change in TBUT.

Our finding of hypoesthesia before surgery in the pterygium area correlates with previous studies [16], which showed that the hypoesthesia is caused by injured corneal nerves [18,19]. Another hypothesis was that the UV light that causes limbal stem cell damage is also responsible for nerve damage [20].

Julio et al. [15] examined corneal sensation change only one month after pterygium surgery and found hypoesthesia postoperatively compared to before surgery. However, the long-term effect on the conjunctiva and cornea was not examined. Sakarya and colleagues [16] examined corneal and conjunctival sensation in longer term follow-up after pterygium surgery. They found hypoesthesia in the nasal cornea and superior bulbar conjunctiva after one month that normalized in the second month after surgery, and hypoesthesia of the nasal bulbar conjunctiva that normalized 6 months post-surgery.

In our current study, we found that there is improvement in sensation in the area of surgery compared to before surgery. We hypothesized the reason for this to be that by 9 months after surgery there is reinnervation of the cornea and conjunctival autograft from the neighboring non-injured nerve fibers that cause sensation improvement. Confocal microscopy can provide detailed anatomy of regenerating nerve endings. This technology can be used in future studies to test this hypothesis.

Patients with pterygium present with dry eye symptoms that improve after surgery [21-23]. The reason for this is unknown, although there are different theories. Some researchers speculate that the quantity of the tear film in patients with pterygium is adequate, but its quality is abnormal. The result is tear hyperosmolarity and abnormal tear film function. Those disturbances improve after surgery [21]. Others speculate that ocular surface disturbance causes unequal distribution of the tears leading to dry eye. This surface disturbance improves after surgery, so the dry eye signs and symptoms also improves [24,25]. We found a positive correlation between the change in nasal corneal and conjunctival sensation and improvement in dry eye tests after surgery. This result may hint to the mechanism of dry eye in pterygium eyes relating to hypoesthesia that improves after surgery. This finding may influence the decision to perform pterygium surgery earlier in patients who present with dry eye disease.

Zloto et al. [14] examined the change in VA after pterygium surgery and did not find a significant change in VA postoperatively. In our study, we did not find a significant change in VA following pterygium surgery. However, we found a positive correlation between increase in sensation and an increase in VA after surgery. These findings did not correlate to the size of the pterygium. This result may be related to improved ocular surface following surgery.

Limitations of our study stem from the small patient sample. Larger, prospective studies should be conducted to examine the change in sensation and the factors that predict improvement in sensation after pterygium surgery. Moreover, another primary objective of the study was to examine the pterygium depth using anterior segment optical coherence tomography (OCT) and to examine the correlation between the depth of pterygium and the change in sensation. However, there was great inter-examiner variability in depth measurements and degraded quality of some of the images. Therefore, these inconclusive results were excluded from our analysis. Further larger studies with accurate OCT images would improve our ability to evaluate pterygium depth and its association with corneal sensation pre- and postoperatively.

CONCLUSIONS

Eyes with pterygium had hypoesthesia before surgery that improved after surgery. A positive correlation was also found between improved sensation and better results of dry eye tests. To the best of our knowledge, this is the longest study to examine sensation following pterygium surgery.

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