

# Corneal aesthesiometry as an indicator for corneal metabolism after corneal surgery

M. Kohlhaas, J. Draeger, A. Böhm (\*)

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## Summary

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The recovery and reinnervation of corneal sensitivity was examined at 82 patients after Excimer - Laser - Ablation, at 35 patients after Radial Keratotomy and at 7 patients after Epikeratophakia. The aesthesiometer of Draeger used in this retrospective study is extremely precise and independent of external changes in temperature and humidity. It could be shown that the corneal sensitivity after radial keratotomy does not change. Even 3 years after Epikeratophakia the lenticle center showed asensible tresholds. The recipients cornea showed normal values at the circular trephination after 6 months. We could demonstrate that the reinnervation of corneal sensitivity after Excimer - Laser - Ablation is parallel to the wound healing and corresponds to the ablationdepth.

Key-Words: Corneal Sensitivity - Refractive Surgery

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## Introduction

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Touching the cornea triggers one of the most sensitive protective reflexes of the human body. The treshold of sensitivity, especially in the center of the cornea, is exceedingly low, so that pathological changes can be diagnosed early and very precisely. Although this has been recognized since von Frey (4) published his original

investigations, aesthesiometry is not yet widely used because of the difficulties of the technique. Because of the low treshold values the applied force also must be very small; furthermore the measurement has to be rapid and reproducible. Up to now the methods used have not met these requirements: Fibre filaments have been used in modern instruments but these vary with age, and are affected by humidity and the temperature of the air. The speed and angle of the approach and the elasticity of the filament vary, not to mention the skill of the examiner, so that the unreliability of the measurement has long hampered its use both clinically and in research.

We have developed a new method of measuring the corneal sensation very precisely and have been able to determine the reinnervation of the cornea, especially after surgical procedures. In this way we have been able to assess not only wound healing but also the state of the corneal metabolism (1, 2, 3). Incising the cornea cuts numerous centripetal nerve fibres and corneal sensitivity has been used as a sensitive indicator of the reinnervation of the particular area of the cornea after cataract extraction and penetrating corneal grafting. At cataract surgery the fibres are cut at the limbus in a semicircle, whereas in corneal grafts the fibres are cut within the cornea and in a complete circle (6,8).

However, what happens to corneal sensitivity after Excimer - Laser - Ablation, after Radial keratotomy (5) or after Epikeratophakia (7)?

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## Method

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The aesthesiometer used in this study is

(\*) Department of Ophthalmology  
University, Hamburg  
Martinistr. 52  
2000 Hamburg 20

extremely precise and is independent of external changes in temperature and humidity. One hand holds the instrument.

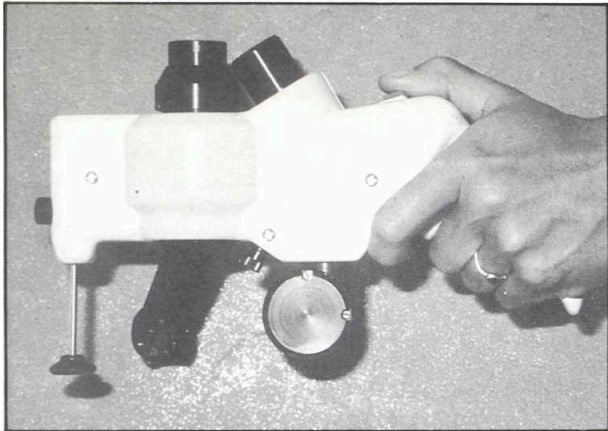


Fig. 1 An esthesiometer ready for use

With the fingertip the motion of the contact pin is released and at the same time the force applied is diminished or increased. Optical control of the measurement is mandatory in order to determine the precise location of contact with the corneal epithelium.

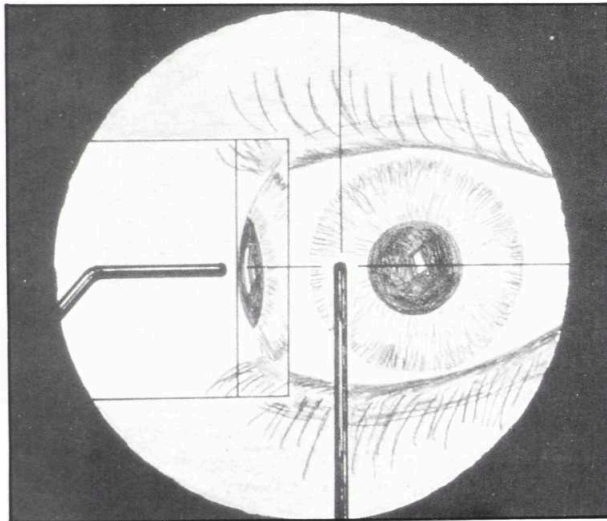


Fig. 2 Optical control of the contact pin

The contact pin touches the cornea rapidly at a predetermined speed which is automatically controlled. The focus adjustment is facilitated by

focusing cross lines. The illumination is part of the instrument. The treshold profile of the instrument is determined first. Before touching the corneal epithelium the forward motion is slowed down to avoid any ballistic effect.



Fig. 3 An esthesiometer applied to the eye

## Patients

In a retrospective study between one month and three years we measured the corneal sensitivity and reinnervation after Excimer - Laser - Ablation, Radial Keratotomy and Epikeratophakia.

82 patients after Excimer - Ablation, 51 female and 31 male, age between 18 and 51 years, with a preoperative myopia between -1,0 and -25,0 dpt, with an ablated optical center between 4,5 and 5,5 mm were examined.

35 patients after Radial keratotomy, 21 female and 14 male, age between 21 and 37, with 4 - 16 incisions and a preoperative myopia between -1,5 and -15,0 dpt and an optical zone of 3,5 - 4,5 mm were examined.

7 patients after Epikeratophakia, 3 female and 4 male, age between 19 and 35, with a preoperative myopia between -13,0 and -24,0 dpt and a lenticle diameter of 7,5 - 8,5 mm were examined.

## Results

In our measurements at corneas after Radial Keratotomy it could be shown that the corneal sensitivity is normal even one month after surgery. The central and peripheral sensitivities have an intact treshold pattern like healthy corneas.

The central sensitivity after Epikeratophakia was totally asensible even three years after surgery. The peripheral parts of the refractive lenticle of each patient showed three years later a mild hyposensitivity. The recipient cornea showed one year later next to the circular trephination a normal sensitivity.

Corneal wound healing and metabolism can effect the outcome of refractive corneal surgery in general and Excimer - Laser - Ablation in particular.

The temporal response of the cornea to Excimer - Laser - Ablation can be divided into three phases: Acute phase 0-4 weeks, intermediate phase 4 weeks to 6 months and long-term phase 6 months and more.

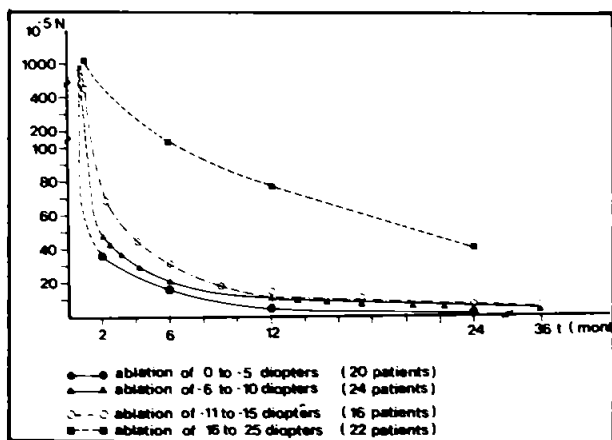


Fig. 4 Corneal reinnervation after Excimer - Laser - Ablation

Ablating the anterior stroma of up to 150 nm causes large to mild hyposensitivity in the first weeks after surgery. The superficial nerve fibres are destroyed and need time to regenerate. After 6 months the corneal sensitivity is almost normal. However, ablating more than 150 nm, which means a correction more than 16 dpt, causes large to moderate hyposensitivity. Even two years after surgery the sensitivity is remarkably reduced.

## Discussion

Concerning Radial Keratotomy we could prove the anatomical corneal structure that radial incisions do not cut the centripetal nerve fibres like after transverse incisions.

The superficial circular trephination of the cornea as a preparatory procedure for the Epikeratophakia leads to peripheral mild hyposensitivity which corresponds to the retrograde nerve fibre degeneration. Because of the small circular wound surface, the dissected superficial nerves and the reduced metabolism at the lenticle, the regeneration and ingrowth of nerve fibres are slowed down. In this way we have been able to assess not only wound healing, but also the state of the corneal metabolism inside the lenticle.

During the acute phase of wound healing, the cornea starts its initial response to epithelial removal and photoablation. In this period corneal sensitivity is decreased. In the intermediate phase the epithelium remodels itself to a normal structure. Nerve fibres regenerate inside the ablated area. However, the corneal sensitivity is still decreased because a large number of fibroblasts populates the anterior stroma which correspond a clinical subepithelial haze and loss of refractive effect.

In the long-term phase the subepithelial stroma remodels itself and corneal haze disappears. Corneal sensitivity and refraction are almost normal and stable. However, ablating more than 100 nm or 10 dpt leads to instable refractive results and a decreased corneal sensitivity. The more stroma is ablated, the worse is the refractive stability and even sensitivity. This proves histological findings that the deeper corneal stroma contains less nerve fibres than the superficial parts. With our examination we are able to show that the regeneration of nerve fibres after Excimer - Laser - Ablation is parallel to the stromal wound healing 3.

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