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Research Article

Confocal Microscopy of the Cornea in Phacoemulsification by the Pre Chop Technique

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Abstract

Objective: To determine the structural changes in the cornea in the cataract surgery using phacoemulsification without complications.

Methods: An observational prospective study in cataract surgery patients using the phacoemulsification Pre Chop technique without complications. These patients were studied by confocal microscopy of the cornea with Confoscan4 (Nidek Technologies) using 40x target and Z - Ring adapter. The study was performed in the preoperative period and postoperative period for 24 hours, one week and one month after surgery.

Results: Structural changes were observed in the cornea such as epithelial cells with hypereflectivity nucleus, occasionally elongated, areas of anomalous hypereflectivity 24 hours after surgery. Activated Keratocytes persisted as well as decreased hypereflectivity of the extracellular matrix that disappeared after a month.

Conclusion: Although biomicroscopy did not show corneal alterations in the postoperative period of the cataract surgery using phacoemulsification, these can be observed in confocal microscopy of the cornea. The study is important to establish a surgical plan in patients with degenerated or dystrophic corneas and to explain to the patient the prognosis of his visual recovery after surgery.

Keywords: *Confocal Microscopy; Phacoemulsification; Cataract; Cornea*

Introduction

Surgery to remove the cataract lens has evolved to achieve perfection and aim to restore the vision of patients in the shortest possible time with the highest quality and quantity, acting on the small details that result in an improvement in the process of diagnosis and surgical treatment, to achieve greater independence of glasses and a rapid social incorporation of patients.

The development of phacoemulsification has currently included the use of confocal microscopy, which is a precise, reproducible and rapid non-invasive diagnostic method, the principle of which is based on the elimination of reflected or fluorescent light from the outer planes of the focus, illuminating a small study area and the light beam from the focal plane is taken [1].

The confocal microscope is an optical instrument that includes a laser light source and an electronic system that helps capture images, thus obtaining an increase in resolution and capturing images of extremely fine optical sections, eliminating the interference produced

by the light that comes from the different optical fields of the thickness of the sample under study, thus achieving focus on a single plane, hence the term confocal, and images obtained digitally, can be magnified more than optical microscopy [2].

It is important to study the cornea with the confocal microscope, whose exploration is carried out directly on the eye [3], with minimal contact with the cornea, even in those with decreased transparency. This study has gained importance in patients with corneal dystrophies prior to cataract surgery and to analyze the viability of donor corneas for keratoplasty.

Confocal microscopy of the cornea with CONFOSCAN 4 (Nidek Technologies) (Figure 1) with the 40x objective and Z-Ring adapter, is a study that demonstrates the structural alterations suffered by the different layers of the cornea even in surgeries. Uncomplicated phacoemulsification, in response to the stress that the tissue supports during surgery, due to the effect of the thermal energy released by the phacoemulsifier tip, during the emulsification of the cataract nucleus [4].

Figure 1: *CONFOSCAN 4 (Nidek Technologies) with 40x lens and Z ring adapter.*

This energy increases in correspondence with the nuclear hardness and the effective phacoemulsification time.

Corneal healing is a complex process due to the great differentiation and strict organization of its structure. It begins at the epithelial level in a period of four to six hours after the surgical trauma and only when it has concluded, does the stromal healing process begin. The recovery of the normal characteristics does not take place when the disposition of the fibers is lost, their diameter increases and the resistance of the tissue decreases. In the absence of mitosis phenomena in endothelial cells, cell loss is covered by an increase in size and the loss of hexagonality of cells neighboring the damaged area. This process causes decreased endothelial activity and endangers the endothelial pump and barrier function, leading to the subsequent loss of corneal transparency [4].

This topic has been analyzed from the procedural technique, the visual results, to the most frequent complications. This research was performed to address the structural changes of the cornea (healing process and corneal inflammatory response) in cataract surgery by histological visualization *in vivo* using confocal microscopy.

Methods

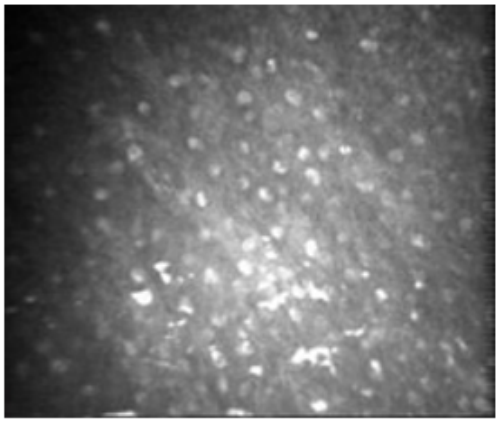
A prospective observational study was carried out in 45 patients operated on for cataract by phacoemulsification using the Pre Chop technique - without complications - at the Ocular Microsurgery Center of the Cuban Institute of Ophthalmology “Ramón Pando Ferrer”,

from January to April 2019. Patients underwent confocal microscopy of the cornea with CONFOSCAN 4 (Nidek Technologies) with the 40x objective and Z-Ring adapter, postoperatively (at 24 hours, one week and one month). Patients who did not complete the scheduled evaluations were excluded. In all cases, the patients' consent was obtained for research in accordance with the Declaration of Helsinki.

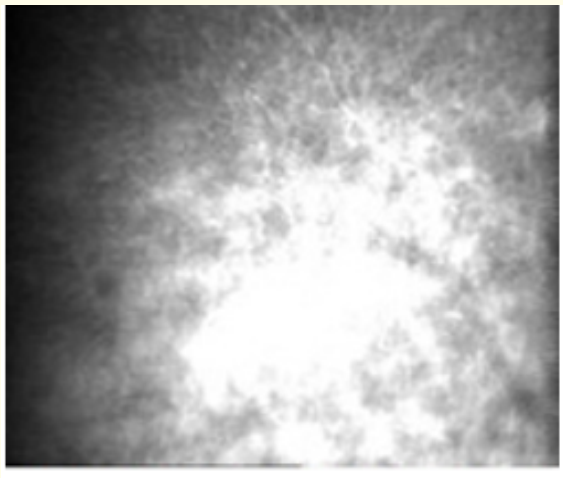
Results

In confocal microscopy 24 hours after surgery, an intact corneal epithelium with normal characteristics could be observed in all patients.

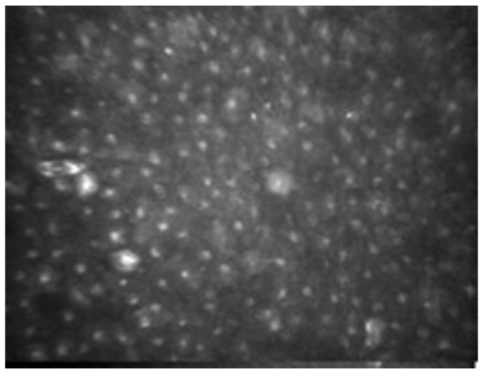
In patients with mild to moderate corneal edema, elongated superficial cells with abnormal reflectivity and hyperreflectivity images representing areas of postoperative subepithelial corneal edema were found.



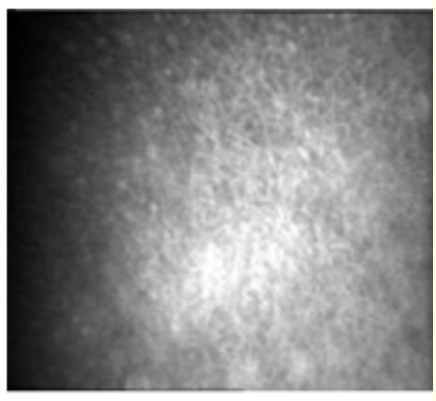
24 hours after surgery. The photograph shows elongated epithelial cells with loss of delimitation of cell borders and areas of abnormal hyperreflectivity.



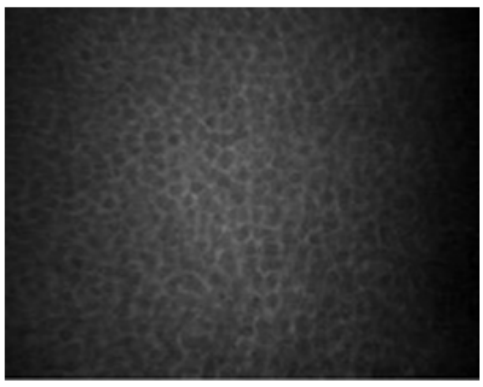
24 hours after surgery. The photograph shows sub epithelial edema, areas of hyperreflectivity under the epithelial basal cell layer.



7 days after surgery. The photograph shows superficial layer with normal-looking cells and hyperreflective nuclei cell.



7 days after surgery. The photograph shows hyperreflective areas below the basal epithelial cell layer.

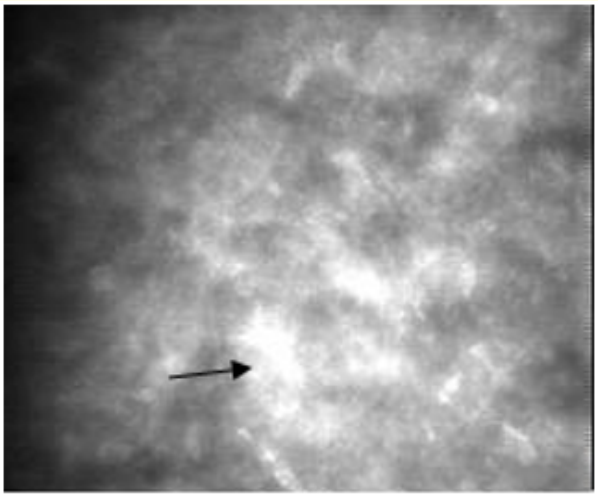


One month after surgery. The photograph shows basal cell layer of normal character, well defined edges.

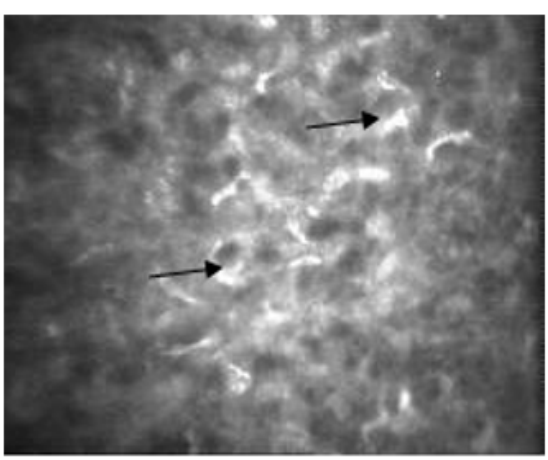
Figure A

Mild to moderate stromal edema results in hyperreflectivity of the extracellular matrix, images of lacunar edema, stromal rarefaction, cellular apoptosis, and keratocyte activation, in addition to finding Descemet's membrane folds.

Anterior stroma changes



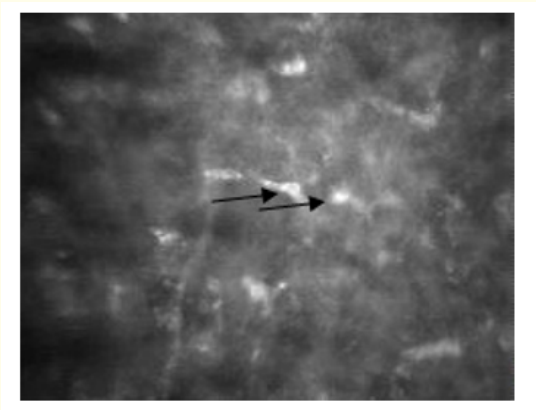
24 hours after surgery. The photograph shows anterior stroma with hyperreflectivity of the extracellular matrix and loss of normal contrast between cells and extracellular tissue. We can observer decreased of the number of keratocytes.



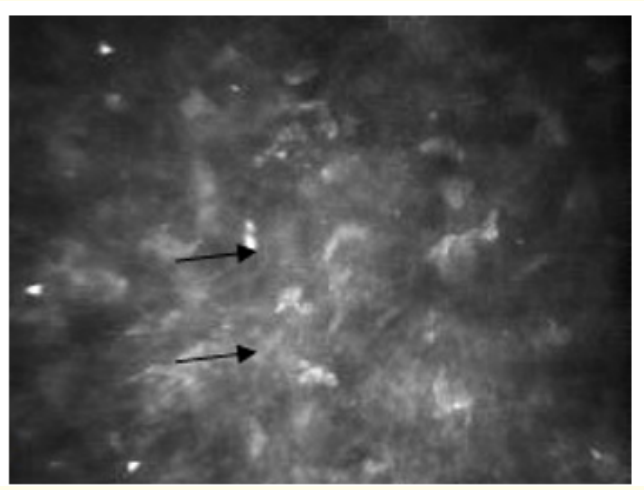
7 days after surgery. The photograph shows corneal edema with the appearance of lacunar cysts and images of activated and apoptotic keratocytes and loss of transparency of the extracellular matrix.

Figure B

Middle stroma changes



24 hours after surgery. The photograph shows stromal edema with decreased of the number of keratocyte, and loss of extracellular matrix transparency, and apoptosis.

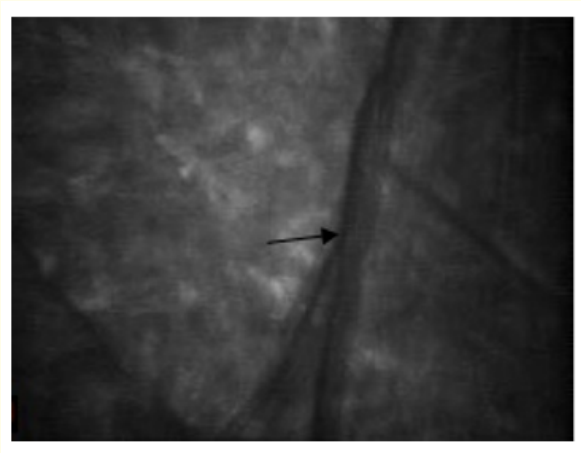


7 days after surgery. The photograph shows recovery of stromal edema, even with a decrease in the number of keratocytes and loss of transparency of the extracellular matrix and apoptosis.

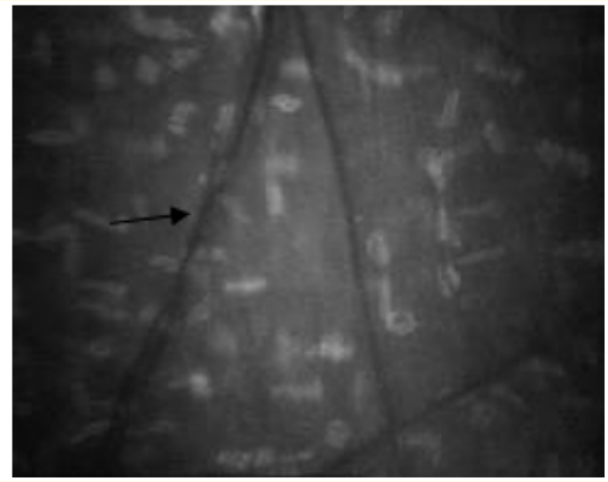
Figure C

Posterior stromal changes

The changes in the corneal endothelium were related to the preoperative state and the phacodynamic parameters used during surgery. For this study group, the effective ultrasound time was less than one minute with powers less than 10%, vacuum 400 mmHg and flow of 38 cc/min, on average. Polymegatism and pleomorphism characteristic of the patient's age were found, and different degrees of dystrophies



24 hours after surgery. The photograph shows hyporeflective images representing thick folds in Descemet's membrane and needle-shaped keratocytes.

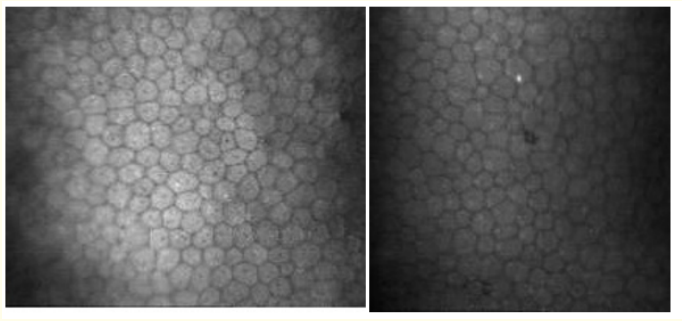


7 days after surgery. The photograph shows hyporeflective images representing fine folds in Descemet's membrane and needle-shaped keratocytes.

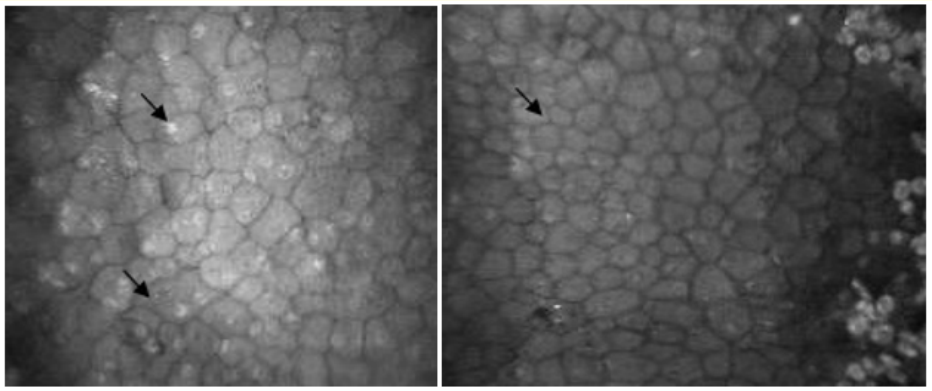
Figure D

accompanied by guttas in the endothelium. The cell nuclei showed hyperreflectivity and there was a blurred appearance of the endothelial mosaic with loss of the delimitation of the cell borders.

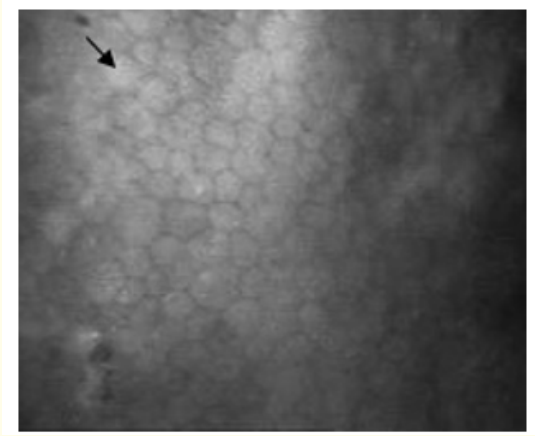
We can observe 30 days after the surgery some activated keratocytes and the recovery of the transparency of the extracellular matrix. Few superficial fine folds of the Descemet's membrane were maintained, with recovery of the anatomical characteristics of the cornea.



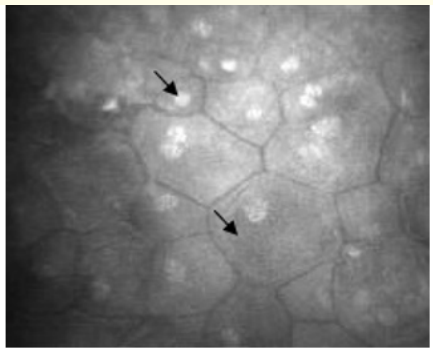
The photograph shows corneal endothelium with polymegatism and pleomorphism corresponding to the age of the patient and presence of isolated guttas.



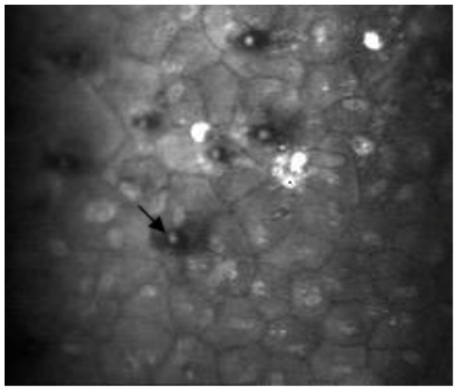
The photograph shows corneal endothelium with polymegatism and moderate pleomorphism, with hyperreflectivity of the nucleus cell.



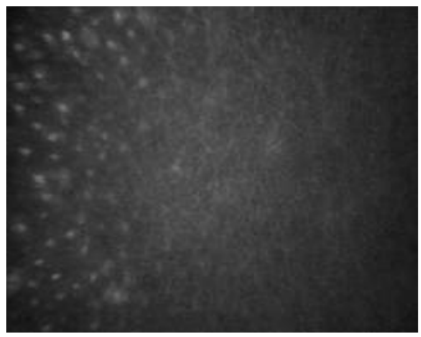
The photograph shows blurred appearance of the corneal endothelium with loss of definition of the edges and the nucleus cell. The photograph shows corneal endothelium with polymegatism and severe pleomorphism, with hyperreflectivity of the nucleus cell.



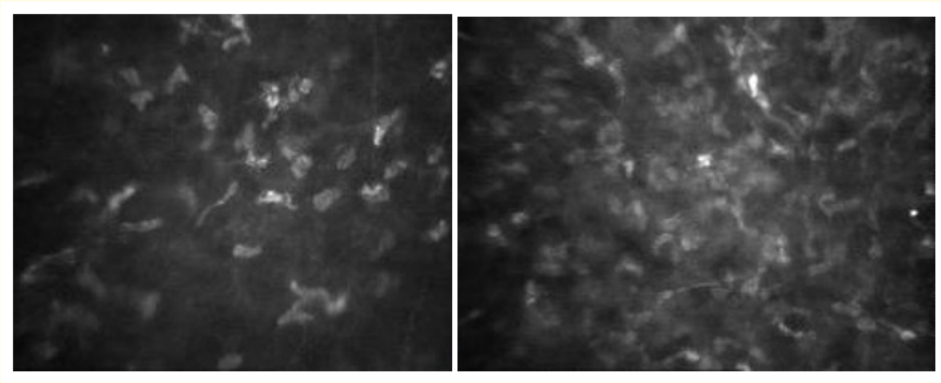
The photograph shows corneal endothelium with polymegatism and pleomorphism, hyperreflectivity of the nucleus cell and Guttas in a patient with Fush dystrophy.



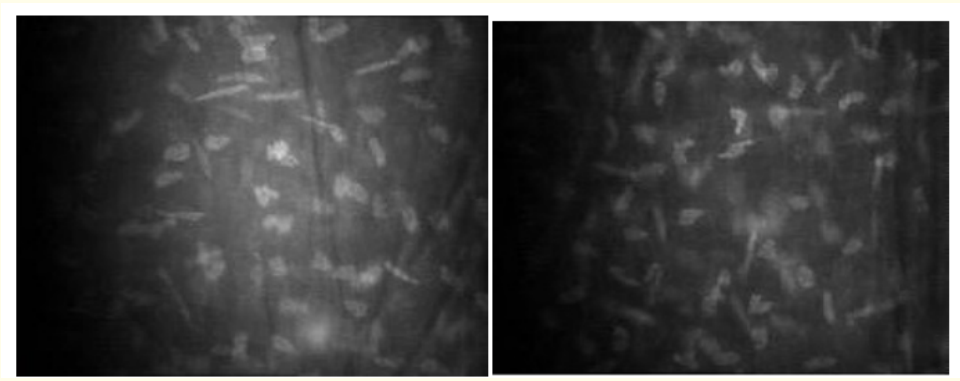
10 days after surgery, the photograph shows an corneal epithelium of normal morphology was observed and a repopulation of keratocytes, needle-shaped keratocytes, decreased corneal stromal hyperreflectivity and images of lacunar cysts were found in the corneal stroma. There was also a decrease in the number, thickness and depth of the Descemet's membrane folds and the number of hyperreflective nuclei cell in the corneal endothelium, with recovery of normal transparency patterns.



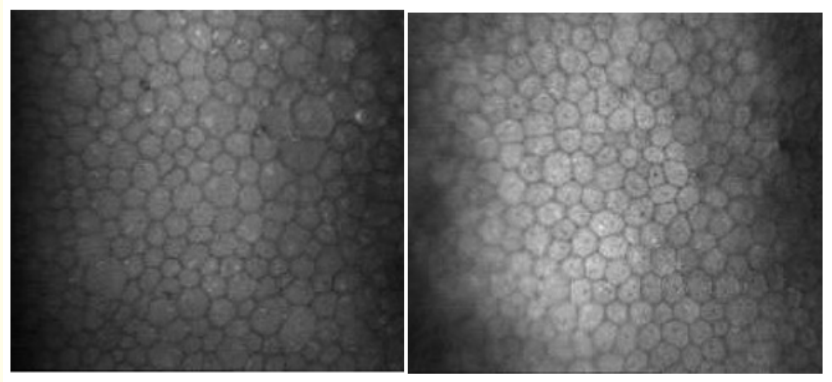
The photograph shows corneal epithelium of normal morphology: superficial cells with hyperrefringent nuclei cell and basal cells with defined edges, without visible nuclei cell.



The photograph shows activated keratocytes and decreased hyperreflectivity of the extracellular matrix.

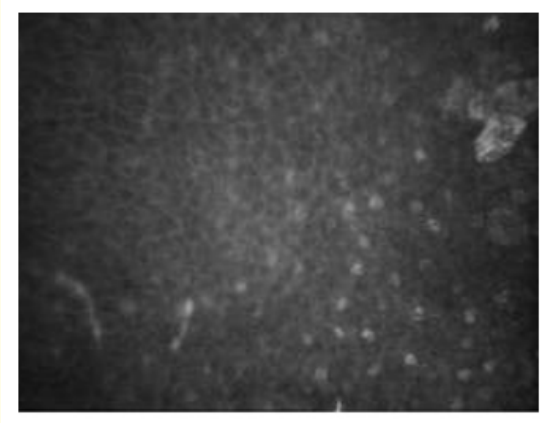


The photograph shows needle keratocytes. Decrease in the number, thickness and depth of folds in Descemet's membrane.



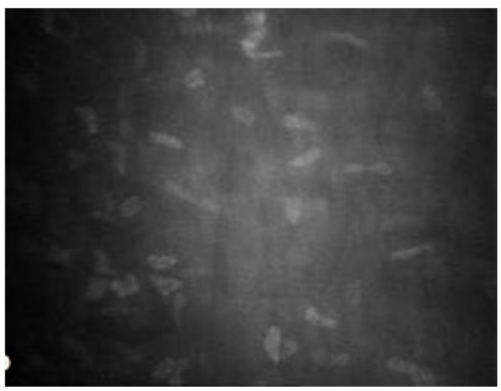
The photograph shows decrease in the number of hyperrefringent nuclei cell.

Figure E

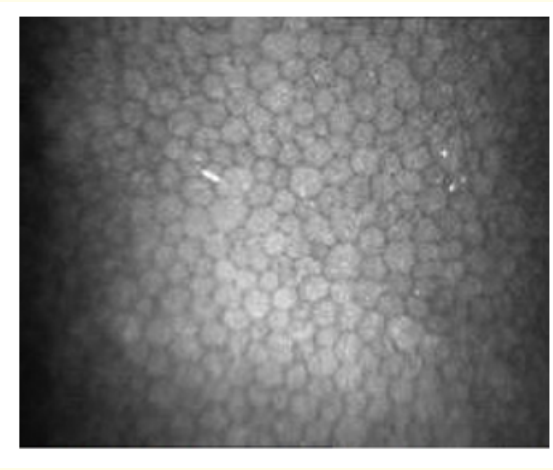


The photograph shows normal-looking epithelial cells.

The photograph shows some hyperactive keratocytes and recovery of the transparency of the extracellular matrix.



The photograph shows Needle-shaped keratocytes and thin creases in Descemet's membrane, not very pronounced.



The photograph shows corneal endothelium of normal appearance.

Figure F

Discussion

The analyzed results show that the corneal alterations that are diagnosed in the preoperative and postoperative period of cataract surgery, even uncomplicated, show the utility of the confocal microscope to observe, analyze the structure and thickness of the cornea; as a result, prognosis of the surgery and repercussion on the corneal tissue can be established.

Given the good visual recovery of the patients, these results could have an important role in the evaluation of the dynamic and structural changes of the cornea, of value in the diagnosis and evaluation of different pathologies of the cornea, therefore in cases with previous corneal diseases or with a poor evolution in the postoperative period that compromise this tissue, this study becomes more important.

The measurement of corneal thickness by confocal microscopy has value to determine the functional state of the corneal endothelium and thus assess the risk of decompensation caused by phacoemulsification and establish prognoses and surgical strategies that minimize tissue damage [5,6].

It should be taken into account that although biomicroscopy does not show corneal alterations in the pre and postoperative period of cataract surgery by phacoemulsification, these alterations can be demonstrated by confocal microscopy of the cornea.

There are studies that showed that there are no significant differences between endothelial cell density measurements using specular and confocal microscopy [7-11], in relation to corneal endothelial morphology, significant differences were shown between the measures collected by both studies [7-11], although confocal microscopy overestimated the degree of polymegetism and pleomorphism.

Conclusion

We can conclude that although biomicroscopy did not show corneal alterations in the postoperative period of the cataract surgery using phacoemulsification, these can be observed in confocal microscopy of the cornea. These variations do not have an impact on optimal visual recovery of the patients. The study is important to establish a cataract surgical plan in patients with degenerated or dystrophic corneas and to explain to the patient the prognosis of his visual recovery after the cataract surgery, to achieve early visual recovery.

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