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Research Article

Corneal Endothelial Cell Changes in Mechanical Versus Alcohol-Assisted Epithelial Debridement During Photorefractive Keratectomy

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Abstract

Purpose: This study aimed to compare the changes in corneal endothelial cells between mechanical isolation of the epithelium and alcohol-assisted isolation six months after photorefractive keratectomy.

Methods: This randomized, controlled trial included 80 eyes from 40 patients undergoing PRK for myopia and myopic astigmatism correction. Each patient was randomly assigned to undergo alcohol-assisted epithelial removal or mechanical epithelial removal.

Results: Forty patients with an average age of 25 years (range, 19 to 55 years) were studied. The alcohol group had a lower postoperative cell density than the mechanical group, but this difference was not statistically significant ($p = 0.062$). In the alcohol-assisted PRK group, the size of the cells was smaller, but the difference between groups before and after surgery was not statistically significant ($p = 0.52$). There was no statistically significant difference between the frequency of hexagonal cells in any of the groups.

Conclusion: According to the findings of this study, there was no significant difference in endothelial cell parameters between the mechanical and alcohol-based epithelial debridement groups. The method of debridement is determined by the surgeon. We recommend a study with a longer follow-up period and a larger statistical sample size.

***Keywords**: Alcohol-Assisted Photorefractive Keratectomy; Mechanical Epithelial Debridement; Photorefractive Keratectomy; Corneal Endothelial Cell; Specular Microscopy*

Introduction

The excimer laser corneal refractive surgery is a traditional, safe and effective method for correcting refractive errors [1]. In spite of the fact that laser in situ keratomileusis (LASIK) is still the most common procedure, corneal surface ablation techniques such as photorefractive keratectomy (PRK) have gained popularity in recent years due to concerns about flap-related complications and postoperative ectasia [2-4]. In photorefractive surgery, the corneal epithelium must be removed before stromal ablation. Different techniques have been used to remove the epithelium; this is typically accomplished with a blunt surgical blade, transepithelial laser ablation, rotating brush or a chemical agent such as ethanol [5,6]. Simple mechanical and alcohol-assisted removal are the most widely employed approaches. Initial epithelial removal involved mechanical debridement. There are downsides to this basic and effective strategy. Manual epithelial debridement with sharp scalpel blades has been observed to cause nicks and scratches in Bowman's membrane and to leave varied quantities of epithelium. The residual epithelium and basement membrane may affect the depth of excimer laser ablation [7]. In addition, especially for unskilled surgeons, mechanical debridement can be time-consuming. Alcohol-assisted removal is simpler, quicker, and likely more comfortable for both the patient and the surgeon, but it may have toxic side effects. The use of alcohol makes epithelial removal simple, rapid, and thorough, but it also poses certain challenges. It has been discovered that high concentrations of ethanol produce inflammation and damage to stromal keratocytes [8].

Concerning postoperative pain and subepithelial scar formation, as well as the toxicity of alcohol, the advantages and disadvantages of each treatment method are contested. Several studies have compared these techniques in terms of epithelial healing time, duration of postoperative pain, corneal haze, and stromal keratocyte loss [9,10]. One of the discrepancies is the impact on endothelial cells, the corneal endothelial barrier and pump function are crucial for maintaining the cornea's optical clarity. Although numerous disease states can affect the function of this tissue, the ophthalmic surgeon is particularly concerned with iatrogenic causes of endothelial loss. If there is evidence that a technique can cause considerable endothelium damage, it should not be conducted [11,12].

In the present investigation on patients undergoing PRK with MMC, we compared endothelial cell characteristics after PRK/ MMC with ethanol-assisted versus mechanical corneal epithelial debridement using Specular microscopy.

Methods

This study was performed on 43 patients who were referred to Al-Zahra Hospital in Zahedan over a period of 3 months, of which 40 patients completed the study. Myopia with a spherical equivalent refraction of better than -6.00 diopters (D) and cylinder error less than -3.00 D, no hard contact lens use for 6 weeks, no soft contact lens wear for 2 weeks and before baseline examination, estimated residual corneal thickness after surgery more than 420 µm stable refraction error over the past year and age between 19 and 50 years old were the inclusion criteria.

Exclusion criteria included a history of systemic diseases (e.g. autoimmune disorders, collagen vascular diseases, and diabetes), one-eyed patients, dry eye, corneal ectasia, history of ocular trauma and intraocular surgery, intraocular pressure greater than 20 mm Hg, lens opacity, uveitis, posterior segment diseases, and any other ocular diseases besides refraction error. All patients were informed of risks and benefits prior to surgery, and they all provided written informed consent in accordance with institutional guidelines and the Declaration of Helsinki.

The patients were randomly divided into two groups. The first group was the mechanical PRK group, and the second group was the alcohol-assisted PRK group. in all patients After clinical examination the noncontact specular microscope (TOMEY EM-4000; USA) was used for endothelium morphology evaluations. The specular microscope uses the automatic function to capture a focused image of central endothelium, and the specular microscope's analysis program calculated the endothelial cell density (ECD), the coefficient of variation of cell area (CV) and the percentage of hexagonal cells (HEX). The same experienced surgeon conducted all PRK procedures with the same excimer laser machine (TECHNOLAS® TENEO™ 317, Bausch and Lomb, Rochester, NY, USA).

The eyelids and periocular area were disinfected with a 10% povidone iodine solution for one minute prior to surgery, and then the eye was rinsed with 20 mL of a balanced salt solution. The eyes were exposed using a wire lid speculum following the administration of tetracaine eye drops twice within a 5-minute interval. In the mechanical group, the epithelium was removed manually using a blunt hockey blade in a centripetal motion. In the alcohol group, corneas were exposed to 20% ethanol alcohol via a well for 30 seconds. After thirty seconds, the alcohol was absorbed by a dry polyvinyl alcohol sponge (Merocel, Medtronic, Inc.) and 8 millimeters was the diameter of epithelial removal. Following the removal of the epithelium, excimer laser ablation was performed. Mitomycin C (MMC) 0.02% was combined with fluorescein and applied to the stromal surface for 5s per one diopter correction using a sponge after laser ablation. The cornea was covered with a bandage contact lens (Bausch and Lomb, Rochester, NY, USA) and irrigated with chilled balanced salt solution. The patients were discharged with a prescription for ciprofloxacin 1% eye drops every four hours, betamethasone 0.1% eye drops every four hours, diclofenac eye drops every six hours, and artificial tears as needed. All statistical analyses were conducted using SPSS Version 26 (SPSS Inc, Chicago, IL, USA). $P < 0.05$ was considered statistically significant. The paired t-test was used to compare the specular microscope study parameters between the two groups.

Result

The 40 patients in the present study had a mean (± SD) age of 26.13 (± 3.9) years (range, 19 to 50 years), and 29 patients (72.5%) were female. Overall, forty eyes from twenty patients were assigned to the alcohol group, and on the other hand, forty eyes from twenty patients were assigned to the mechanical group. Six months of follow-up care was provided to each patient.

Comparison of preoperative and 6-month postoperative endothelium cell morphology, including ECD, CV, and HEX, was performed in this study. Specular microscopy examinations showed that There was also no statistically significant difference between preoperative and postoperative values of corneal endothelial cell variables between the two groups. When patients underwent mechanical and alcohol surgery, the mean postoperative cell density was lower in the alcohol group but was not statistically significant ($p = 0.062$). In the alcohol-assisted PRK group, the cell size was smaller, but in general, the difference before and after surgery between any of the groups was not significant ($p = 0.52$). In none of the groups, there was no statistically significant difference between the frequency of cells Hexagon (Table 1).

		ECD Mean ± SD	P-value	Coefficient of variation Mean ± SD	P-value	Hexagonal cell variation Mean ± SD	P-value
Pre-operative	Mechanical	2672 ± 324.6	0.35	38.3 ± 8.03	0.23	48.51 ± 9.6	0.31
	Alcohol	2601 ± 411.1		36.9 ± 3.7		50.28 ± 7.19	
Post-operative	Mechanical	2597.8 ± 314.4	0.07	44.48 ± 8.89	0.41	41.65 ± 8.23	0.34
	Alcohol	2469 ± 285.6		36.15 ± 7.41		42.93 ±7.24	

Table 1: *Comparison of preoperative and 6-month postoperative endothelium cell morphology (ECD, CV, HEX).*

Discussion

Photorefractive keratectomy is a refractive surgical procedure with a superficial corneal incision with a long history in correcting myopia and myopic astigmatism. In PRK surgery, the corneal epithelium must be removed before laser stromal incision. Various techniques have been used to deplete the epithelium; mechanical applications include the use of alcohol, the use of lasers, and tools such as rotating brushes. Among these, mechanical and alcoholic methods are more common than others. In the study by Nasiri., *et al*. [13], there was no statistically significant difference between any of the groups in terms of cell density, which is consistent with our own findings. In addition, Peter Isager., *et al*. [14] who examined cell density in PRK with alcohol debridement, observed a significant decrease in endothelial cell density, which was inconsistent with our findings. In the alcohol-assisted PRK group, the cell size was smaller, but in general, there was no statistically significant difference in cell size between any of the groups between before and after surgery. In the study of Nasiri., *et al*. [13], there was no statistically significant difference between the cell sizes in the different groups, which was consistent with our study. There was no statistically significant difference between the frequencies of hexagonal cells in any of the groups, according to the results of our study. In the study by Nasiri., *et al*. [13], there was no statistically significant difference between the frequency of hexagonal cells in any of the groups before and after surgery, which is consistent with our findings. The study was conducted by Patel Sv [15], endothelial cell parameters, such as cell density, cell size, and hexagonal cell frequency, were not statistically significant after 9 years of follow-up, which examined endothelial cell parameters in PRK with non-alcoholic debridement. In other studies, two methods of epithelial debridement were evaluated for variables other than endothelial cell parameters. Einollahi., *et al*. [16], examined keratocyte density in these two groups and found that mechanical debridement decreased keratocyte density. And finally, alcohol was proposed as the preferred debridement method. Also, in abad jc's study [17], which examined the time of epithelial separation, defect size, BCVA, and subepithelial haze, the alcohol group was suggested as a viable alternative to the mechanical method. Also in the study by Browning., *et al*. [18], they suggested alcohol as a superior method because alcohol debridement produces a smoother surface. Other studies, such as the study of BCVA, epithelial repair, and postoperative pain conducted by Ghoreishi., *et al*. [19], found no difference between the two groups.

We found no statistically significant differences between the two corneal epithelial debridement methods in terms of corneal endothelial cell density, hexagonality, and polymegathism. Due to the fact that the inclusion criteria for MMC were identical between the two treatment groups in our study, we can conclude that alcohol consumption does not exacerbate the potential adverse effects of PRK with MMC on corneal endothelial cells.

Conclusion

The results of this research showed that there was no discernible difference in the endothelial cell parameters between the groups that underwent mechanical epithelial debridement and those that underwent alcohol-based epithelial debridement. The surgeon will decide the approach that will be taken to the debridement. We suggest an investigation that has a greater number of participants in the statistical sample and a follow-up period that is significantly longer.

Conflict of Interest

The authors state no conflict of interest.

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Statements and Declarations

The ethical aspects were considered and confirmed by the related ethical committee of Zahedan University of Medical Sciences (IR. ZAUMS.REC.1400.072).

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