

Comparative study between manual and brush de-epithelization in photorefractive keratectomy (PRK)

Estudo comparativo entre a técnica manual e a escova rotatória na remoção do epitélio corneano na ceratectomia fotorrefrativa (PRK)

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ABSTRACT

Objective: To compare the influence of two techniques for corneal epithelial removal in photorefractive keratectomy (PRK) – blunt scrape versus rotary brush – regarding duration of technique application, intraoperative comfort, and reepithelization. **Methods:** This prospective randomized study included 58 eyes of 29 patients that underwent simultaneous and sequential PRK in both eyes – blunt scrape (scraped group) in one eye and rotary brush (brushed group) in the fellow eye. **Results:** The faster technique, measured in seconds, was the rotary brush (16.4 ± 6.3) compared to the blunt scrape (35.7 ± 7.6). There was no difference between the methods regarding discomfort reported by the patient during surgery and the type of symptom reported postoperatively ($p > 0.05$). The analysis of variance (ANOVA) showed that the brushed group were related to a greater intensity of symptoms [$F(8,104) = 1.5, p < 0.05$] and post hoc testing indicated that this difference was only significant ($p < 0.05$) on day 2. All eyes of the 2 groups showed complete corneal epithelialization on day 5 postoperatively. **Conclusion:** In this study, it was found that epithelial removal with rotating brush was superior to manual only by its shorter application. It showed the same level of intraoperative discomfort and determined a greater intensity of symptoms postoperatively.

Keywords: Refractive errors; Photorefractive keratectomy; Cornea; Epithelium; Wound healing; Postoperative period

RESUMO

Objetivo: Comparar a influência de duas técnicas de remoção do epitélio da córnea quanto ao tempo de aplicação, ao conforto intraoperatório, à sintomatologia e à reepitelização no pós-operatório de ceratectomia fotorrefrativa (PRK). **Métodos:** Este estudo prospectivo e randomizado incluíam 58 olhos de 29 pacientes que tiveram ambos os olhos submetidos sequencial e simultaneamente à PRK, sendo que em um dos olhos foi realizado a desepitelização manual com espátula e no outro, a técnica mecanizada com escova rotatória. **Resultados:** A técnica mais rápida, medida em segundos, foi a escova rotatória ($16,4 \pm 6,3$) em comparação com a manual ($35,7 \pm 7,6$). Não houve diferença entre os métodos quanto ao desconforto referido pelo paciente durante a cirurgia e quanto ao tipo de sintoma referido no pós-operatório ($p > 0,05$). A análise de variância (ANOVA) mostrou que o método da escova estava relacionado a uma maior intensidade de sintomas [$F(8,104)=1,5; p < 0,05$], e o teste *post hoc* indicou que essa diferença só foi significativa ($p < 0,05$) no 2º dia de pós-operatório. Todos os olhos dos 2 grupos apresentaram epitelização corneana completa no 5º dia de pós-operatório. **Conclusão:** Neste estudo, observou-se que a desepitelização com escova rotatória foi superior à técnica manual unicamente pelo seu menor tempo de aplicação. Comparativamente esteve relacionada a um mesmo nível de desconforto intraoperatório e uma intensidade maior nos sintomas pós-operatórios.

Descritores: Erros refrativos; Ceratectomia fotorrefrativa; Córnea; Epitélio; Cicatrização de feridas; Período pós-operatório

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INTRODUCTION

The modern era of refractive surgery began in 1983 with the introduction of excimer laser to modify the structure of the cornea⁽¹⁾. Photorefractive keratectomy (PRK), one of the most popular and effective techniques to correct refractive errors, consists of laser surface ablation of the anterior corneal stroma after carefully removing the epithelium⁽²⁾. One disadvantage of this technique is the postoperative ocular discomfort associated with de-epithelialisation and consequent exposure of corneal nerve fibres⁽³⁾, as well as the release of inflammatory factors. Initial pain usually lasts 12 to 24 hours, followed by irritation and epiphora until the epithelium is completely healed⁽⁴⁾.

Candidates to refractive surgery are becoming more demanding not only with respect to the visual outcome, but also regarding comfort during the procedure and the length of postoperative recovery. Even though many ophthalmologists believe that PRK is a safer method, laser *in situ* keratomileusis (LASIK) is still the most commonly performed refractive surgery worldwide⁽⁵⁾. The ocular discomfort reported by patients after PRK, despite the availability of various analgesic options, and the longer time for visual recovery remain a challenge for surgeons, who often opt for LASIK in order to avoid these drawbacks⁽⁶⁾.

Several modifications to the conventional manual technique have been introduced in an attempt to decrease pain and accelerate epithelial postoperative recovery. Most of them consist of different methods to remove the epithelium⁽⁷⁾: de-epithelialisation with a rotating brush^(8,9), laser transepithelial ablation^(6,10) and alcohol de-epithelialisation⁽¹¹⁻¹³⁾.

This study aimed to evaluate two de-epithelialisation techniques (the manual technique with a blunt spatula and the rotating brush) at different moments of the PRK procedure. This is one of the few studies in the literature that compared the two techniques regarding not only the time for re-epithelialisation and postoperative comfort, but also intraoperative discomfort.

METHODS

This prospective randomised study included patients from the Refractive Surgery Unit of the Ophthalmology Department, ABC Medical School (FMABC), who underwent surgery at the ABC

Ocular Laser Ophthalmic Centre in Santo André/SP, Brazil. The inclusion criteria were: patients of both genders, aged 21-45 years, with indications for PRK, and with identical or very similar refractive errors in both eyes. The exclusion criteria were: a preoperative difference in refractive error >1.5 spherical equivalent dioptres between both eyes, patients who did not attend follow-up visits, and patients with intra- or postoperative complications. Immediately prior to surgery, the first eye to be operated and the technique to be used in each eye were chosen randomly. Since technique comparison relied on subjective symptom assessment by patients, they were blinded to the type of de-epithelialisation performed in each eye.

The study was approved by the Research Ethics Committee of FMABC and all procedures followed the provisions of the Declaration of Helsinki. Participation was voluntary and all patients provided their informed consent after receiving detailed information about the study.

Preoperative evaluation included the following tests: visual acuity, static and dynamic refraction, slit lamp biomicroscopy, applanation tonometry, ultrasound pachymetry, corneal tomography, and retinal mapping. All assessments were done by the authors of the study.

Surgical procedure

The procedures were performed under topical anaesthesia with two drops of proxymetacaine hydrochloride 0.5% (Anestalcon™, Alcon). A 9 mm optical zone marker was used to demarcate the area to be de-epithelialised. Each patient had both eyes sequentially subjected to PRK surgery using the 400-Hz WaveLight Allegretto Eye-Q excimer laser. In the first eye, de-epithelialisation was performed manually with a straight, round-tip crescent knife (Alcon, Brazil) (Figure 1); in the other, a 9 mm rotating brush (Amoils Rotary Epithelial Scrubber, Innovative Excimer Solutions, Inc., Toronto, Canada) (Figure 2) was employed, following the manufacturer's instructions. All procedures were performed by the same surgeon, who was very experienced in this type of procedure.

Mitomycin C 0.02% was applied for 30 seconds on all eyes after ablation using a high-profile 6 mm optical zone marker.

A balanced salt solution frozen in polyvinyl alcohol (PVA) sponge surgical spears was used to improve analgesia, being applied for 10 seconds before and after photoablation.

At the end of the procedure, all eyes received one drop of moxifloxacin 0.5% (Vigamox™, Alcon) and prednisolone acetate 1% (Falcon Genéricos, Alcon), and hydrophilic bandage contact lenses were applied.

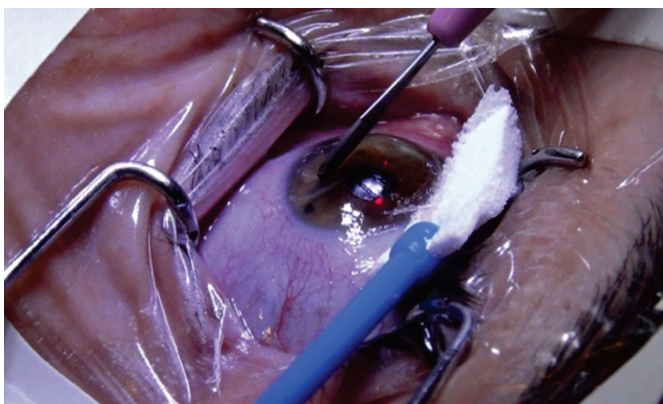


Figure 1: Manual de-epithelialisation with a straight, round-tip crescent knife (Alcon, Brazil)

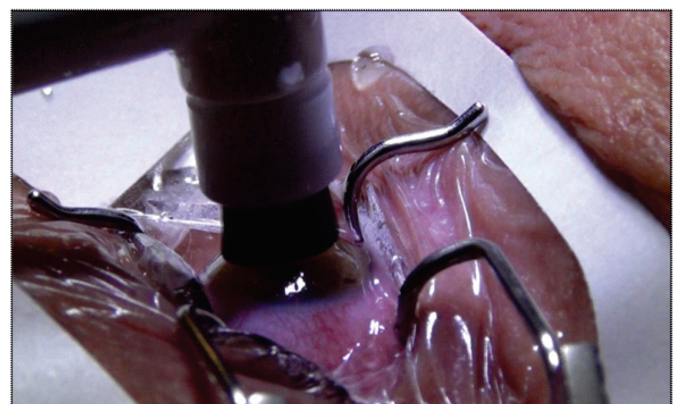


Figure 2: De-epithelialisation with a 9 mm rotating brush (Amoils Rotary Epithelial Scrubber, Innovative Excimer Solutions, Inc., Toronto, Canada).

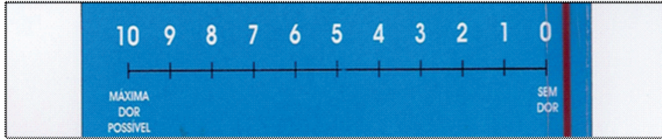


Figure 3: Visual analogue scale

Postoperative treatment

Patients were instructed to apply the following eye drops in both eyes postoperatively: moxifloxacin 0.5%, one drop three times daily for seven days; nepafenac 0.1% (Nevanac™, Alcon), one drop three times daily for four days; fluorometholone acetate 0.001 g (Florate™, Alcon), one drop four times daily for three weeks; and carmellose sodium 0.5% (Fresh Tears™, Allergan), one drop six times daily for two months.

Patients were examined on postoperative days 1 and 5.

Evaluation of surgical times for each technique

All surgical steps for each de-epithelialisation technique were timed. Time was only measured in seconds during de-epithelialisation.

Evaluation of intraoperative discomfort

During surgery, immediately after de-epithelialising the second eye, patients were asked to score their discomfort during surgery from 0 to 10 in each eye, with 0 for no discomfort and 10 for maximum discomfort.

Questionnaire for postoperative symptoms

On the first day after PRK patients were questioned about their most significant symptom in each eye. Symptom severity was measured using a visual analogue scale (Figure 3) consisting of a 10-cm line with a mobile marker that quantifies symptoms from 0 to 10⁽¹⁴⁾, with 0 for no symptoms and 10 for maximum severity. Patients were asked to slide the marker until the point that represented the severity of their symptoms in each eye.

At the end of postoperative days 2 and 3, always at the same time, patients recorded the severity of their symptoms in each eye on the leaflet they received on their first postoperative visit. On the fifth day after PRK patients returned for evaluation of corneal healing and to present the information they recorded at home.

Statistical analysis

The IBM SPSS 19 software was used for data analysis. Quantitative statistical analysis was performed to verify whether the data were parametric (homogeneity of variance, normality, and absence of outliers), followed by appropriate analysis of variance (ANOVA) and a post-test (*post hoc*). The chi-squared test was used to compare symptom frequency.

RESULTS

Thirty-three patients met the inclusion criteria and four were excluded from the study, leaving a total of 58 eyes in 29 patients for data analysis. Three of the exclusions were because of bandage contact lenses falling out before postoperative day 5, and one was because the patient did not attend the scheduled visit within the stipulated period.

Intraoperative analysis

The fastest technique was the rotating brush, with a minimum surgical time of 9 seconds and a maximum of 38 seconds (16.4±6.3). The manual technique required 17-51 seconds (35.7±7.6). The difference between techniques was statistically

significant ($t[46]=-9.5; p=0.00$).

There was no statistically significant difference between groups for the discomfort reported by patients during surgery ($t[56]=0.9; p=0.37$).

Postoperative analysis

The most significant symptom reported on the first day after PRK was always identical in both eyes, except for two patients who reported no symptoms in the eye operated with the manual technique (Table 1). No patients reported pain. Foreign body sensation and burning were the most common symptoms in both groups and were significantly more frequent than other symptoms ($p<0.05$). There was no difference between methods regarding the types of postoperative symptoms ($p>0.05$).

Figure 4 shows the symptom scores obtained using the subjective visual analogue scale. ANOVA showed greater symptom severity with the brush method compared to the manual technique ($f[8.104]=1.5; p<0.05$). The *post hoc* test showed that this difference was only significant ($p<0.05$) on the second postoperative day (Table 2).

All eyes in both groups presented complete corneal epithelialisation on postoperative day 5, at which time the bandage contact lenses were removed.

DISCUSSION

This study compared two de-epithelialisation techniques used in PRK: manual de-epithelialisation with a spatula and the rotating brush technique. This is one of the few studies that compared not only the time required for re-epithelialisation and postoperative comfort, but also intraoperative discomfort.

In 1994, Pallikaris et al.⁽¹⁵⁾ showed that the rotating brush technique was faster than the manual approach. Subsequent studies proved that this is a safe and effective method^(8,9,16). In the present study, the rotating brush technique was faster, and the level of intraoperative discomfort was similar for both techniques.

In a study comparing manual de-epithelialisation with and without diluted alcohol, Corpa et al.⁽¹³⁾ reported that the most frequent postoperative symptoms in both groups were foreign body sensation and burning. The present study found very similar results.

In PRK, photoablation reaches the sub-basal nerve plexus and the anterior corneal stroma, leaving abruptly-cut nerve fibres at the wound base and edges⁽¹⁷⁾. Cytokines and nerve growth

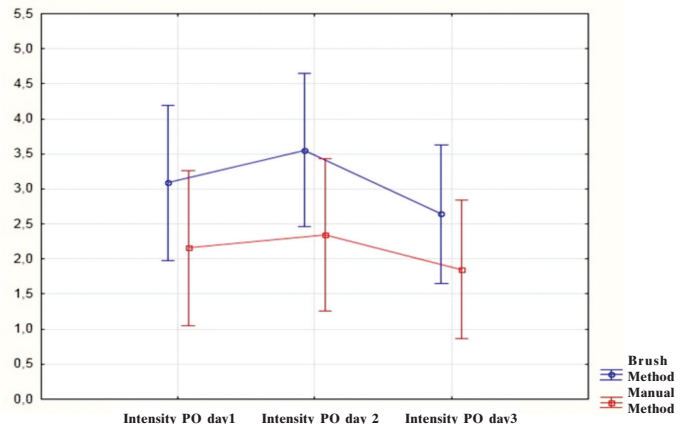


Figure 4: Symptom scores obtained using the subjective visual analogue scale after manual and rotating brush de-epithelialisation.

Table 1
Symptoms most commonly cited by patients after manual and brush de-epithelisation

Symptom	Manual		Brush	
	N	%	N	%
Foreign body sensation	11	40,7	12	41,4
Burning	10	37	10	34,5
Sharp pain	3	11,1	4	13,8
Photophobia	2	7,4	2	6,9
Discomfort	1	3,7	1	3,4
Total	27	100	29	100

Table 2
Subjective assessment of postoperative symptoms after manual and brush de-epithelisation

	PO day 1		PO day 2		PO day 3	
	Manual	Brush	Manual	Brush	Manual	Brush
Mean	2,38	3,31	2,17	3,38	1,72	2,52
SD	2,23	3,31	2,11	2,58	2,03	2,10
P-value	0,13		0,06		0,15	

* PO = postoperative; SD = standard deviation

factor (NGF) released after injury can also produce nerve sensitisation, lowering the excitation threshold^(4,18). Several modifications to the conventional manual technique have been introduced in an attempt to decrease pain and accelerate epithelial recovery, mostly by changing the de-epithelisation method⁽⁷⁾. Chang et al.⁽¹⁹⁾ found that mechanical de-epithelisation increased the response to inflammatory cytokines and the expression of the TGF-beta 1 gene to a greater degree than the alcohol technique. However, recent studies have demonstrated that alcohol produces more postoperative symptoms than the manual technique, probably due to alcohol toxicity^(3,13). A 2012 study showed that the rotating brush produces significantly more postoperative pain in PRK than epithelial-laser *in situ* keratomileusis (epi-LASIK) with flap removal⁽²⁰⁾. It has been suggested that the rotating brush crushes epithelial cells, thus releasing more proinflammatory cytokines in the surgical site⁽²¹⁾. In the present study, symptoms were more severe in eyes de-epithelialised with a rotating brush.

Weiss et al.⁽²²⁾ analysed electron microscopy images of rabbit corneas subjected to different de-epithelialisation methods and concluded that the alcohol, rotating brush, and laser methods were superior to the blunt spatula method, as they produced a smoother surface in the anterior corneal stroma. Manual de-epithelialisation with a spatula creates a more irregular surface, which hinders epithelial healing. In a comparative study of different de-epithelialisation techniques in PRK, Griffith et al.⁽¹⁶⁾ concluded that the rotating brush resulted in faster epithelial regeneration than the manual technique. In our study, eye examination was done only on postoperative day 5, by which time all eyes showed complete epithelialisation.

A limitation of this study was that we did not conduct a daily review of the healing process of the epithelium, which would have been more appropriate to assess the potential influence of

a slower re-epithelialisation process on postoperative symptoms.

In further studies it would be interesting to compare the inflammatory response after different types of epithelial removal in PRK in order to determine the level and causes of postoperative discomfort for each method, which would assist surgeons in choosing the most comfortable technique.

CONCLUSION

In this study, de-epithelialisation with a rotating brush was superior to the manual technique only in terms of surgical time. The rotating brush method was associated with more severe postoperative symptoms, while intraoperative discomfort was similar for both techniques.

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