

# PRK in eyes with atypical topography and normal pentacam

## *PRK em olhos com topografia atípica e pentacam normal*

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### ABSTRACT

**Objective:** To evaluate the safety of PRK in patients with atypical corneal topography, but without features of keratoconus in Pentacam. **Methods:** Medical records of patients who underwent PRK method that presented atypical corneal topography and Pentacam rates considered normal in the pre operative were analyzed. The sample consisted of nineteen eyes of ten patients. The considered criteria of corneal irregularity were: increased curvature greater than 47D with asymmetry less than 1,5D, 1,5D displacement above the apex and inferior-superior asymmetry greater than or equal to 1,5D. All eyes had rates of anterior elevation, posterior elevation and profile of progression pachymetric within the normal range. The safety of the procedure was evaluated for loss of visual acuity and / or development of ectasia. **Results:** Nine (90%) of the patients were female and one (10%) was male. The average age was 31.8 years, ranging from 24 to 47 years. The distribution of corneal irregularity had 11 eyes (57.89%) with increased corneal curvature greater than 47D and inferior-superior asymmetry less than 1,5D, 3 eyes (15.78%) with displacement of the apex above 1,5D, 2 eyes (10.52%) with inferior-superior asymmetry above 1,5D and 3 eyes (15.78%) which included more than one criteria. Patients were followed postoperatively with an average of 16.4 months. Loss of visual acuity or development of ectasia disease was not present in any eyes. **Conclusion:** This study suggests that corneal tomography may be decisive to perform corneal refractive surgery. Prospective studies with longer follow-up time must be done to confirm our findings.

**Keywords:** Photorefractive keratectomy; Corneal topography; Tomography; Keratoconus

### RESUMO

**Objetivo:** Avaliar a segurança do PRK em olhos com topografia de córnea atípica, porém sem características de ceratocone no Pentacam. **Métodos:** Foram analisados dados de pacientes submetidos à PRK que apresentavam topografia corneana atípica e tomografia normal no pré-operatório. A amostra foi composta de dezenove olhos de dez pacientes. Foram considerados critérios de irregularidade corneana: aumento de curvatura superior a 47D com assimetria inferior-superior menor que 1,5D, ápice deslocado acima de 1,5D e assimetria inferior-superior maior ou igual a 1,5D. Todos tinham índices de elevação anterior, elevação posterior e perfil de progressão paquimétrica obtidos através do Pentacam considerados normais. A segurança foi avaliada quanto à perda da acuidade visual e/ou desenvolvimento de doença ectásia. **Resultados:** Dos dez pacientes, nove (90%) eram do sexo feminino e um (10%) do sexo masculino. A média de idade foi de 31,8 anos, variando de 24 a 47 anos. A distribuição quanto à irregularidade corneana apresentou 11 olhos (57,89%) com aumento da curvatura acima de 47D e assimetria inferior-superior menor que 1,5D, 3 olhos (15,78%) com deslocamento do ápice acima de 1,5D, 2 olhos (10,52%) com assimetria inferior-superior acima de 1,5D e 3 olhos (15,78%) que incluíam mais de um critério. Os pacientes foram acompanhados por um período médio de 16,4 meses. Em nenhum caso houve perda de acuidade visual ou desenvolvimento de ectasia. **Conclusão:** Este estudo sugere que a tomografia corneana pode ser decisiva na indicação de cirurgia refrativa. Estudos prospectivos com maior tempo de seguimento devem ser realizados para uma avaliação mais efetiva.

**Descritores:** Ceratectomia fotorrefrativa; Topografia de córnea; Tomografia; Ceratocone

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## INTRODUCTION

**L**aser refractive surgery is now one of the most common surgical procedures worldwide, with excellent results and low complication rates<sup>(1)</sup>. The success of the procedure depends mainly on the proper selection of candidates, with surgery being avoided in patients with a higher risk of operative and postoperative complications. Among the most feared complications is corneal ectasia, which is quite rare but has a devastating effect<sup>(2)</sup>. Preoperative analysis includes ultrasound pachymetry and keratometry with Placido disc, which are still considered the gold standard tests for refractive surgery. Changes in corneal topography are the main risk factor for iatrogenic keratoconus<sup>(3,4)</sup>, identifying candidates with a predisposition to the condition.

The occurrence of ectasia after refractive surgery in eyes with no abnormal findings on pachymetry and topography<sup>(5)</sup> has pointed to the need for a more thorough investigation of the anatomy and biomechanical properties of the cornea. In this context, corneal tomography has emerged as an important part of the preparation for refractive surgery and is increasingly used in preoperative investigations. The test has introduced new parameters for identifying patients with a susceptibility to ectasia, such as the analysis of posterior corneal elevation<sup>(6,7)</sup> and the profile of pachymetric progression, which, according to certain authors, can detect patients with a predisposition to ectasia<sup>(8-10)</sup>.

The aim of this study was to evaluate the refractive results and the safety of photorefractive keratectomy (PRK) in patients with atypical corneal topography but normal preoperative corneal tomography findings on Pentacam (Oculus, Wetzlar, Germany).

## METHODS

Retrospective observational study based on the review of ten medical records of patients treated at Santa Luzia Eye Hospital who were submitted to PRK from August 2008 to January 2010. All patients were operated by the same surgeon at the Oftalmolaser clinic in Recife, Brazil. The sample comprised 19 eyes with atypical preoperative topography. The criteria for corneal irregularity were: Increase in curvature greater than 47D with inferior-superior asymmetry lower than 1.5D, apex displacement greater than 1.5D, and inferior-superior asymmetry greater than or equal to 1.5 D. All eyes had normal anterior elevation, posterior elevation and pachymetric progression on Pentacam. Reference values were based on the manual calculation of the BFS (best fit sphere) for 9mm, with a relative scale of 5 microns, American style and 61 colours. The following criteria were used for anterior elevation: Normal, up to 12 microns; suspected, between 12 and 15 microns; keratoconus, above 15 microns. For posterior elevation, 5 microns are added to these values<sup>(11)</sup>. The pachymetric profile was considered normal when the chart was within the range defined in the *Belin/Ambrosio enhanced ectasia* map on Pentacam<sup>(12)</sup>. Data from the late postoperative period and from postoperative corneal topography were analysed. The safety of the procedure was evaluated by checking for loss of visual acuity and/or ectasia.

## RESULTS

Of the ten patients, 9 (90%) were female and 1 (10%) was male. The mean age was 31.8 years, ranging from 24 to 47 years (Table 1).

The sample comprised 19 eyes with atypical corneal topography. Of those, 11 eyes (57.89%) had increased corneal curvature greater than 47D and inferior-superior asymmetry lower than 1.5D, 3 eyes (15.78%) had apex displacement greater than 1.5D, 2 eyes (10.52%) had inferior-superior asymmetry greater than 1.5D, and 3 eyes (15.78%) had more than one criterion (Table 2).

All eyes had normal anterior elevation, posterior elevation and pachymetric progression on Pentacam. Patients were followed up in the late postoperative period for an average of 16.4 months, ranging from 8 to 23 months. Preoperative and postoperative data are shown on Tables 3 and 4.

The safety of the procedure was assessed by analysing the loss of visual acuity in lines of vision and changes in corneal topography postoperatively.

None of the eyes suffered loss of visual acuity or ectasia.

**Table 1**

**Sample distribution according to demographic variables**

Demographic variable	Number of patients
<b>Gender</b>	
Female	9
Male	1
<b>IAge</b>	
21-24	1
25-30	5
31-35	2
35-40	1
> 41	1

**Table 2**

**Sample distribution according to corneal irregularities**

Corneal irregularity	Number of eyes
Increased curvature greater than 47D with asymmetry lower than 1.5D	11
Apex displacement greater than 1.5D	3
Inferior-superior asymmetry greater than 1.5D	2
More than one parameter	3

**Table 3**

**Distribution of eyes according to pre and postoperative visual acuity**

Number of eyes	Preoperative corrected visual acuity	Postoperative corrected visual acuity
14	20/20	20/20
2	20/25	20/25
1	20/25	20/20
2	20/30	20/30

**Table 4**  
**Pre and postoperative data of the sample**

<b>Preoperative spherical equivalent Mean ± SD</b>	<b>Preoperative keratometry Mean ± SD</b>	<b>Preoperative pachymetry Mean ± SD</b>	<b>Postoperative spherical equivalent Mean ± SD</b>	<b>Postoperative keratometry Mean ± SD</b>
-4,81474	46,18053	521,1579	-0,00632	42,72211
+ - 1,85262	+ -0,989949	+ -4,242641	+ -0,53033	+ -0,487904

\*SD, Standard Deviation

## DISCUSSION

Refractive surgery has evolved considerably since the first reports of the use of excimer laser to correct refractive errors<sup>(13,14)</sup>. PRK, and then LASIK (laser-assisted in situ keratomileusis), quickly became common surgical procedures in the 1990s with excellent visual results worldwide<sup>(15)</sup>.

The importance of a thorough preoperative evaluation became more evident after the first reports of iatrogenic ectasia following LASIK<sup>(16,17)</sup>, which showed that not all patients could undergo the new surgical technique. The careful analysis of corneal topography and pachymetry became mandatory for all candidates for refractive surgery with excimer laser. In a 1994 study, topographic abnormalities were found in 33% of 106 eyes of patients seeking correction of myopia; of these, 5.7% (3 eyes) were diagnosed as keratoconus<sup>(18)</sup>. Similarly, a 1995 study found that 6% of patients interested in undergoing laser refractive surgery had the condition<sup>(19)</sup>. Whether or not to operate patients who do not have a regular and symmetrical topography is still a matter of debate and research. A study by Silva Filho et al. reported that preoperative topographic irregularities may predict the loss of corrected visual acuity in the postoperative period<sup>(20)</sup>. On the other hand, refractive surgery with high success rates and minimal adverse effects in patients with atypical or irregular topography has already been described in the literature<sup>(21,22)</sup>. A recent study reports the use of LASIK in eyes with suspected keratoconus on topography but confirmed as normal through epithelial thickness mapping with digital high frequency ultrasound (Artemis VHF, ArcScan Inc.); the patients were followed up for one year without developing ectasia<sup>(23)</sup>.

The preoperative evaluation of these individuals needs to evolve, as traditional tests such as ultrasonic pachymetry and computer-assisted corneal topography with Placido disc do not provide all the necessary information. According to Belin and Khachikian, the following limitations of topography need to be addressed: Computer-assisted videokeratoscopy covers only 60% of the corneal surface; information about the posterior surface of the cornea is lacking; a pachymetric map of the entire cornea is not available; and in some patients the apex displacement presents with significant asymmetry, simulating a keratoconus<sup>(6)</sup>.

The occurrence of post-LASIK ectasia in patients with normal topography and pachymetry underscores the importance of improving the diagnostic methods used to select the eyes to be operated. New concepts such as posterior elevation and pachymetric progression can be of great value in identifying individuals who do not have the classic signs of keratoconus but who may be susceptible to the condition after surgery. One study reported changes in posterior elevation and/or pachymetric progression in 88% of contralateral eyes in cases of unilateral

keratoconus with normal topography<sup>(24)</sup>.

Apart from changes in corneal anatomy, another factor to be considered is corneal resistance, which plays a key role in the development of ectasia after laser surgery. This has led many researchers to conduct in-depth studies of the biomechanics of the cornea<sup>(25)</sup>, but the results still have low sensitivity and specificity in unconfirmed cases of keratoconus<sup>(26)</sup>. Another device currently under development examines the deformation of corneal tissue by a jet of air through a series of Scheimpflug images, associating the curvature of the cornea with its biomechanical response<sup>(27)</sup>. All these studies and developments underscore the importance of the issue and the need to better understand the pathogenesis of this serious complication after refractive surgery.

Corneal tomography uses elevation maps to examine the corneal anatomy more accurately. These are differential maps between the corneal surface (anterior or posterior) and a calculated reference curve that best fits to that surface and may be spherical (Best Fit Sphere), ellipsoid, or toric ellipsoid, being usually adjusted to the central 8 or 9 mm<sup>(11)</sup>. Various devices produce these maps using different methods: Slit scanning (Orbscan, Bausch and Lomb Surgical, Utah, USA), arc scanning with very high frequency ultrasound (VHFUS), and optical coherence tomography (OCT). Pentacam is a corneal tomograph which uses the Scheimpflug camera system with 360-degree rotation and provides a three dimensional image of the anterior segment of the eye through 25 to 50 images captured in a few seconds. It also produces axial and tangential curvature maps, pachymetric maps, corneal aberrometry, and the *Belin/Ambrosio enhanced ectasia display*, a combination of elevation with a summarised pachymetric evaluation that assists the surgeon in his/her final evaluation<sup>(12)</sup>.

For patients with atypical topography and normal tomography, it is necessary to decide on the best surgical procedure. In situations like this, surface ablation seems to be an appropriate choice.

The literature shows that the postoperative incidence of ectasia is higher after LASIK than after surface ablation (PRK, LASEK or EPI-LASIK), as the creation of a flap and a deeper stromal ablation seem to be the most important risk factors<sup>(28,29)</sup>. PRK is a surgical procedure with excellent refractive results and good stability even after years of follow-up<sup>(30)</sup>. Its disadvantages compared to LASIK are: Postoperative pain, delayed visual recovery, use of bandage contact lenses, haze, and the use of steroid eye drops for a longer period. These are justified in the presence of risk factors that may increase the frequency of operative or postoperative complications related to the incision in the anterior stroma with a microkeratome or even a femtosecond laser. These include patients with very thin corneas (under 500 microns), high refractive error, very flat or steep

corneal curvature, and irregular and/or asymmetrical topography.

This study found very positive results for PRK in eyes with atypical corneal topography but normal findings on Pentacam; no loss of best visual acuity or iatrogenic ectasia were observed in any operated eyes. Postoperative topography was consistent with the ablation, and the refractive results were satisfactory, with a mean spherical equivalent close to zero. The study has limitations due to the small sample size. Evaluating a larger number of eyes with a longer follow-up period is necessary to support these results.

## CONCLUSION

This study suggests that corneal tomography can be used as a decision support tool for performing refractive surgery in patients with atypical topography. A normal tomography can ensure the safety of the procedure. Prospective studies with a longer follow-up period are needed to validate the results.

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