CORNEAL BIOMECHANICAL PROPERTIES USING THE OCULAR RESPONSE ANALYZER OF REICHERT: FINDINGS PRE-AND POST-LASIK PRE Y POST LASEK

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Corneal Biomechanical properties using the ocular response Analyzer of Reichert: findings pre-and post-LASIK pre y post LASEK

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Prupose: Evaluate and compare the biomechanical of pre and post surgical Keratomileusis properties, in situ laser-assisted (LASIK) and laser-assisted subepithelial keratomileusis (LASEK), measured with the Ocular Response Analyzer from Reichert (ORA).
Location: Vejarano Laser Vision Center, Metepec, Estado de México, México.
Method: Retrospective descriptive observational records on patients, who underwent refractive surgery LASIK or LASEK who prior to the procedure used the ORA to measure parameters of corneal hysteresis (CH), corneal resistance factor (CRF) and compared with the parameters obtained after six months of surgery and compared with the literature findings.
Results: It brings together a total of 117 records of patients of whom 74 (129 eyes) underwent LASIK (Group 1) and 53 (97 eyes) underwent LASEK (Group 2). The preoperative mean values CH (10.42 mmHg ± 1.20 1 group, 8.3 ± 1.98 mm Hg group 2) and CRF (10.90 mmHg ± 1.50 1 group, 8.5 ± 1.74 mm Hg, group 2), decreased significantly from the values found in postoperative CH (8.34 ± 1.50 mm Hg, group 1, 6.6 ± 1.64, group 2) and CRF (7.43 ± 1.70 group 1, group 2 6.3 ± 1.32). No correlation values of CH and CRF with age and with the central pachymetry.
Conclusions: Refractive Procedures LASIK and LASEK produce significant changes in corneal biomechanics when they are viewed from the values of CH and CRF. Evidenced both values decreased It shows a subsequent decrease of both values, in both procedures, and this decrease though is not significant , is higher in LASIK what it means to be the effect of the creation of the flap in the corneal biomechanics. Following either of these two procedures, the CRF value reduces more than the CH value.

Corneal Biomechanical Properties using the ocular response analyzer of REICHERT: findings pre-and post-LASIK pre y post LASEK

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INTRODUCTION

The study of the biomechanics of the cornea, it is vital to understand the results of long-term refractive surgery. There have been many studies that have attempted to measure these properties corneal. Luce,determined the biomechanical properties of the cornea using the Ocular Response Analyzer Reichert ® (ORA), which is based on a dynamic bidirectional applanation process 1.

The Ocular Response Analyzer (ORA) is an instrument capable of measuring the viscoelastic properties of the cornea 1.2. According to the factory corneal hysteresis (CH) is the corneal tissue viscous damping or the capacity of energy absorption.
The parameter corneal resistance factor (CRF) is a measure of the cumulative effects of viscous damping and elastic resistance of the cornea 1. Refractive surgery alter the biomechanical properties of the cornea which is thought to play an important role in treatment results, the values of CH and CRF which is significantly lower with a refractive procedure suggesting that the creation of the flap , ablation or both, alter the ability of the cornea to absorb or dissipate energy1, 2. Corneas Queratocónicas have low values of CH and CRF, with a high tendency to develop ectasia post-LASIK2.

Additional to the data of CH and CRF, the ORA provides two types of variables such as the Goldmann correlated intraocular pressure (IOPG) which corresponds to the average of the two measurements from the process of dynamic applanation bidirectional and the pressure intraocular compensated (IOPCC), as it is less affected by properties as corneal hysteresis and pachymetry central, which remains relatively constant after an keratomileusis assisted in situ by laser (LASIK) 1,3.

In this study, we use the ORA to determine the biomechanical properties characterized by corneal hysteresis and corneal resistance factor. The objective was to measure the biomechanical properties in eyes that had refractive surgery through LASIK or laser-assisted subepithelial keratomileusis (LASEK) to compare these two procedures that produce changes in the corneal biomechanics.

PATIENTS AND METHODS:

We reviewed the medical records of all patients who underwent between June 2008 and February 2009 the refractive surgery procedures LASEK or LASIK in Laser Vision Institute Vejarano. Exclusion criteria, non contemplate records within the study were incomplete stories either in observing events as preoperative and postoperative studies at 6 months,previous clinical history of refractive surgery ,clinical history of previous eye surgery or ocular pathology and / or systemic as glaucoma or diabetes.

The selection criteria for LASIK are patients with refractive error in the whose corneal in the preoperative, satisfies the following characteristics: pachymetry higher than 520 micron queratometrías (40-47 diopters, steep axis) that would allow creation of flap, residual lecho stromal after ablation greater than 300 microns, no dry eye and discard suspicion or presence of ectasia by ORA and PentacamHR (OCULUS Optikgeraete GmbH).

The selection criteria for LASEK are: patients with refractive errors were not candidates for LASIK to present thin corneas for the type of refractive error or queratometrías curves, residual lecho stromal higher to 300 microns,corneas with elevations of rear face, by Pentacam. It is considered suspect patients who also have CH and CRF minor at 8.5 mm Hg, but that in other studies presence there will not evidence or suspicion of ectasia.

Preoperative tests:

All patients, prior to any of the two procedures were performed automated and subjective refraction, corneal topography and pachymetry (Pentacam HR ®, OCULUS Optikgeraete GmbH), CH and CRF by ORA,which was taken verifying readings show symmetrical peaks in height and width. With these results, the patients were examined under slit lamp and dilated fundus low. In patients with a history of contact lens wear, patients had a minimum rest period of 15 calendar days prior to taking action.

Surgical Technique

The procedures were performed by any of the authors, operating room temperature between 18 and 21 ° C, humidity between 30 and 40%. It uses the same excimer laser Esiris ® (Schwind).

In programming laser, is used nomogram own of clinic in programming of the same laser,always provided with optical zones of 6.5 and 6.5 mm or 5 in case of multizone ablations. To create the flap in case of LASIK should be used microkeratome M2 (Moria).

LASEK technique was used 20% alcohol solution for 20 seconds, complete removal of the epithelium was performe in all cases by placing contact lens. In any type of ablation was used mitomycin-C 0.02% for 20 seconds for ablation of 50 microns, 40 seconds for ablations between 51 and 99 microns.For ablation, greater than 100

microns time Mitomycin-C was one minute, with subsequent washing with balanced salt solution and placement of therapeutic contact lens.
Patients are reviewed at three and six months after the treatments.

RESULTS.

It includes a total of 117 patients in the study who fulfilled the requirements outlined, which are divided into two groups: group number one, is for those who underwent LASIK, 74 patients (129 eyes), and group number two, LASEK, 53 patients (97 eyes). The characteristics of the patients described, are summarized in table No. 1.

Table No. 1. Characteristics of patients studied				
	Group 1 (LASIK)		Group 2 (LASEK)	
	Media ± DE	Rank	Media ± DE	Rank
Age (years)	34.34 ± 10.52	18 – 53	31.63 ± 9.08	23 - 51
refraction (D)				
sphere	-3.30 ± 1.5	-7.50 a +2.00	-2.19 ± 3.3	-9.00 a +1.75
cylinder	-3.0 ± 1.74	-5.0 a 0	-3.2 ± 1.98	-7.00 a 0
Preop pachymetry (microns)	545 ± 30.52	498 a 618	527.5 ± 40.30	476 a 620
D= Diopters, SD = standard deviation.				

The values of CH and CRF not correlate with the age of the patients and there is no correlation between these values and central pachymetry values. The decrease in CH and CRF regarding preoperative values was significant for both group 1 ($p < 0.004$) and for group 2 ($p < 0.003$), with a greater decrease in CRF values for CH in both groups. (See Table # 2 and Figure # 1).

While no further decline between CH and CRF values in LASIK over LASEK, this difference is not statistically significant for the analyzed groups ($p < 0.07$).

Table No. 2. Parameters pre-and post-surgical				
	Group 1 (LASIK)		Group 2 (LASEK)	
presurgical				
	Media ± DE	Rank	Media ± DE	Rank
EE (Dioptrías)	-4.02 ± 2.00	-5.00 a +2.00	-3.83 ± 1.98	-9.80 a -0.125
CH	10.42 ± 1.20	8.1 a 14.50	8.3 ± 1.98	6 a 10.5
CRF	10.90 ± 1.50	8.3 a 14.90	8.5 ± 1.74	6.2 a 11
IOPg	16.69 ± 4.39	10 a 22	15.50 ± 3.50	9.03 a 22.30
IOPcc	17.85 ± 3.57	11 a 24	16.10 ± 4.00	10.10 a 23
post Surgical				
EE	-0.20 ± 0.52	-1.20 a +1.50	-0.86 ± 1.0	-1.25 a +1.00
CH	8.34 ± 1.50	6.10 a 11.70	6.6 ± 1.64	5 a 8
CRF	7.43 ± 1.70	5.80 a 10.90	6.3 ± 1.32	5.2 a 8.30
IOPg	13.19 ± 2.24	7 a 18.40	11.7 ± 2.45	8.3 a 19
IOPcc	16.00 ± 2.10	9 a 20	14.1 ± 2.28	9.0 a 20.40
Change				
EE	3.82 ± 2.10	-5.00 a +0.75	2.97 ± 2.50	-9.80 a +1.00
CH	2.08 ± 1.20	0.40 a 5.30	1.7 ± 1.40	0.55 a 5.10
CRF	3.47 ± 1.30	0.55 a 6.90	2.2 ± 1.70	0.35 a 6.30
IOPg	3.5 ± 3.20	-4.00 a 8.00	3.8 ± 3.35	-4.50 a 8.50
IOPcc	1.85 ± 2.05	-3.00 a 6.10	2 ± 2.10	-2.60 a 7.00
DE = Standard deviation. EE = spherical equivalent. CH = corneal hysteresis. CRF. Corneal resistance factor IOPg = Intraocular Pressure related with Goldmann IOP. IOPcc = Intraocular pressure corneal compensated All values of ORA are shown in units of millimeters of mercury (mm Hg).				

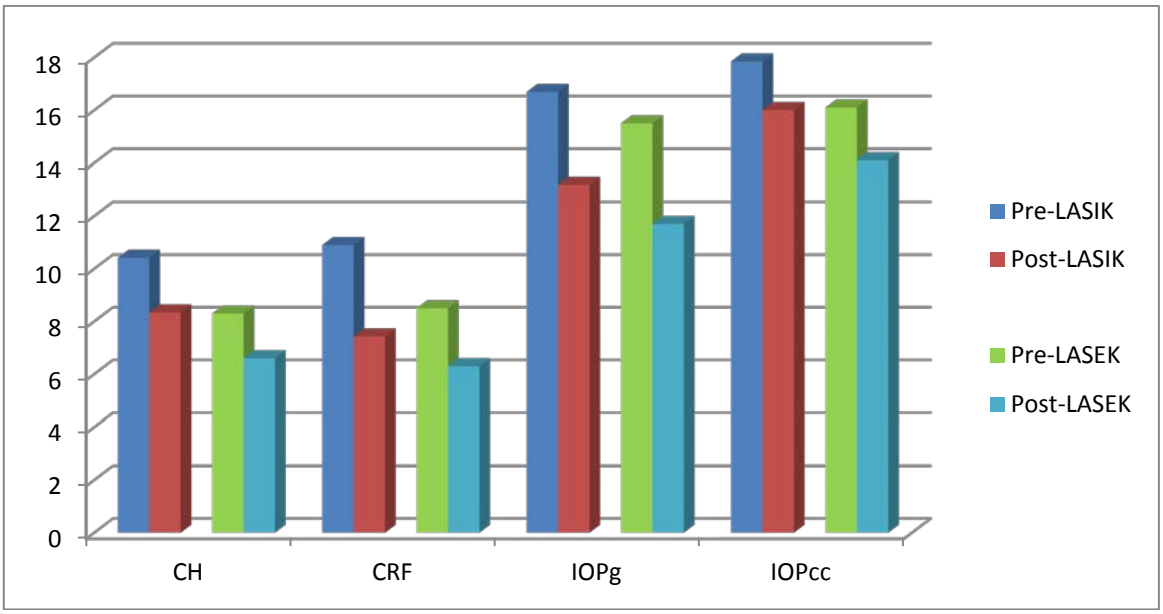

Figure No. 1. It shows the mean values before and after surgery CH, CRF, IOPg (intraocular pressure correlated with Goldmann) and IOPcc (intraocular pressure compensated to the cornea).

Although is not the object of this study, examines the values of intraocular pressure showing ORA, it was observed IOPg significant decrease in both groups ($p < 0.002$ and $p < 0.001$ respectively) in Postoperative measurements at 6 months as well as of IOPcc values ($p < 0.003$ and $p < 0.002$). Mean ΔIOPg (3.5 ± 3.20 mm Hg in group 1 and 3.8 ± 3.35 mm Hg in group 2) was significantly higher for both procedures that the mean ΔIOPcc (1.85 ± 2.05 mm Hg in the group 1 and 2 ± 2.10 mm Hg in group 2) (figurna No. 1). No significant differences between preoperative measures of IOPcc and IOPg in both groups, but a significant difference in measures IOPg and IOPcc and at six months post-surgery in both groups ($p < 0.004$)

DISCUSION

The ORA to date, is the only way to measure the viscoelastic properties of the cornea in a reproducible and reliable values of CH and CRF [1, 3]. These values do not correlate with age [8] nor, as we found in this study, is correlated with central corneal thickness [3].

After refractive procedures such as LASIK and LASEK, and consistent with previous reports of literature [2, 3,4,5,7,9], measurements of CH and CRF in our study, there is a significant decrease, which confirms the same laser ablation, significantly alters the ability of the cornea to absorb and / or dissipate energy [2, 4]. Although the decrease between CH and CRF in both groups shows no statistically significant difference, it is observed that the change of these measures is always greater in LASEK than LASIK, suggesting that in LASIK corneal properties can also be altered by creation of the flap[2, 4]. Another interesting finding is that the value of the CRFThen, remaining refractive procedures in 95% of the cases, lower than the value of CH, a finding consistent with other reports in the literature [8].

In regard to intraocular pressure measurements provided by the ORA, there is a significant decrease in IOPg that goes hand in hand with measures of CH and CRF corroborating weakness of the cornea by the same corneal ablation, no differences were found in IOPg values and IOPcc according procedure performed (LASIK or LASEK).

According to the head office of the ORA the measures IOPcc is theoretically independent of corneal thickness and can be useful for determining intraocular pressure after perform surgery refractiva10 perform. In this study there was no significant difference between preoperative IOPg and IOPcc but there was a significant decrease in both parameters after LASIK or LASEK. Although there was a change in the measure post-operative of IOPcc this was less than the IOPg, which confirms that the IOPcc is a parameter closest and indicator of true intraocular pressure but the ORA does not completely offset biomechanical properties of the cornea This finding is correlated with the findings described in literature 2, 3.9. There are not difference in the pre and postoperative intraocular pressure measured by the ORA according to the refractive procedure.
Further studies are needed to determine whether these findings have clinical relevance over time.

REFERENCES:

1. Luce DA. Determining in vivo biomechanical properties of the cornea with an ocular response analyzer. J Cataract Refract Surg 2005; 31: 156-162
2. Chen M, Lee N, Bourla N, Hamilton R. Corneal biomechanical measurements before and after laser in situ Keratomileusis. J Cataract Refract Surg 2008; 34:1866-1891
3. Ortiz D, Piñero D, Shabayek M, Arnalich-Montiel F, Alió J. Corneal biomechanical properties in normal, post-laser in situ Keratomileusis and keratoconic eyes. J Cataract Refract Surg 2007; 33(8): 1371-75.
4. Kamiya K, Shimizu K, Ohmoto F. Comparison of the changes in corneal biomechanical properties after photorefractive keratectomy and laser in situ Keratomileusis. Cornea. 2009 Aug; 28(7):765-9
5. Kirvan C, O´Keefe M. Corneal hysteresis using the Reichert Ocular Response Analyzer: findings pre and post-LASIK and LASEK. Acta Ophthalmol. 2008 Mar; 86(2): 215-8.
6. Slade SG. Thin-flap laser-assisted in situ Keratomileusis. Curr Opin Ophthalmol. 2008 Jul; 19(4): 325-9.
7. Shah S, Laiquzzaman M, Yeung I, Pan X, Roberts C. The use of the Ocular Response Analyzer to determine corneal hysteresis in eyes before and after excemer laser refractive surgery. Cont Lens Anterior Eye. 2009 Jun; 32(3): 123-8
8. Touboul D, Roberts C, Kérautret J, Garra C, Maurice-Tison S, Saubusse E, Colin J. Correlations between corneal hysteresis, intraocular pressure, and corneal central pachymetry. J Cataract Refract Surg 2008; 34:616-622.

9. Pepose JS, Feigenbaum SK, Qazi MA, et al. Changes in corneal biomechanics and intraocular pressure following LASIK using static, dynamic and noncontact tonometry. Am J Ophthalmol 2007; 143: 39-47
10. Medeiros FA, Weinreb RN. Evaluation of the influence of corneal biomechanical properties on intraocular pressure measurements using the ocular response analyzer. J Glaucoma. 2006 Oct; 15(5): 364-70
11. Dups WJ Jr, Wilson SE. Biomechanics and wound healing in the cornea. Exp Eye Res. 2006 Oct;83(4):709-20.