SUB-BOWMAN KERATOMILEUSIS COMPARED WITH PHOTOREFRACTIVE KERATECTOMY – CONTRALATERAL EYE STUDY

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SUMMARY – The aim of this study was to compare two different refractive surgery approaches in correction of myopia with or without astigmatism. In patients where one eye underwent sub-Bowman keratomileusis (SBK) and the other eye photorefractive keratectomy (PRK), the objective and subjective results were retrospectively compared during the six-month follow-up. Eighty four patients (168 eyes) were involved in this retrospective contralateral study. The mean preoperative spherical refraction was -3.88 diopters (D) and the mean cylinder was -0.82 D for all eyes. Each patient underwent SBK on one eye and PRK on the contralateral eye. The eyes in the PRK group underwent mechanical epithelial removal, which was followed by laser treatment. Mitomycin C 0.02% was used for 15 seconds if ablation was deeper than 50 microns. In the SBK group, the intended 100-µm corneal flap was created with IntraLase femtosecond laser. All eyes underwent customized wavefront guided laser ablation using a VISX Star S4 IR excimer laser. Preoperative and postoperative outcome measures included best spectacle-corrected visual acuity, uncorrected visual acuity, corneal topography, contrast visual acuity, and anterior optical coherence tomography imaging. Patients were asked to complete subjective satisfaction questionnaires at each visit. Through the first 3 months of follow up, the SBK eyes demonstrated clinically and statistically better visual results than PRK eyes, between 3 and 6 months the results in the two groups began to equalize, and after 6 months of follow up there were no clinical and statistical differences between the SBK and PRK groups. SBK seems to be more practical for the patient with less pain, faster visual recovery, fewer medications, and overall superior experience.

Key words: *Sub-Bowman keratomileusis; Photorefractive keratectomy*

Introduction

In the last twenty years, two major approaches have become relevant in laser vision correction: LASIK (laser in situ keratomileusis) and advanced surface ablation techniques, i.e. photorefractive keratectomy (PRK), laser epithelial keratomileusis (LASEK) and epi-LASIK, of which the PRK method is most commonly used[1-5].

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LASIK offers several advantages over PRK including faster clinical and functional rehabilitation, minimal postoperative pain, subepithelial scarring avoidance, reduced need for prolonged steroid therapy, reduced risk of infectious keratitis, less irregular astigmatism, and stable refraction with predictable outcomes shortly after the procedure. Limitations of this method include possible difficulties in the use of microkeratome, difficulties in flap repositioning and deeper corneal stromal ablations (120-140 µm greater than for PRK), which can theoretically weaken the corneal tectonics[1,6-10].

Some surgeons prefer PRK method because it provides better visual quality, less dry eye problems and less higher order aberrations, with the possibility of correcting refractive anomalies in patients with thinner cornea. Pain and discomfort of the eye are much more pronounced in PRK than in LASIK. Also, achieving final visual acuity and patient recovery is much slower[11-13].

Thin flap LASIK/Sub-Bowman keratomileusis (SBK) is a refractive surgical procedure that combines the advantages of LASIK and PRK, quick and painless recovery as in LASIK while saving tissue with thinner flap compared to conventional LASIK. Theoretically, SBK should have more benefits for patients: a predictable thin flap, quicker visual recovery with minimal pain and discomfort, minimal biomechanical changes with fewer higher order aberrations, reduced incidence of postoperative dry eye, and a decrease in the loss of corneal sensitivity[14].

The aim of this study was to compare two different refractive surgery approaches in correction of myopia with or without astigmatism. In patients where one eye underwent SBK and the other eye PRK, objective and subjective results were compared during the six-month follow-up.

Patients and Methods

A contralateral retrospective study of 84 patients (168 eyes) was conducted in the period from April 2008 until November 2010. The study included 44% of men and 56% of women. The mean patient age was 32.14±6.22 years. Two groups were formed, SBK and PRK groups. Each patient underwent SBK on one eye and PRK on the contralateral eye. All patients signed the informed consent form before entering the study. The inclusion criteria were spherical myopia up to -6.00 diopters (Dsph) with up to -2.50 diopters of refractive astigmatism (Dcyl), stable refraction for 1 year, best corrected visual acuity of at least 20/20 on each eye, and an average central corneal thickness between 470 and 510 μm. The exclusion criteria were corneal topographic pattern suggestive of ectatic disease, disease status that could delay the healing process of the cornea, and previous trauma or surgical procedure on the eye. Soft contact lens wearers were required to discontinue lens use for at least 10 days before surgery, whereas rigid contact lens wearers were required to discontinue use for at least 4 weeks before surgery. In the SBK group, flaps were created using an IntraLase femtosecond laser (60 kHz, Advanced Medical Optics, Santa Ana, CA). Intended flap thickness was 100 μm. In the PRK eyes, corneal epithelium was mechanically removed, subsequently undergoing laser treatment. Mitomycin C 0.02% was used for 15 seconds if ablation was deeper than 50 microns. Mitomycin C is an antineoplastic agent that inhibits DNA and RNA replication and protein synthesis. When applied on the cornea, mitomycin C regulates fibroblast proliferation and myofibroblast formation, which is responsible for corneal haze after PRK[15-18].

In both cases, laser correction was performed with the Wavefront CustomVue method using VISX Star S4 excimer laser. Preoperative and postoperative outcome measurements included the following: determination of uncorrected visual acuity (UCVA) and best spectacle corrected visual acuity (BSCVA) using Snellen charts, corneal topography (Oculus Pentacam), wavefront aberrometry (Advanced CustomVue Wavefront Wavescan), contrast visual acuity (Peli-Robson letter chart), tear secretion measurement (Schirmer test) and anterior optical coherence tomography (OCT) imaging (SOCT Copernicus, Optopol Technology S.A., Zawiercie, Poland).

Pentacam Comprehensive Eye Scanner (Oculus, Inc., Lynwood, WA) provides an accurate three-dimensional view of anterior eye segment and individualized approach to refractive surgery using rotation Scheimpflug camera in all meridians. This includes an objective determination of corneal topography (elevation maps), overall pachymetry, tomographic analysis, 3D analysis of anterior chamber, measuring lens density, and intraocular lens (IOL) calculation after corneal refractive surgery. Measurement is non-contact and entirely agreeable to the patient[19,20].

Advanced CustomVue Wavefront Wavescan procedure allows for more precise adjustment of higher order aberrations that cannot be removed with eyeglasses or contact lenses, and have a significant impact on the quality of vision. Higher order aberrations are unique to each person and include the difficulty seeing at night, glare, halos, blurring, starburst patterns and double vision (diplopia). WaveScan-based digital technology identifies and measures imperfections in

the eye 25 times more precisely than standard methods. WaveScan software translates the information into a set of CustomVue treatment instructions for the laser. These digital treatment instructions are then transferred to the laser, driving a new level of precision and accuracy[21,22].

Spectral-domain Optical coherence tomography (SOCT Copernicus, Optopol Technology S.A., 42-400 Zawiercie, Poland) provides analysis of the eye anterior segment with a resolution of 3 microns. It is used to record pachymetry maps, measure corneal epithelial thickness, LASIK flap thickness, and anterior chamber angle[23].

All patients were examined preoperatively and on follow-up examinations 1 day, 1 week, 1, 3 and 6 months after surgery. Patients were also required to complete a subjective questionnaire about ocular pain, eye dryness and satisfaction with vision. Pain and dryness were evaluated on a scale from 0 to 3, provided that 0 denotes absence of pain and dryness of eyes, 1 mild, 2 moderate, and 3 extreme soreness and dryness of the eyes. Patients were asked to assess their vision on each eye as poor, reasonable, good or excellent. The goal of all surgeries was emmetropia. No intra- or postoperative complications were encountered except for one patient who needed enhancement surgery on both eyes (one SBK and the other PRK).

Results

Flap thickness

All flaps were measured with an OCT system at 1 month postoperatively. The results demonstrated that the SBK flaps had a mean thickness of 104±5 μm. Standard deviation for each individual flap was 5 μm.

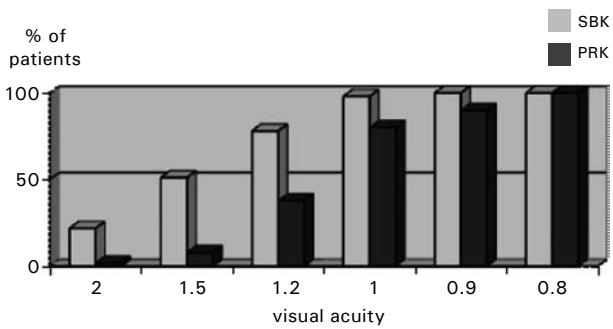

Fig.1. Snellen visual acuity one month after surgery.

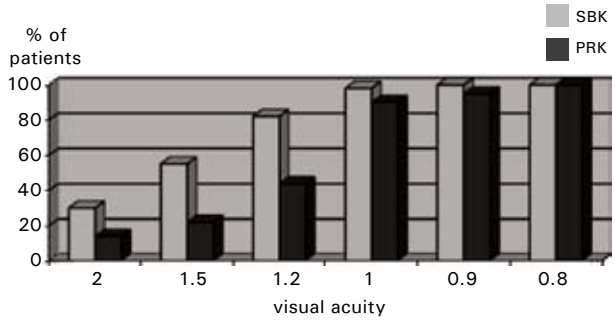

Fig. 2. Snellen visual acuity two months after surgery.

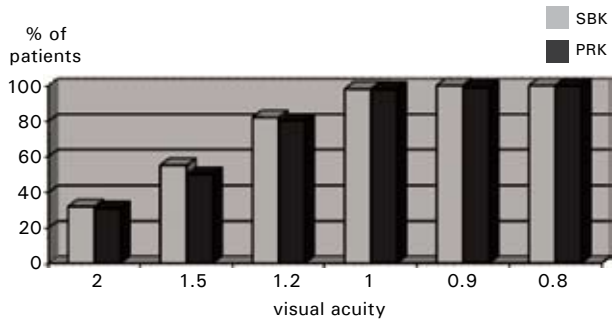

Fig. 3. Snellen visual acuity three months after surgery.

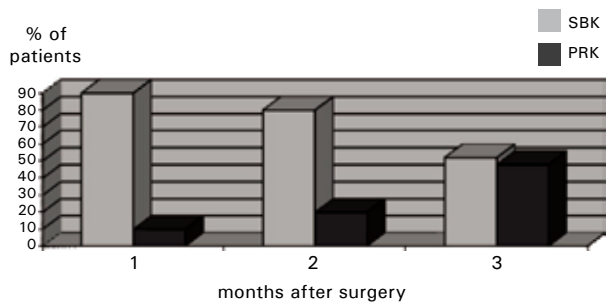

Fig. 4. Patient satisfaction with vision.

Visual acuity results

Results are summarized in Figures 1-3. Figure 1 shows UCVA 1 month after surgery. Uncorrected visual acuity at 1 month showed a statistically significant difference between the SBK and PRK groups, with 98% of the SBK eyes at 1.0 or better compared to 80% of the PRK eyes (P<0.0001). Figure 2 shows UCVA 2 months after surgery. Uncorrected visual acuity at 2 months still showed a statistically significant difference between the SBK and PRK groups, with 98% of the SBK eyes at 1.0 or better compared to 90% of the PRK eyes (P<0.0001). Figure 3 shows

no statistically significant difference between the two groups at visual acuity of 1.0 three months after surgery (P=0.4751).

Contrast visual acuity

Contrast visual acuity showed better results for SBK eyes up to 3 months after surgery, although the difference decreased over time. There was no difference between the two eyes six months after surgery.

Subjective results

PRK eye was more painful for up to one month. On later examination, there was no statistically significant difference. The feeling of dryness was significantly greater on PRK eyes for up to 3 months after surgery. At 6-month follow up there was no difference. Patients were more satisfied with vision on the SBK eye for up to 3 months after surgery. We found no statistically significant difference in satisfaction with vision six months after surgery (Fig. 4).

Discussion

There are a great number of studies comparing PRK with SBK results, but not so many where these two methods were compared in the same patient. Durrie *et al*. performed a study using different methods on each eye[14]. They showed advantages of SBK as a method in refractive surgery over PRK. Slight differences were recorded in several measured results but the fact that SBK eyes performed better in the beginning and that the differences equalized over 3 to 6 months was the same. They also conclude that SBK provides faster visual recovery while providing end results similar to PRK. SBK seems to be more practical for the patient with less pain, faster visual recovery, fewer medications, and an overall superior experience.

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Sažetak

LASIK ULTRATANKOG POKLOPCA (*SUB-BOWMAN KERATOMILEUSIS*) ILI FOTOREFRAKTIVNA KERATEKTOMIJA

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Cilj ove studije bio je tijekom šestomjesečnog praćenja bolesnika usporediti subjektivne i objektivne rezultate korekcije miopije s astigmatizmom očiju ili bez njega podvrgnutih dvama različitim zahvatima: refrakcijskoj kirurgiji ultratankog poklopca (*sub-Bowman keratomileusis*, SBK) ili fotorefraktivnoj keratektomiji (*photorefractive keratectomy*, PRK). Osamdeset četiri bolesnika (168 očiju) su bila uključena u ovu retrospektivnu studiju. Prosječna kratkovidnost bila je -3,88 sfernih dioptrija s prosječnim astigmatizmom od -0,82 cilindrične dioptrije. U svakog bolesnika je primijenjen SBK na jednom oku i PRK na drugom oku. Rožnični epitel je mehanički uklonjen na očima iz skupine PRK, nakon čega je učinjen laserski zahvat. Zatim je apliciran mitomicin C 0,02% (vrijeme ekspozicije 15 sekunda) ako je ablacija bila dublja od 50 mikrona. Kod očiju iz skupine SBK formiran je ultratanki poklopac od 100 mikrona pomoću IntraLase femtosekundnog lasera. Laserska korekcija je u oba slučaja izvršena metodom *wavefront CustomVue* laserom VISX Star S4. Prijeoperacijska i poslijeoperacijska izlazna mjerenja uključivala su određivanje vidne oštrine (nekorigirane i najbolje korigirane), rožničnu topografiju, aberometriju, test kontrastne osjetljivosti i optičku koherentnu tomografiju prednjega očnog segmenta. Bolesnici su na svakom kontrolnom pregledu ispunjavali upitnik o subjektivnoj procjeni rezultata. Klinički i statistički su značajno bolji rezultati bili u skupini očiju operiranih metodom SBK i to poslijeoperacijski do trećeg mjeseca. Od trećeg do šestog mjeseca su se rezultati počeli izjednačavati te nakon 6 mjeseci praćenja više nije bilo statistički i klinički značajnih razlika između dviju skupina očiju. Metoda SBK je objektivno i subjektivno bolja metoda u odnosu na PRK, te bolesniku omogućuje brži oporavak uz manje nuspojava.

Key words: *Keratomileuza ispod razine Bowmana; Fotorefraktivna keratektomija*