Title

Refractive and visual outcomes of SUPRACOR TENEO 317 laser-assisted in-situ keratomileusis of presbyopia in hyperopia eyes: 24 months follow-up.

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Abstract

Purpose

PresbyLASIK surgery is based on LASIK principles and creates a multifocal cornea surface that simultaneously corrects distance and near vision. The aim of our retrospective study was to analyze the efficacy, safety, predictability, and stability in hyperopes presbyopic LASIK surgeries with TENEO™ 317 algorithm.

Method

Eighty eyes from 40 patients who underwent hyperopic and presbyopic LASIK in this retrospective, observational, and longitudinal study were included. All patients had a 24-month follow-up. Excimer laser was performed with TECNOLAS ® Perfect Vision GmbH TENEO™ 317 software version 1.25 (Bausch + Lomb, Munich, Germany) with the PROSCAN platform for distance dominance eye and SUPRACOR™ mild platform for near dominance eye.

Results

Eighty eyes from 40 patients underwent TECNOLAS® Perfect Vision GmbH TENEO™ 317. Mean age was 53.90 ± 4.84 (42 to 66) years. Postoperative uncorrected distance visual acuity (UDVA) was 0.00 ± 0.04 (20/19.97) for the dominant eye and 0.14 ± 0.05 (20/27.65) for the non-dominant eye. Postoperative uncorrected near visual acuity (UNVA) was 0.51 ± 0.17 (J9) for the dominant eye and 0.09 ± 0.06 (J1.5) for the non-dominant eye, while 2.5% of non-dominant eyes lost 2 lines. Half of non-dominant eyes lost 1 line, and 2.5% of dominant and non-dominant eyes changed 0.50 D or more between 3 and 24 months.

Conclusion

PROSCAN surgery in the dominant eye and SUPRACOR in the non-dominant eye using the TENEO™ 317 algorithm have demonstrated that hyperope presbyopic excimer laser surgery technique is effective, safe, predictable, and stable after 24 months of follow-up.

Introduction

In the last decade, presbyopia refractive surgery has been 1 of the most discussed subjects in refractive ophthalmology. At present, there are different techniques for presbyopia treatment, including intraocular lens replacement,[1] intraestromal implants (inlays),[2] conductive keratoplasty,[3] scleral expansion procedures,[4] monovision LASIK ,[5] micro-monovision,[6] contact lens,[7] presbyopia drops,[8] intraestromal femtosecond laser treatment (IntraCOR®)[9] and presbyopic laser-assisted in-situ keratomileusis (PresbyLASIK).[10] The IntraCOR® technique remodels the central cornea by producing circular concentric intrastromal incisions with femtosecond laser, preserving the epithelium.[11] The term PresbyLASIK was first introduced by Ruiz et al.[12] and designates different multifocal corneal techniques based on a LASIK procedure. There are different commercial versions of PresbyLASIK: Nidek EC-5000 excimer laser (Nidek, Gamagori, Japan),[13,14] VISX STAR S4 excimer laser system (Abbot Medical Optics, Santa Ana, California),[15] WaveLight ALLEGRETTO Eye-Q (Alcon Laboratories Inc, Ft Worth, Texas),[16] SCHWIND PresbyMAX (SCHWIND eye-tech-solutions, Kleinostheim, Germany),[17] SUPRACOR 217P, and TENEO™ 317 (both Bausch and Lomb Technolas, Munich, Germany).[18]

PresbyLASIK surgery is based on LASIK principles and creates a multifocal cornea surface that simultaneously corrects distance and near vision. Multifocal ablations could be classified into 2 ablative profiles: central PresbyLASIK (center for near vision) and peripheral PresbyLASIK (peripheral cornea for near vision).[19] Central PresbyLASIK creates topographical corneal profiles with a central elevation for near vision and a topography flatter toward the periphery for intermediate and distance vision.[20] SUPRACOR® available algorithms are Technolas 217P and TENEO™ 317 (both Bausch and Lomb Technolas, Munich, Germany). Platforms 217P and 317 use a 6-mm area; the near zone represents the central 3 mm and from 3 to 6 mm is used as the peripheral zone. The main difference between 217P and 317 lies in the central bump. The 217P only had a regular platform (larger bump), and 317 had mild (softer bump) and regular platforms. The ablation profile algorithm was improved to minimize aberration inside the pupil region.[21] SUPRACOR® may be used in 1 eye or both according to patient's needs and expectations.[22] The aim of our retrospective study was to analyze the efficacy, safety, predictability, and stability in hyperopes presbyopic LASIK surgeries with the TENEO™ 317 algorithm.

Patients and Methods

Design

Eighty eyes from 40 patients who underwent hyperopic and presbyopic femtosecond laser-assisted in-situ keratomileusis (LASIK) in this retrospective, observational and longitudinal study were included. Patients underwent surgery between January 2016 and October 2016. All surgeries were performed at the facilities of the Ophthalmology Center Tecnolaser Clinic Vision® in Seville, Spain. All patients had a 24-month follow-up.

Ethical aspects

All patients included in this work were adequately informed verbally and in writing of the benefits, characteristics, and risks of the surgeries. All patients signed an informed consent prior to the surgery and after the interview performed with the ophthalmologist. This study was conducted in accordance with the tenets of the Helsinki Declaration. The Institutional Review Board of Andalusia approved the research.

Subjects

Forty patients (31 women and 9 men) voluntarily went to the clinic to undergo the tests, and after the ophthalmologist determined their suitability for surgery, they underwent hyperopic and presbyopic femtosecond LASIK surgery voluntarily. The inclusion criteria were (1) age over 40 years; (2) a stable refraction for at least 1 year, means a change ≤ to 0.50 diopters (D) in the spherical and cylindrical refraction; (3) presence of hyperopia in spherical equivalent (MSRE) between + 1.00 D and + 6.00 D; (4) presence of astigmatism between 0.00 D and - 1.25 D; (5) best preoperative corrected visual acuity ≥ 20/25 in both eyes; (6) the maximum and minimum values of the corneal curvature could not differ by more than 10 diopters; and (7) a disparity ≤ 0.50 diopters in the keratometry between 2 measurements with a minimum interval of 1 week. The exclusion criteria were: (8) eye diseases, such as glaucoma and cataracts; (9) progressive corneal diseases, such as keratoconus or presumed keratoconus and pellucid marginal degeneration; (10) pathologies on the ocular surface; (11) signs of retinal vascular pathology; (12) immunodeficient patients or those diagnosed with connective tissue diseases; (13) pregnant or

lactating patients; (14) patients with known sensitivity to the drugs used in the standard laser refractive surgery; (15) patients with disorders of the eye muscles, such as strabismus or nystagmus, or any other disorder that affects ocular fixation; and (16) mate eyes without vision or amblyopia.

Preoperative examinations

Before the presbyopic surgeries, a thorough preoperative study of all patients was conducted. Soft contact lens wearers had their contact lenses removed for a minimum period of 2 weeks. In the case of hard lenses, the period was 4 weeks. Visual examinations were performed in a full 20-foot lane; digital screen visual acuity projection and photopic lighting conditions were used. Motor dominance was measured with a hole-in-card test, and sensory ocular dominance was measured with plus-one diopter test.[23] The examination was performed by an expert optometrist, and it included uncorrected and corrected visual acuity in distance and near vision (decimal and Snellen scale), manifest refraction without and with cycloplegia by the maximum positive refraction method. Astigmatism was assessed by the Jackson cross cylinder method. These data were checked with the Wavefront Supported Custom Ablation (WASCA) autorefractor-aberrometer (Carl Zeiss Meditec AG, Jena, Germany). Horizontal and vertical heterophoria, near point of convergence, directional and sensory dominance, and stereopsis studies were completed in all patients. Corneal pachymetry, keratometry, and topography patterns were measured with the Pentacam HR® single rotation Scheimpflug camera (Oculus Optikgeräte GmbH, Wetzlar, Germany). Intraocular pressure and corneal biomechanics were measured with CORVIS ST® (Oculus Optikgeräte GmbH, Wetzlar, Germany). Epithelial thickness and retinal optical coherence tomography were measured with spectral domain optical coherence tomography (SD-OCT) (Optovue Inc., Fremont, CA). Finally, prior to the surgery planning, a topography was performed using ZYOPTIX® ORBSCAN® II z Anterior Segment Analyzer (Bausch & Lomb, Rochester, New York, USA) and ZYOPTIX® ZYWAVE® II Aberrometer (Bausch & Lomb, Rochester, New York, USA).

Surgical technique

All surgeries were performed by 2 surgeons with experience in presbyopia laser correction (F.A.A and J.A.C). Ten minutes prior to surgery, the eye contour was

disinfected with 5% povidone-iodine (Betadine; Meda Manufacturing, Bordeaux, France). Just before the surgery, a drop of double anesthetic (tetracaine 0.1% and oxybuprocaine 0.4%) (Alcon Cusí, El Masnou, Barcelona, Spain) was instilled in both eyes.

Flap was performed with the VisuMax Femtosecond Laser System (Carl Zeiss Meditec AG, Jena, Germany). The patient was placed on the table under the cone. The laser was focused on the patient's pupil. The patient was asked to observe a green light inside the cone. The pulses of the laser were applied with a pulse energy of approximately 130 nJ. The frequency of the laser was 500 KHz. The line and spot distance of each laser spot was 4.5 µm. The raster pattern was circular. The estimated flap thickness was 100 µm, and the flap diameter was 8.5 mm.

Excimer laser was performed with TECNOLAS ® Perfect Vision GmbH TENEO™ 317 software version 1.25 (Bausch + Lomb, Munich, Germany) with PROSCAN platform (target at 0.00, optical zone at 6.5 mm and nomogram at 100%) for distance dominance eye and SUPRACOR ™ Mild platform (target from 0.00 to -0.50, optical zone at 6.00 mm and nomogram at 117%) for near dominance eye. The laser type was excimer pulsed argon and fluoride (ArF). The shooting frequency was 500 Hz. The wavelength was 193 nm. The size of the spot was 1 mm. The shooting energy was 120 mJ/cm^2.

Postoperative evaluation

Patients were trained to use plastic shields though sleeping for 2 nights. Tobramycin 0.3% and dexamethasone 0.1% (Tobradex ®, Alcon Cusí, Barcelona, Spain) and fluorometholone 0.3% (FML, Allergan, Westport, Ireland) were applied 5 times daily for the first week, 3 times daily for the second week, and finally 1 time daily for the third week. Patients were revised at 1 day, 15 days and 1, 3, 6, 12, and 24 months.

Statistical analysis

Statistical analysis was carried out with SPSS statistics 25.0 (IBM Corporation, Armonk, NY, USA). All visual acuity data were converted into Snellen formats. The T Student’s t-test was performed for parametric dependent variables. All statistical tests were performed with 95% confidence levels ($p < 0.05$).

Results

Eighty eyes from 40 patients underwent TECNOLAS ® Perfect Vision GmbH TENEO™ 317 software version 1.25 (Bausch + Lomb, Munich, Germany). There were 31 females and 9 males. The mean age of the patients was 53.90 ± 4.84 (42 to 66) years. In the preoperative examination, for the dominant eye, mean sphere was +1.92 ± 1.17 (0.00 to +4.50) D, mean cylinder was +0.43 ± 0.38 (0.00 to +1.25) D, and mean spherical equivalent was +2.14 ± 1.14 (+0.63 to +5.00) D. For the non-dominant eye; mean sphere was +2.10 ± 1.10 (+0.75 to +4.50) D ($P > .05$), mean cylinder was +0.31 ± 0.43 (-1.25 to +1.00) D ($P > .05$), and mean spherical equivalent was +2.26 ± 1.12 (+0.38 to +5.00) D ($P > .05$). Preoperative visual acuity data is reported in Table 1.

In terms of efficacy, postoperative UDVA was 0.00 ± 0.04 (20/20) for the dominant eye and 0.14 ± 0.05 (20/30) for the non-dominant eye. Binocular UDVA was 0.00 ± 0.04 (20/20). Postoperative UNVA was 0.51 ± 0.17 (J9) for the dominant eye and 0.09 ± 0.06 (J1.5) for the non-dominant eye. Binocular UNVA was 0.09 ± 0.06 (J1.5). Distance cumulative Snellen visual acuity (20 / x or better) for the dominant and non-dominant eyes are presented in Figure 1A and Figure 2A, respectively. Near cumulative Jaeger visual acuity (Jx or better) for dominant and non-dominant eyes are presented in Figure 3A and Figure 3B, respectively. Binocular cumulative visual acuity (20/x or better for distance/Jx or better for near) are presented in Figure 3C and Figure 3D, respectively. Regarding safety, at 24-months postoperative, 18% of dominant eyes did not change CDVA lines. Eighty-three percent of dominant eyes gained 1 line of CDVA (Figure 1B). 2.5% of non-dominant eyes lost 2 lines. Half of non-dominant eyes lost 1 line. Finally, 48% of non-dominant eyes did not change CDVA lines (Figure 2B). There were no intraoperative or postoperative complications, although 2 patients needed a near enhancement in 12 months after the surgery. Surgeries were performed with excimer laser in the non-dominant eye with +0.25 D treatment (MEL® 80, Carl Zeiss Meditec, Germany). Near Jaeger visual acuity changed from J3 to J2 in both patients.

For predictability, dominant and non-dominant achieved spherical equivalent refraction versus attempted spherical equivalent refraction are presented in Figure

1C and 2C, respectively. The percentage of dominant and non-dominant eyes in postoperative spherical equivalent refraction are presented in Figure 1D and 2D, respectively. The percentage of dominant and non-dominant eyes in postoperative refractive astigmatism are presented in Figure 1E and 2E, respectively. Finally, among stability, the preoperative dominant eye spherical equivalent was 2.14 ± 1.13 D and after 24 months changed to +0.23 ± 0.37 D; 2.5% of eyes changed 0.50 D or more between 3 and 24 months (Figure 1F). The preoperative non-dominant eye spherical equivalent was 2.24 ± 1.15 D and after 24 months changed to - 0.24 ± 0.57 D; 2.5% of eyes changed 0.50 D or more between 3 and 24 months (Figure 2F). At the 6th month of follow-up, 4 patients did not attend their appointment.

Discussion

Our retrospective study reported visual and refractive outcomes obtained with the TENEO™ 317 SUPRACOR® and PROSCAN® algorithms (Bausch and Lomb Technolas, Munich, Germany) in 80 presbyopic hyperope eyes 24 months after surgeries. We reported the efficacy, safety, predictability, and stability. To the best of our knowledge, there is no published research on 317 algorithms. All the authors described below had used the 217P platform. The main difference between 217P and 317 lies in the central bump. The 217P only had a regular platform (larger bump), and 317 had mild (softer bump) and regular platforms.

In terms of efficacy, we found that 93% achieved 20/20 or better binocular UDVA (Figure 2A), and 90% achieved J1.5 or better binocular UNVA (Figure 3B). Previously published studies are reported in Table 2. Thus, some authors[10,24,25] found similar results to ours, while others[18,21,22,26] reported loss in far vision. Authors with the worst results performed bilateral SUPRACOR surgeries, while the authors who performed SUPRACOR in the non-dominant eye and adjusted the manufacturer's nomogram obtained better results. We can confirm that dominant eye corneal central steepening induces myopia. This myopia affects distance vision. In this sense, Cosar et al.[26] performed bilateral surgery in the first 55 patients. After that, they changed the methodology and only performed SUPRACOR surgery in the non-dominant eye.

In terms of safety, our results showed 50% of non-dominant eyes with 1 line of loss (Figure 1B). Previously published studies are reported in Table 2. Our results showed 2.5% of non-dominant eyes with corrected distance visual acuity CDVA with 2 lines of loss (Figure 2B). These results matched those published by other authors; Abrieu-Lacaille et al.[24] and Soler Tomás et al.[25] found that no patients lost 2 lines or more.

In terms of predictability, our results obtained 1.08 x 0.41 (R^2 = 0.91) for the dominant eye (PROSCAN) and 0.98 x + 0.17 (R^2 = 0.93) for the non-dominant eye (SUPRACOR). Most of the authors who have studied the results of SUPRACOR 217P did not present the predictability in terms of a regression line between the

attempted refraction and achieved refraction. Ryan and O' Keefe[18] obtained poor predictability for SUPRACOR (y = 0.56 x + 1.04) and Ang et al.[22] also obtained poor predictability (y = -0.54 x 0.56). Both studies were bilateral surgeries. In addition Ang et al.[22] achieved 2 additional groups in which 1 eye was treated with SUPRACOR and contralateral eye with hyperope LASIK and a third group in which only 1 SUPRACOR surgery was performed on the non-dominant eye. The presentation of predictability is in a single chart for all cases without distinguishing between groups and without distinguishing between the plano target for dominant eye and negative target for non-dominant eye. Therefore, comparing predictability results with other authors is tricky. Our results showed good predictability and a regression coefficient greater than 0.90 for both eyes, separately. Regarding the spherical equivalent obtained, our results showed 65% of SUPRACOR surgeries within ± 0.50 D and 93% within ± 1.00 D. Other authors, such Ryan and O´Keefe[18], reported 54% within ± 0.50 D/83% within ± 1.00 D, and Ang et al.[22] found 68% within ± 0.50 D/94% within ± 1.00 D. These results are conditioned by the corneal multifocality. Central PresbyLASIK, such SUPRACOR, increases the corneal multifocality[19,27], and therefore, the postoperative spherical equivalent and residual astigmatism were greater than non-multifocal surgery without central elevation.[6,15,28]

In terms of stability, our results showed a change of +0.22 D from 3 months of follow-up (-0.46 D) to 24 months of follow-up (-0.24 D) for the non-dominant eye with SUPRACOR surgery, While the change was +0.39 D in the dominant eye with PROSCAN surgery. After 3 months of follow-up, the mean spherical equivalent was -0.16 D, and at 24 months of follow-up, it changed to +0.23 D. Authors, such as Ryan and O´Keefe,[18] Abrieu-Lacaille et al.,[24] Cosar et al.[26], and Ang et al.[22] had a short-term follow-up, while other studies reported a postoperative follow-up of 12 and 18 months. Among them, Saib et al.[10] reported a change of +0.50 D in the dominant eyes. After 3 months of follow-up, the mean spherical equivalent was -0.25 D and at 24 months of follow-up, it changed to +0.25 D. Soler Tomás et al.[25] reported both dominant and non-dominant eyes together with a change of +0.30 D. After 3 months of follow-up, the mean spherical equivalent was -0.40 D and at 24 months of follow-up it changed to -0.20 D. Finally, Schlote and Heuberger[21] did not report the change in the spherical equivalent. Although the number of studies that can be compared is scarce, all the authors showed similar results to ours, and that showed the slight

regression that occurs. Epithelium cellular changes influence postoperative visual regression following hyperopic LASIK.[29] It is necessary to achieve a long-term follow-up of these patients.

PROSCAN surgery in the dominant eye and SUPRACOR in the non-dominant eye using the TENEO™ 317 algorithm has demonstrated that hyperope presbyopic excimer laser surgery technique is effective, safe, predictable, and stable after 24 months of follow-up. The results obtained improve the existing ones for bilateral surgeries of SUPRACOR with the algorithm 217P. A greater volume of patients and a long-term follow-up is essential to confirm the reported results.

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290 References

291 1. Chang JSM, Ng JCM, Lau SYF. Visual Outcomes and Patient Satisfaction
292 After Presbyopic Lens Exchange With a Diffractive Multifocal Intraocular Lens.
293 *J Refract Surg*. 2012;28(7):468-475. doi:10.3928/1081597X-20120612-01
294 2. Bouzoukis DI, Kymionis GD, Panagopoulou SI, et al. Visual outcomes and
295 safety of a small diameter intrastromal refractive inlay for the corneal
296 compensation of presbyopia. *J Refract Surg*. 2012;28(3):168-173.
297 doi:10.3928/1081597X-20120124-02
298 3. Stahl JE. Conductive keratoplasty for presbyopia: 3-year results. *J Refract*
299 *Surg*. 2007;23(9):905-910.
300 4. Wirbelauer C, Karandish A, Aurich H, Pham DT. Imaging scleral expansion
301 bands for presbyopia with optical coherence tomography. *J Cataract Refract*
302 *Surg*. 2003;29(12):2435-2438.
303 5. Schallhorn SC, Teenan D, Venter JA, et al. Monovision LASIK Versus
304 Presbyopia-Correcting IOLs: Comparison of Clinical and Patient-Reported
305 Outcomes. *J Refract Surg*. 2017;33(11):749-758. doi:10.3928/1081597X-
306 20170721-03
307 6. Reinstein DZ. b c, Carp GI., Archer TJ., Gobbe M. LASIK for presbyopia
308 correction in emmetropic patients using aspheric ablation profiles and a micro-
309 monovision protocol with the Carl Zeiss Meditec MEL 80 and VisuMax. *J*
310 *Refract Surg*. 2012;28(8):531-539. doi:10.3928/1081597X-20120723-01
311 7. Wolffsohn JS, Davies LN. Presbyopia: Effectiveness of correction strategies.
312 *Prog Retin Eye Res*. 2019;68:124-143. doi:10.1016/j.preteyeres.2018.09.004
313 8. Renna A, Alió JL, Vejarano LF. Pharmacological treatments of presbyopia: a
314 review of modern perspectives. *Eye Vis*. 2017;4(1):3. doi:10.1186/s40662-017-
315 0068-8
316 9. Thomas BC, Fitting A, Auffarth GU, Holzer MP. Femtosecond laser correction
317 of presbyopia (INTRACOR) in emmetropes using a modified pattern. *J Refract*
318 *Surg*. 2012;28(12):872-878. doi:10.3928/1081597X-20121115-03
319 10. Saib N, Abrieu-Lacaille M, Berguiga M, Rambaud C, Froussart-Maille F, Rigal-
320 Sastourne J-C. Central PresbyLASIK for Hyperopia and Presbyopia Using
321 Micro-monovision With the Technolas 217P Platform and SUPRACOR
322 Algorithm. *J Refract Surg*. 2015;31(8):540-546. doi:10.3928/1081597X-

20150727-04
11. Ruiz LA, Cepeda LM, Fuentes VC. Intrastromal Correction of Presbyopia Using a Femtosecond Laser System. *J Refract Surg*. 2009;25(10):847-854. doi:10.3928/1081597x-20090917-05
12. Ruiz LA., inventor. Apparatus and method for performing presbyopia corrective surgery. US patent 5 533 997, 1996.
13. Cantú R, Rosales M a, Tepichín E, Curioca A, Montes V, Bonilla J. Advanced surface ablation for presbyopia using the Nidek EC-5000 laser. *J Refract Surg*. 2004;20(5 Suppl):S711-3.
14. Telandro A. Pseudo-accommodative cornea: a new concept for correction of presbyopia. *J Refract Surg*. 2004;20(5 Suppl):S714-S717.
15. Jackson WB, Tuan KA, Mintsioulis G. Aspheric Wavefront-guided LASIK to Treat Hyperopic Presbyopia: 12-Month Results With the VISX Platform. *J Refract Surg*. 2011;27(7):519-529. doi:10.3928/1081597x-20101110-02
16. Gordon M. Presbyopia Corrections with the WaveLight ALLEGRETTO: 3-Month Results. *J Refract Surg*. 2010;26(10):S824-S826. doi:10.3928/1081597x-20100921-10
17. Uthoff D, Pölzl M, Hepper D, Holland D. A new method of cornea modulation with excimer laser for simultaneous correction of presbyopia and ametropia. *Graefe's Arch Clin Exp Ophthalmol*. 2012;250(11):1649-1661. doi:10.1007/s00417-012-1948-1
18. Ryan A, O'Keefe M. Corneal approach to hyperopic presbyopia treatment: Six-month outcomes of a new multifocal excimer laser in situ keratomileusis procedure. *J Cataract Refract Surg*. 2013;39(8):1226-1233. doi:10.1016/j.jcrs.2013.03.016
19. Alarcón A, Anera RG, Soler M, del Barco LJ. Visual Evaluation of Different Multifocal Corneal Models for the Correction of Presbyopia by Laser Ablation. *J Refract Surg*. 2011;27(11):833-836. doi:10.3928/1081597x-20111005-02
20. Pinelli R, Ortiz D, Simonetto A, Bacchi C, Sala E, Alió JL. Correction of Presbyopia in Hyperopia With a Center-distance, Paracentral-near Technique Using the Technolas 217z Platform. *J Refract Surg*. 2007.
21. Schlote T, Heuberger A. Multifocal Corneal Ablation (Supracor) in Hyperopic Presbyopia: 1-Year Results in a Cross-Sectional Study. *Eur J Ophthalmol*. 2017;27(4):438-442. doi:10.5301/ejo.5000871

22. Ang RET, Cruz EM, Pisig AU, Solis MLPC, Reyes RMM, Youssefi G. Safety and effectiveness of the SUPRACOR presbyopic LASIK algorithm on hyperopic patients. *Eye Vis*. 2016;3(1):1-10. doi:10.1186/s40662-016-0062-6
23. Seijas O, Gómez de Liaño P, Gómez de Liaño R, Roberts CJ, Piedrahita E, Diaz E. Ocular Dominance Diagnosis and Its Influence in Monovision. *Am J Ophthalmol*. 2007;144(2):209-216.e1. doi:10.1016/j.ajo.2007.03.053
24. Abrieu-Lacaille M, Saib N, Rambaud C, et al. Prise en charge de patients hypermétropes presbytes par chirurgie cornéenne de type presbylasik centré. *J Fr Ophtalmol*. 2014;37(9):682-688. doi:10.1016/j.jfo.2014.02.011
25. Soler Tomás JR, Fuentes-Páez G, Burillo S. Symmetrical Versus Asymmetrical PresbyLASIK. *Cornea*. 2015;34(6):651-657. doi:10.1097/ICO.0000000000000339
26. Cosar CB, Sener AB. Supracor Hyperopia and Presbyopia Correction: 6-Month Results. *Eur J Ophthalmol*. 2014;24(3):325-329. doi:10.5301/ejo.5000371
27. Stival LR, Figueiredo MN, Santhiago MR. Presbyopic Excimer Laser Ablation: A Review. *J Refract Surg*. 2018;34(10):698-710. doi:10.3928/1081597x-20180726-02
28. El Danasoury AM, Gamaly TO, Hantera M. Multizone LASIK with peripheral near zone for correction of presbyopia in myopic and hyperopic eyes: 1-year results. *J Refract Surg*. 2009;25(3):296-305.
29. Moshirfar M, D Desautels J, D Walker B, S Murri M, C Birdsong O, C Hoopes P. Mechanisms of Optical Regression Following Corneal Laser Refractive Surgery: Epithelial and Stromal Responses. *Med hypothesis, Discov Innov Ophthalmol J*. 2018;7(1):1-9.

Figure Legends

Figure 1 – PROSCAN ® (dominant eye) standard graphs for reporting refractive surgery. (A) uncorrected visual distance acuity (UDVA): efficacy histogram. (B) Change in corrected distance visual acuity (CDVA): safety histogram. (C) Spherical equivalent attempted versus achieved. (D) Spherical equivalent refractive accuracy. (E) Refractive astigmatism. C, D, and E graphs represent predictability. (F) Stability of spherical equivalent refraction.

Figure 2 – SUPRACOR ® (non-dominant eye) standard graphs for reporting refractive surgery. (A) uncorrected visual distance acuity (UDVA): efficacy histogram. (B) Change in corrected distance visual acuity (CDVA): safety histogram. (C) Spherical equivalent attempted versus achieved. (D) Spherical equivalent refractive accuracy. (E) Refractive astigmatism. C, D, and E graphs represent predictability. (F) Stability of spherical equivalent refraction.

Figure 3 – Distance and near complementary visual outcomes for reporting refractive surgery. (A) Near cumulative Jaeger visual acuity (Jx or better) for dominant eye. (B) Near cumulative Jaeger visual acuity (Jx or better) for non-dominant eye. (C) Distance binocular cumulative visual acuity (20/x or better). (D) Near binocular cumulative visual acuity (Jx or better).

Table 1. Preoperative visual acuity data logMAR scale (Snellen for distance and Jaeger for near). Uncorrected distance visual acuity (UDVA), uncorrected near visual acuity (UNVA), corrected distance visual acuity (CDVA) and corrected near visual acuity (CNVA).

Visual acuity	Dominant eye	Non-dominant eye	Binocular	P value between both eyes
UDVA	0.37 ± 0.19 (20/60)	0.36 ± 0.18 (20/60)	0.30 ± 0.13 (20/40)	P > .05
UNVA	0.45 ± 0.28 (J11)	0.45 ± 0.28 (J11)	0.46 ± 0.15 (J8)	P > .05
CDVA	0.08 ± 0.04 (20/25)	0.08 ± 0.04 (20/25)	0.00 ± 0.00 (20/20)	P > .05
CNVA	0.10 ± 0.00 (J1.5)	0.10 ± 0.00 (J1.5)	0.00 ± 0.00 (J1)	P > .05

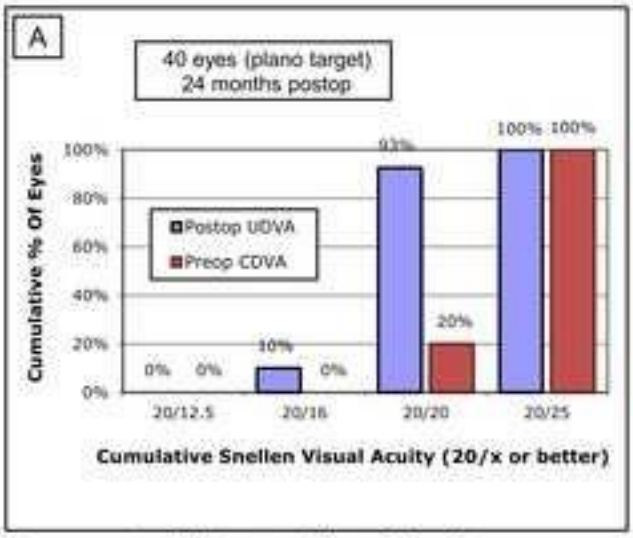
Table 2

Table 2. SUPRACOR results among previous studies. **Efficacy**. Percentage postoperative uncorrected binocular distance and visual acuity (UDVA) (with 20/20 or better for distance / J2 or better for near distance) (Efficacy index is also shown when percentage was not available). **Safety**. Percentage of eyes with corrected distance visual acuity CDVA with 1 and 2 lines of loss or more (in unilateral SUPRACOR surgery, this eye data was presented).

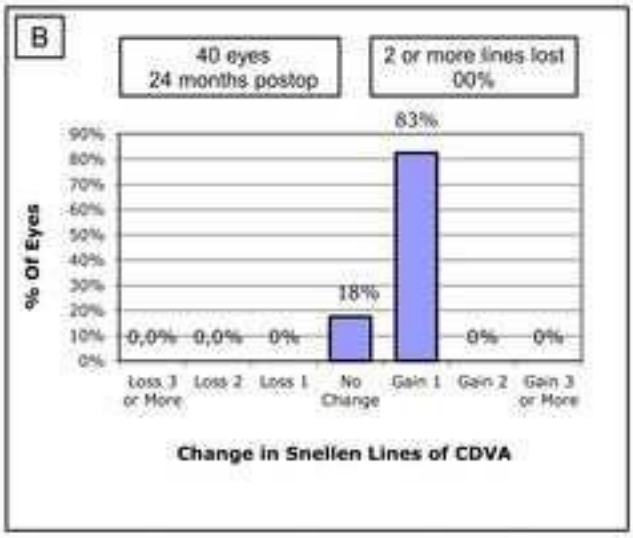
Autor	Year	Algorithm	Eyes	Eye surgery	Efficacy	Safety	Follow up (months)
Ryan and O´Keefe[18]	2013	217P	46	Both	48% / 73.9%	15.2% / 6.5%	6
Abreu-Lacaille et al[24]	2014	217P	58	Both	≈ 95% / 100%	≈ 2.5% / 0%	6
Cosar and Sener[26]	2014	217P	123	Both / NDE	22% / 89.4%	28.5% / 10.6%	6
Saib et al[10]	2015	217P	74	Both	100% / 93.1%	9.45% / 4.05%	12
Soler Tomás et al[25]	2015	217P	24	NDE	100% / 100%	0% / 0%	18
Ang et al[22]	2016	217P	69	Both / NDE	63% / 93%	12.1 % / 6.1%	6
Schlote and Heuberger[21]	2017	217P	39	Both	77% / 93%	NR / 20%	12
NR: Not reported; DE: Dominant eye; NDE: Non-dominant eye							

Figure 1

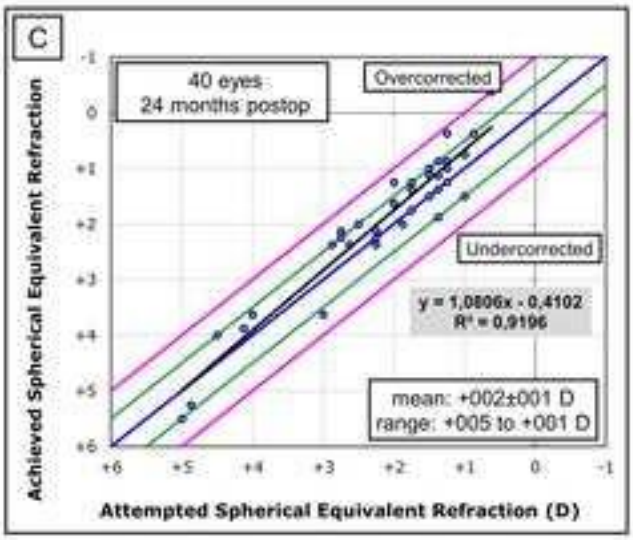
Click here to access/download;Figure with Hyperlink;Figure 1 - Proscan Eye Six Graphs.tif



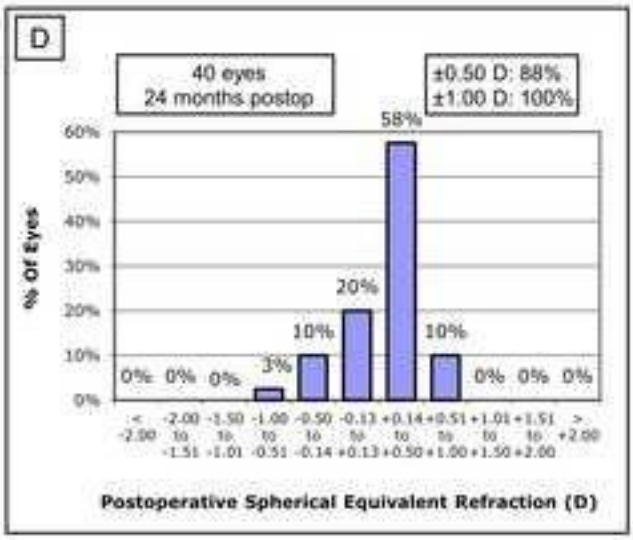
Uncorrected Distance Visual Acuity



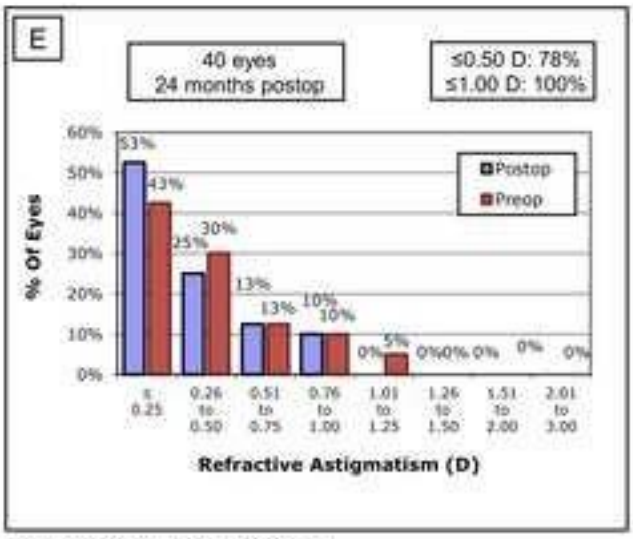
Change in Corrected Distance Visual Acuity



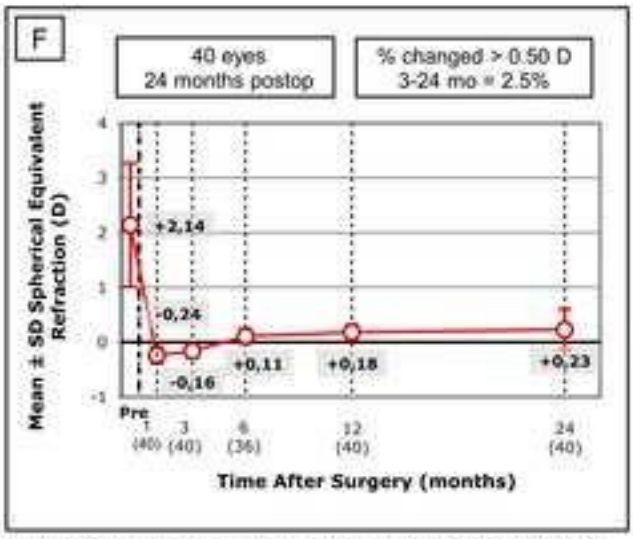
Spherical Equivalent Attempted vs Achieved



Spherical Equivalent Refractive Accuracy



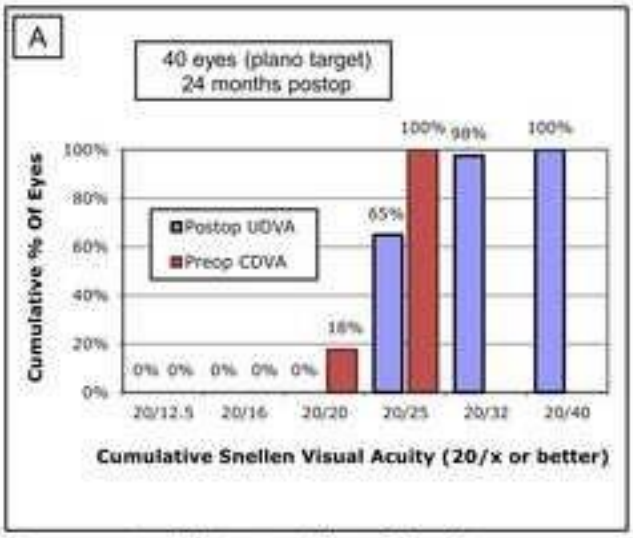
Refractive Astigmatism



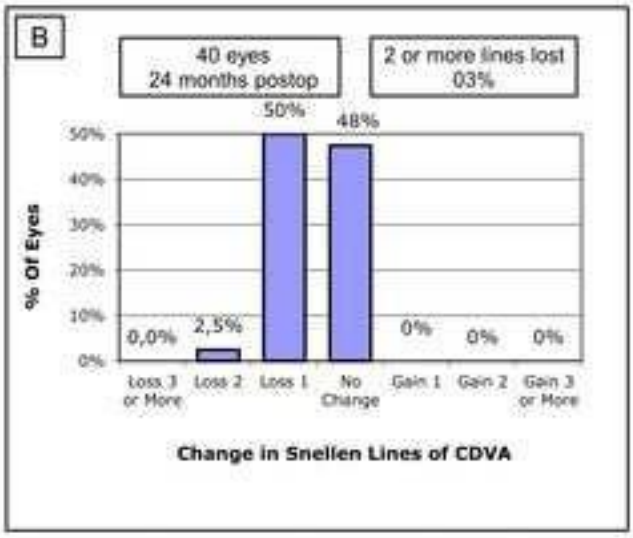
Stability of Spherical Equivalent Refraction

Figure 2

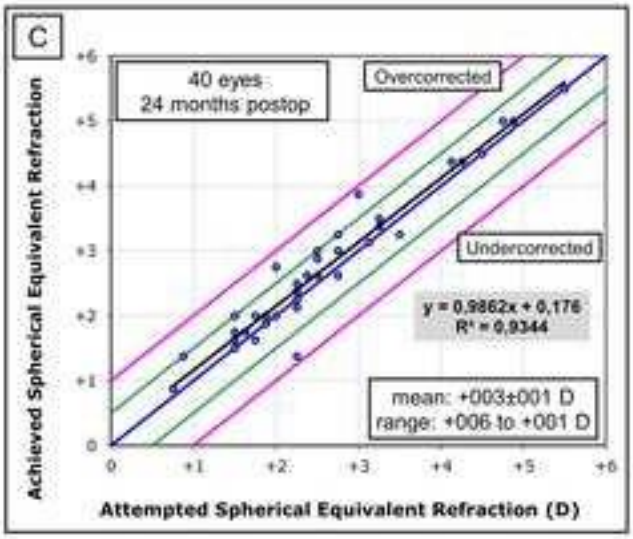
Click here to access/download;Figure with Hyperlink;Figure 2 - Supracor Eye Six Graphs.tif



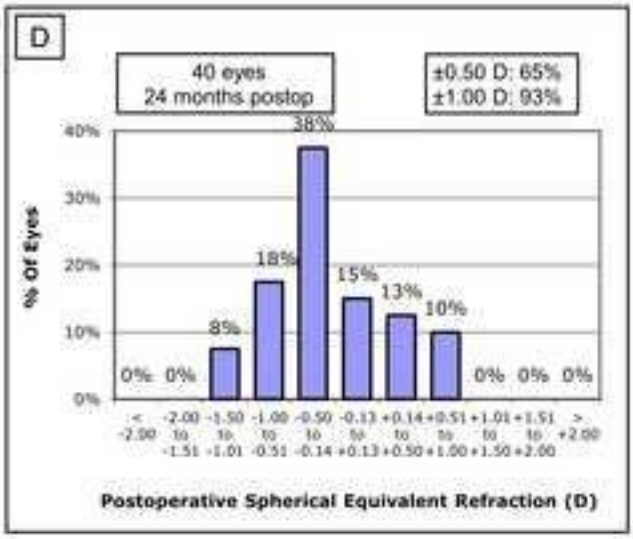
Uncorrected Distance Visual Acuity



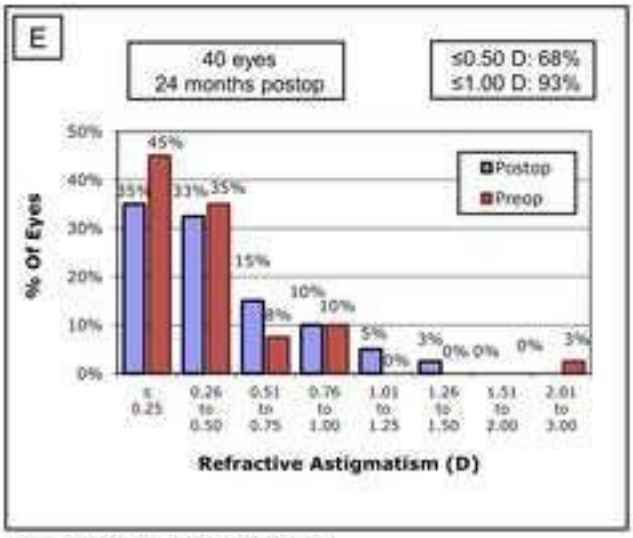
Change in Corrected Distance Visual Acuity



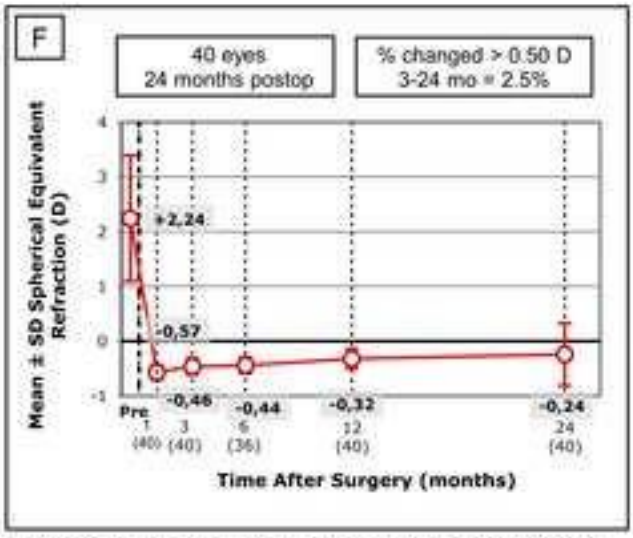
Spherical Equivalent Attempted vs Achieved



Spherical Equivalent Refractive Accuracy



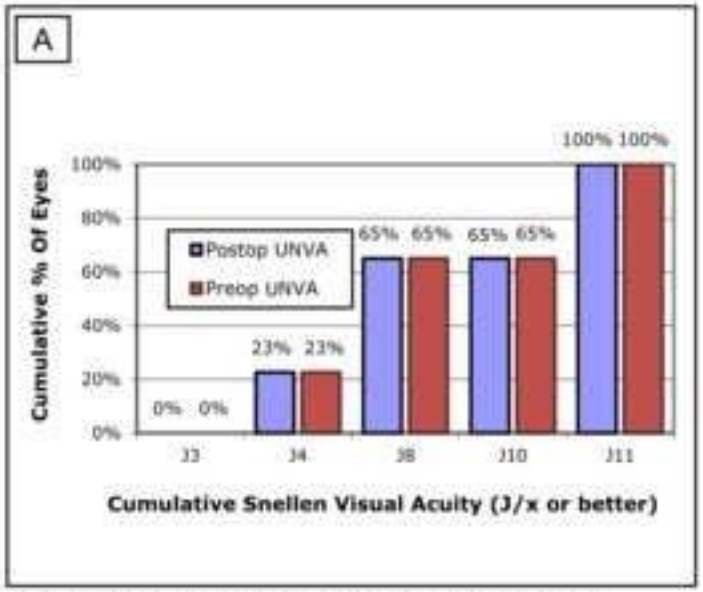
Refractive Astigmatism



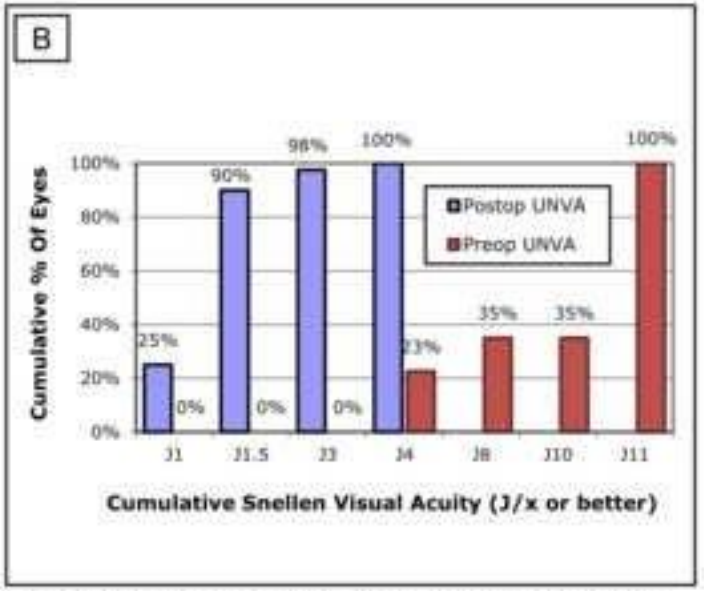
Stability of Spherical Equivalent Refraction

Figure 3

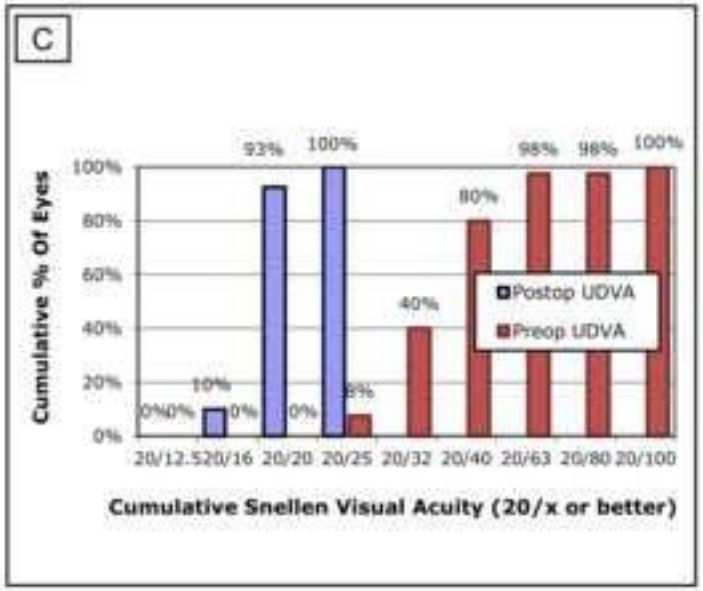
Click here to access/download;Figure with Hyperlink;Figure 3. Efficacy Complementary.tiff



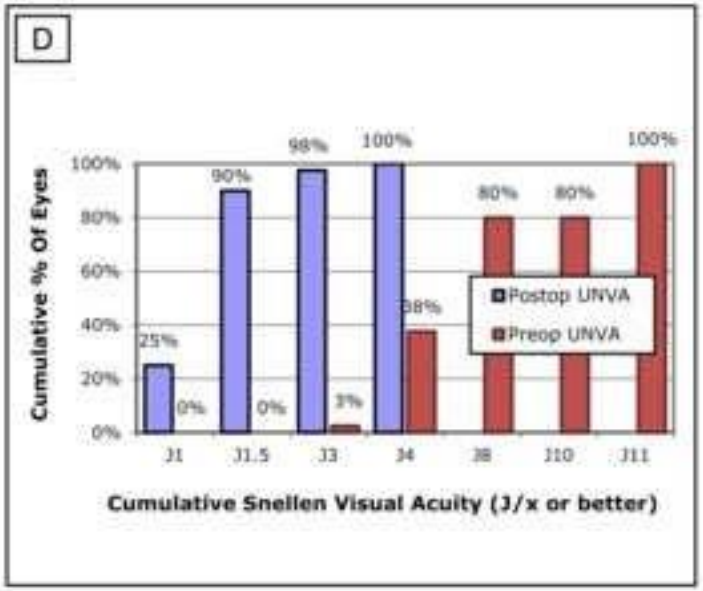
Uncorrected Near Dominant Eye Visual Acuity



Uncorrected Near Non Dominant Eye Visual Acuity



Uncorrected Distance Binocular Visual Acuity



Uncorrected Near Binocular Visual Acuity