ARTYKUŁ PRZEGLĄDOWY REVIEW ARTICLE

DOI: 10.24292/01.OT.120622

Choosing the right surgical treatment for hyperopia

Jan Grzeszkowiak[1], Joanna Wierzbowska[1, 2]

[1] Optegra Eye Clinic
Head: Jolanta Oficjalska MD, PhD

[2] Departament of Ophthalmology, Central Clinical Hospital of the Ministry of National Defence, Military Institute of Medicine in Warsaw
Head: Prof. Marek Rękas, MD, PhD

HIGHLIGHTS

This article presents the guidelines for choosing the right surgical treatment option for hyperopia.

ABSTRACT

Several aspects make the treatment of hyperopia and selecting the treatment method challenging. This article has reviewed the main surgical options for hyperopia and factors that must be considered when choosing the right treatment. The modern refractive technology offers excellent options with the optimal choice of procedure being dependent on the level of refractive error, age of the patient and the unique anatomical factors in each case. Surgeons must perform a complete evaluation and risk-benefit assessment of the individual patient to select the best procedure.

Key words: hyperopia, refractive surgery, LASIK, refractive lens exchange, phakic lenses

INTRODUCTION

Hyperopia is a refractive error in which light is focused behind, instead of on, the retina. It is caused by a short axial length, a flat cornea, or a combination thereof. It can be categorized into low (≤ +2.00 D), moderate (+2.00 – +4.00 D), and high (> +4.00 D) [1]. The modern refractive surgeon has a variety of options available to treat patients with hyperopia who wish to be independent of spectacles and contact lenses. These include laser refractive surgery (LRS), phakic lens implantation and refractive lens exchange (RLE). Conductive keratoplasty (CK) has been abandoned by majority of surgeons due to the high rate of regression and low predictability [2].

There are several reasons why choosing the right treatment method for hyperopia can be particularly challenging. Firstly, hyperopic patients who are not yet presbyopic may have a significant disparity between their manifest and latent (cycloplegic) refractions. This means that a refractive treatment targeted on their manifest refraction, while being the best option for immediate restoration of good unaided distance vision may result in regression of effect with time when the residual hyperopia which may have been untreated becomes unmasked. Secondly, hyperopes often have different eye anatomy to myopes in terms of corneal shape, anterior chamber depth and axial length. This has implications for the feasibility and safety of laser refractive surgical correction, phakic lenses and accurate lens calculations for a refractive lens exchange [3]. Selecting the safest and most appropriate technique for each individual patient is critical. Factors to consider when deciding between these options include the degree of hyperopia, the patient's age, lens opacification, accommodative ability, keratometry, corneal topography, and endothelial status [1, 4].

LASER REFRACTIVE SURGERY

Laser refractive surgery techniques are based on modifying the corneal curvature with the excimer laser (i.e. FS-LASIK, LASIK, LASEK, PRK) [5–8] or recently also with the femtosecond laser (hyperopic SMILE) [9–11]. These procedures flatten the paracentral cornea in order to steepen the its central area.

Femtolasik (FS-LASIK) and LASIK for patients with low to moderate degrees of hyperopia has been shown in numerous studies to be safe, effective and predictable. For those with higher degrees of hyperopia, the results are less predictable, and regression of effect is more common [8, 12, 13]. When considering hyperopic FS-LASIK or LASIK, cycloplegic refraction and keratometry (K) readings are very important. Hyperopic individuals often have high accommodative ability and may have hyperopia that is unmasked by cycloplegia. For those with latent hyperopia (most young adults fall into this category) preoperative adaptation to a higher prescription (possibly as close to cyclorefraction as possible) should therefore be considered [14]. Hyperopic presbyopes can still be treated with FS-LASIK or LASIK providing the degree of hyperopia is low enough to accommodate the extra treatment required for a laser blended vision treatment (micro-monovision) to make them spectacle independent [15, 16]. Additional consideration should be given to the anticipated postoperative K reading. Corneal steepness will increase after hyperopic LASIK, so the surgeon must not make the cornea steeper than about 49.00 D [17]. Patients with overly steep corneas can also suffer from an abnormal tear film, causing poor visual quality. In hyperopic eyes characterized more often than myopic eyes with large κ angle, treatments are more prone to quality of vision issues if the laser treatment is decentered at all so for high hyperopic treatments targeting the laser on the corneal vertex rather than on the pupil centre is preferable [18]. Also, as laser pulses are applied more in the periphery of the cornea and a larger corneal flap is required, hyperopic laser treatments tend to be more prone to dry eye postoperatively. Other risks of the procedure include: abnormalities of the corneal flap, epithelial ingrowth, corneal ectasia, over- or undercorrection, visual aberrations, a loss of BCVA, infectious keratitis, dry eye symptoms, and diffuse lamellar keratitis [19]. Some regression of effect is well described in all hyperopic laser refractive surgery, as the midperipheral location of treatment is more susceptible to stromal remodeling than the central cornea. This is particularly true of hyperopic surface laser treatments (LASEK/PRK) as the removal of the epithelium triggers a more profound wound healing response. For this reason, most surgeons reserve surface laser treatments only for low hyperopia in patients where flap procedure is not possible or unadvisable, such as in those with thin corneas. With hyperopic surface ablation there is also a higher risk of postoperative haze as the result of fibroblasts activation [20].

In summary, the anatomical peculiarities of the hyperopic eye make laser refractive surgery for hyperopia a considerable challenge. Large optical ablation zones now allow correction of high hyperopia by reducing the risks of optical aberrations and regression. The patient must be informed and understand the postoperative course, which differs from that of surgery for myopia and is usually longer [20].

PHAKIC INTRAOCULAR LENSES

Phakic intraocular lenses (pIOL) are the surgical treatment of choice for patients who are unsuitable for laser eye surgery but satisfy the anatomical requirements for safe placement of the lenses. The operation involves placing an intraocular lens into the eye without removing the natural lens of the eye. The advantage of this over RLE is the preservation of normal accommodative function and a much lower risk of retinal detachment. There are two main options:

- Placement in the ciliary sulcus in front of the natural lens of the eye and behind the iris such as the Staar Visian Implantable Collamer Lens (ICL) [21].
- Iris clip lens that sit in the anterior chamber such as the Ophtec Artisan lenses [22].

Each of these two options has various advantages and disadvantages. The authors' preference is the Visian ICL as this causes the least endothelial cell loss and, in fact, long-term endothelial cell loss beyond the first few years is thought to be negligible. It can be used to treat hyperopia from +3.00 D to +10.00 D. Implantation of a posterior chamber ICL has been found to be a safe, effective, predictable, and stable method for the correction of moderate and high hyperopia in highly selected patients [23]. The treatment requires performing of two peripheral Yag-laser iridotomies prior to ICL implantation to facilitate aqueous circulation [23]. Complications are rare. The main complications of ICL are: anterior subcapsular cataract formation, pigment dispersion, and luxation or pupillary block glaucoma. No causative relationship between pIOL implantation (of any pIOL type) and retinal detachment has been established [24–27]. The treatment requires an adequate anterior chamber depth, anterior chamber angle width, endothelial cell density and intraocular pressure for safe ICL implantation [28]. Monitoring of intraocular pressure, endothelial cell density, crystalline lens clarity and vault (the distance between the back surface of the ICL and the anterior surface of the crystalline lens) postoperatively is critical.

REFRACTIVE LENS EXCHANGE

Due to the loss of accommodation with RLE, presbyopic or "peripresbyopic" patients are more likely to benefit from the procedure than pre-presbyopes [29]. The literature suggests that 40–45 years should be the lower limit of the age range considered for RLE [30, 31]. A young hyperopic patient often will not tolerate his or her quality of near vision after a pseudophakic loss of accommodation compared to natural lens function [32]. The procedure is identical to cataract surgery and involves removing the clear natural lens and replacing it with an artificial intraocular lens. The other term for this procedure – clear lens exchange (CLE) – separates this approach from cataract surgery, where a cloudy lens has to be removed [32, 33].

Advantages of this procedure include: no regression of refractive effect, no long-term risk of dry eye, removal of the risk of angle closure glaucoma in eyes that otherwise have a predisposition to this and avoiding the risk of cataract in the future.

The main disadvantage of this over laser eye surgery is the risk of sight loss due to bleeding or infection, which is estimated to be around 1 : 2000 [30], whereas the risk of significant loss of vision (more than two lines of best corrected visual acuity) in laser eye surgery is much lower [34]. There is also a long-term risk of retinal detachment [35]. Apart from well-known intraocular treatments complications, the risk of those in short, hyperopic eyes (axial length < 21.0 mm) is mostly due to anatomical conditions – less space in the anterior segment and narrow anterior chamber predispose to pupillary block or secondary postoperative intraocular pressure increase. The postoperative uveal effusion is also seen more often in hyperopic eyes [36].

There are several lens options for providing uncorrected distance, intermediate and near vision. These include: monovision, accommodating lenses, multifocal and trifocal lenses of various powers and types, and extended depth of focus lenses [37, 38].

RLE is not a good option for pre-presbyopic patients, as they will perceive a significant loss in quality of their intermediate and near vision even with the advanced lens options described earlier. Furthermore, the risk of retinal detachment makes this an inferior choice to phakic intraocular lenses or laser refractive treatments for these patients.

CHOOSING THE BEST TREATMENT OPTION

As mentioned earlier there are several factors that need to be considered when choosing the right surgical treatment option for hyperopic patients. The decision should always be made individually depending on the patient's age and after a careful analysis of the medical history, manifest- and cyclorefraction, accommodative ability, results of eye examination and its anatomy, corneal topography, intraocular pressure, endothelial status etc. All well-known contraindications for any type of the refractive surgery presented here should be kept in mind to properly assess the patient's suitability for the treatment. The treatment selected should promise the highest chances for the safety and predictability and aim to provide the patient with the best quality of vision possible.

For young adults with low to moderate hyperopia, adequate pachymetry, normal corneal topographies and K readings the laser surgery should be given the priority as much safer than any intraocular treatment. For those with steep corneas and/or higher prescriptions and thin corneas pIOL implantation could be a better option.

Pre-presbyopic or presbyopic hyperopes with no lens opacities can still benefit from laser treatment, especially if they tolerate monovision well. Laser blended vision techniques with micromonovision protocol applied may provide them with a level of spectacle independency they are looking for without the risks involved with RLE.

Higher prescriptions, steep and/or thin corneas, narrow anterior chambers, dry eye symptoms, lens opacities make hyperopic presbyopes good candidates for RLE. Various options of visual outcomes depending on the type of the intraocular lens to be implanted should be discussed with the patient prior to treatment.

Table 1 summarizes authors' preferences for the right treatment of hyperopia based on personal 22-year experience in refractive surgery and the literature available.

TABLE 1

Comparison of FS-LASIK, PIOL and RLE for the best treatment of hyperopia.

	FS-LASIK	PIOL	RLE
Age	Younger (18–50 years of age)	Younger (18–35 years of age)	Older (≥ 45 years of age)
Presbyopia	Benefit (consider LBV treatment with micromonovision)	No benefit (so far)	Benefit
Degree of hyperopia	Low/moderate (≤ +4.00 D)	High (≥ +5.00 D)	High (≥ +5.00 D)
Keratometry	Normal	Abnormal, expected postoperative keratometry > 49.00 D	Abnormal, expected postoperative keratometry > 49.00 D
Narrow anterior chamber	No benefit	Contraindication	Benefit
Pachymetry	≥ 500 µm	n/a	n/a
Complications	Regression, dry eye, epithelial ingrowth, ectasia, glares and halos, flap-related complications	Postoperative intraocular pressure increase, pigment dispersion, cataract formation, intraoperative complications	Retinal detachment, uveal effusion, cystoid macular edema, endophthalmitis, endothelial cell loss, postoperative intraocular pressure increase, intraoperative complications

CONCLUSION

Selecting the right surgical treatment for hyperopia can be particularly challenging. There is no ideal solution that can be applied to all patients. When choosing the right option one should consider several factors, such as age, eye anatomy, degree of hyperopia, corneal topography, patient's expectations and preferences. The modern refractive technology provides surgeons with a variety of options available to treat patients with hyperopia who wish to be independent of spectacles and contact lenses. Whereas laser refractive surgery, phakic intraocular lens implantation and refractive lens exchange all have been found safe and predictable, it still remains the responsibility of the surgeon to choose the right treatment for each patient individually.

CORRESPONDENCE
Jan Grzeszkowiak, MD, PhD, CertLRS RCOphth
Optegra Eye Hospital
61-101 Poznań, ul. Wenecjańska 8
e-mail: j.grzeszkowiak@optegra.com.pl

ORCID
Jan Grzeszkowiak – ID – http://orcid.org/ 0000-0002-0346-392X
Joanna Wierzbowska – ID – http://orcid.org/0000-0002-6993-7518

References

1. Rosen E. Hyperopia – RLE, pIOL, or LVC? J Cataract Refract Surg. 2008; 34(2): 175-6.
2. Meduri A, Alessandrello F, Rechichi M et al. Transepithelial photorefractive keratectomy for the management of hyperopic regression after conductive keratoplasty. BMJ Case Reports CP. 2021; 14: e241144.
3. Lee BS. Accuracy and stability of hyperopic treatments. Curr Opin Ophthalmol. 2014; 25(4): 281-5.
4. Barnett V, Barsam A. Update on Laser Vision Correction Versus Intraocular Lens Options. Curr Ophthalmol Rep. 2020; 8: 104-10.
5. Biscevic A, Pidro A, Pjano MA et al. Lasik as a Solution for High Hypermetropia. Med Arch. 2019; 73(3): 191-4.
6. Kaluzny BJ, Piotrowiak-Slupska I, Kaszuba-Modrzejewska M et al. Three-year outcomes after high hyperopia correction using photorefractive keratectomy with a large ablation zone. Brit J Ophthalmol. 2019; 103: 849-54.
7. Settas G, Settas C, Minos E et al. Photorefractive keratectomy (PRK) versus laser assisted in situ keratomileusis (LASIK) for hyperopia correction. Cochrane Database Syst Rev. 2012; 6: CD007112. http://doi.org/10.1002/14651858.CD007112.pub3.
8. Reinstein DZ, Carp GI, Archer TJ et al. Outcomes for Hyperopic LASIK With the MEL 90® Excimer Laser. J Refract Surg. 2018; 34(12): 799--808. http://doi.org/10.3928/1081597X-20181019-01.
9. Reinstein DZ, Pradhan KR, Carp GI et al. Small Incision Lenticule Extraction for Hyperopia: 3-Month Refractive and Visual Outcomes. J Refract Surg. 2019; 35(1): 24-30. http://doi.org/10.3928/1081597X-20181025-01.
10. Pradhan KR, Reinstein DZ, Carp GI et al. Small Incision Lenticule Extraction (SMILE) for Hyperopia: 12-Month Refractive and Visual Outcomes. J Refract Surg. 2019; 35(7): 442-50.
11. Spiru B, Torres-Netto EA, Kling S et al. Hyperopic SMILE Versus FS-LASIK: A Biomechanical Comparison in Human Fellow Corneas. J Refract Surg. 2021; 37(12): 810-5. http://doi.org/10.3928/1081597X-20210830-02.
12. Humayun S, Ishaq M, Fawad A et al. Assessment of Refractive Outcomes of Femtosecond-assisted Laser in Situ Keratomileusis (LASIK) for Hyperopia. J Coll Physicians Surg Pak. 2021; 30(4): 434-9. http://doi.org/10.29271/jcpsp.2021.04.434.
13. Demir G, Sucu ME, Yıldırım Y et al. Long-term assessment of visual and refractive outcomes of laser in situ keratomileusis for hyperopia using the AMARIS® 750S Excimer laser. J Fr Ophtalmol. 2019; 42(7): 703-10. http://doi.org/10.1016/j.jfo.2019.02.006.
14. Mimouni M, Zoller L, Horowitz J et al. Cycloplegic autorefraction in young adults: is it mandatory? Graefes Arch Clin Exp Ophthalmol. 2016; 254: 395-8. http://doi.org/10.1007/s00417-015-3246-1.
15. Brar S, Sute SS, Bagare SN et al. Functional Outcomes and Reading Speeds following PRESBYOND LBV Using Nonlinear Aspheric Ablation Profiles Combined with Micro-Monovision. J Ophthalmol. 2021; 2021: 2957443. http://doi.org/10.1155/2021/2957443.
16. Reinstein DZ, Carp GI, Archer TJ et al. LASIK for presbyopia correction in emmetropic patients using aspheric ablation profiles and a micro-monovision protocol with the Carl Zeiss Meditec MEL 80 and VisuMax. J Refract Surg. 2012; 28(8): 531-41. http://doi.org/10.3928/1081597X-20120723-01.
17. Williams LB, Dave SB, Moshirfar M. Correlation of visual outcome and patient satisfaction with preoperative keratometry after hyperopic laser in situ keratomileusis. J Cataract Refract Surg. 2008; 34(7): 1083-8.
18. Delbarre M, Le HM, Boucenna W et al. Hypermétropie et chirurgie réfractive [Refractive surgery for hyperopia]. J Fr Ophtalmol. 2021; 44(5): 723-9. http://doi.org/10.1016/j.jfo.2020.11.008.
19. Melki SA, Azar DT. LASIK complications: etiology, management, and prevention. Surv Opthhalmol. 2001; 46(2): 95-116.
20. Lwowski C, Kohnen T. Korneale Komplikationen nach hyperoper PRK [Corneal complications after PRK for hyperopia]. Ophthalmologe. 2020; 117(2): 150-3. http://doi.org/10.1007/s00347-019-0912-4.
21. Alfonso JF, Baamonde B, Belda-Salmerón L et al. Collagen copolymer posterior chamber phakic intraocular lens for hyperopia correction: three-year follow-up. J Cataract Refract Surg. 2013; 39(10): 1519-27. http://doi.org/10.1016/j.jcrs.2013.04.035.
22. Bartels MC, Santana NT, Budo C et al. Toric phakic intraocular lens for the correction of hyperopia and astigmatism. J Cataract Refract Surg. 2006; 32(2): 243-9. http://doi.org/10.1016/j.jcrs.2005.12.083.
23. El Khatib L, Hatoum AK, Moukhadder HM et al. Transient crystalline lens deposits following the insertion of a phakic sulcus-fixated collamer intraocular lens in a hyperopic eye. Am J Ophthalmol Case Rep. 2020; 17: 100598. http://doi.org/10.1016/j.ajoc.2020.100598.
24. Gimbel HV, LeClair BM, Jabo B et al. Incidence of implantable Collamer lens-induced cataract. Can J Ophthalmol. 2018; 53(5): 518-22. http://doi.org/10.1016/j.jcjo.2017.11.018.
25. Kocová H, Vlková E, Michalcová L et al. Incidence of cataract following implantation of a posterior-chamber phakic lens ICL (Implantable Collamer Lens) – long-term results. Cesk Slov Oftalmol. 2017; 73(3): 87-93.
26. Fernandes P, González-Méijome JM, Madrid-Costa D et al. Implantable collamer posterior chamber intraocular lenses: a review of potential complications. J Refract Surg. 2011; 27(10): 765-76. http://doi.org/10.3928/1081597X-20110617-01.
27. Kohnen T, Kook D, Morral M et al. Phakic intraocular lenses: part 2: results and complications. J Cataract Refract Surg. 2010; 36(12): 2168--94. http://doi.org/10.1016/j.jcrs.2010.10.007.
28. Benda F, Filipová L, Filipec M. Correction of moderate to high hyperopia with an implantable collamer lens: medium-term results. J Refract Surg. 2014; 30(8): 526-33. http://doi.org/10.3928/1081597X-20140711-05.

29. Nicula CA, Popescu R, Rednik AM et al. Refractive Lens Exchange in Hyperopic Presbyopes with the Acrysof IQ Panoptix Intraocular Lens: One-Year Results and Analysis of the Literature. Ther Clin Risk Manag. 2020; 16: 1125-37. http://doi.org/10.2147/TCRM.S279065.
30. Schallhorn SC, Schallhorn JM, Pelouskova M et al. Refractive lens exchange in younger and older presbyopes: comparison of complication rates, 3 months clinical and patient-reported outcomes. Clin Ophthalmol. 2017; 11: 1569-81. http://doi.org/10.2147/OPTH.S143201.
31. Alió JL, Grzybowski A, Romaniuk D. Refractive lens exchange in modern practice: when and when not to do it? Eye Vis (Lond). 2014; 1: 10. http://doi.org/10.1186/s40662-014-0010-2.
32. Alio JL, Grzybowski A, El Aswad A et al. Refractive lens exchange. Surv Ophthalmol. 2014; 59(6): 579-98.
33. Hengerer FH, Conrad-Hengerer I. Refraktiver Linsenaustausch [Refractive Lens Exchange]. Klin Monbl Augenheilkd. 2017; 234(10): 1299-314. http://doi.org/10.1055/s-0043-115030.
34. Barsam A, Allan BD. Excimer laser refractive surgery versus phakic intraocular lenses for the correction of moderate to high myopia. Cochrane Database Syst Rev. 2014; 6: CD007679.
35. Nanavaty MA, Daya SM. Refractive lens exchange versus phakic intraocular lenses. Curr Opin Ophthalmol. 2012; 23(1): 54-61.
36. Kook D, Kampik A, Kohnen T. Komplikationen des refraktiven Linseneaustausches. Ophthalmologe. 2008; 105: 1005-12. http://doi.org/10.1007/s00347-008-1829-5.
37. Ozulken K, Kiziltoprak H, Yuksel E et al. A Comparative Evaluation of Diffractive Trifocal and New Refractive/Extended Depth of Focus Intraocular Lenses for Refractive Lens Exchange. Curr Eye Res. 2021; 46(6): 811-7. http://doi.org/10.1080/02713683.2020.1833347.
38. Schallhorn SC, Hettinger KA, Teenan D et al. Predictors of Patient Satisfaction After Refractive Lens Exchange With an Extended Depth of Focus IOL. J Refract Surg. 2020; 36(3): 175-84. http://doi.org/10.3928/1081597X-20200211-01.

Authors' contributions:
Jan Grzeszkowiak: writing of manuscript, final review of manuscript;
Joanna Wierzbowska: advising on manuscript structure, final review of manuscript.

Conflict of interest:
None.

Financial support:
None.

Ethics:
The content presented in the article complies with the principles of the Helsinki Declaration, EU directives and harmonized requirements for biomedical journals.