Guide for patients and family doctors
on the costs and benefits of corneal refractive surgery

Summary

1. Vision
Vision is the most important human sense, delivering over 80% of the information received by individuals from the environment. External information is collected through vision based on light reflection and refraction.

Light from different sources meets objects from the environment, and is partly absorbed, partly reflected by these. The human eye captures the light that is reflected by an object.

The human eye is highly complex. It can capture and forward large amounts of information from the environment to the brain.
In order to deliver an image, the light beams need to focus on the retina. Light beams are initially parallel or divergent. Inside the eyeball, they are focused through successive refractions while crossing the cornea, the aqueous humour, the lens of the eye and the glassy humour.

Structure of the Cornea

Refraction is essential for the human eye, as light needs to cross the transparent layers and be focused on the retina. The focus of the light on the retina is the consequence of the repeated adjustment of its direction while crossing the contact surface between successive transparent layers of the eyeball (cornea, aqueous humour, lens of the eye and glassy humour).

Chapter 1 describes the mechanism of vision and provides information on the anatomy of the human eye and the light refraction process.
2. Refractive errors

The light entering the eyeball needs to focus on the retina, in order for the individual to see. Refraction is essential for light beams to focus. A deficient focus of the light on the retina is called refractive error. Myopia, hypermetropia, astigmatism and presbyopia are refractive errors.

Refractive errors are caused sometimes by an imperfect curvature, or asymmetries of the cornea. However, the light focus on the retina depends not only on the refractive power and symmetry of the cornea, but also on the adaptability of the lens of the eye and the length of the anterior/posterior axis. The emmetropic eye (i.e. the eye with a normal vison) allows the entry of the light along the anterior/posterior axis and its focus on the retina, through refractions at the level of the cornea and the lens of the eye. An eye with the same refraction parameters at the level of the cornea and the lens of the eye, but with a longer anterior/posterior axis causes light to focus in front of the retina (myopia). In the same line, an eye with a shorter anterior/posterior axis than a regular one (ca. 24 mm) could provide a normal sight if it had a lower refractive power (given by the cornea and the lens of the eye).

Refractive errors are caused by imperfections regarding the length of the eyeball, the curvature of the cornea or the lens of the eye, the chemical composition of the transparent layers inside the eye (impacting on the refractive index), or the deficient correlation of these parameters.

Chapter 2 describes the causes, symptoms and diagnosis of refractive errors.
3. Classic therapeutic solutions
The classic therapeutic solutions for refractive errors are spectacles and contact lenses.
Spectacles remain the most frequently applied therapeutic solution for refractive errors.
Spectacle lenses can be classified according to their material, their refractive index, the focals and the lens treatment. The spectacle frames or mountings can be classified according to their material and fixing.

The frequency with which spectacle lenses or frames need to be replaced may vary from case to case. There are several factors influencing this decision. The average annual costs generated by wearing and replacing spectacles depend mainly on the quality of the lenses and mountings, but also on the location of the purchase.

The maintenance is essential to increasing the useful life of spectacles and involves both their daily cleaning with microfiber and cleaning solutions, and their protection while not being used.

The main advantage of spectacles compared to contact lenses is the fact that no infection risk is associated to their use. More, wearing spectacles does not require a special application procedure. There are however also drawbacks of wearing spectacles.

Contact lenses are an alternative solution for refractive errors. They provide a visual field with no distortions in the peripheral area and also play an aesthetic role. The frequency of their replacement may vary, according to their type: disposable contact lenses, daily contact lenses, or long term contact lenses. Both benefits, and drawbacks are associated to wearing contact lenses.

Chapter 3 describes the main features of spectacles and contact lenses as classic therapeutic solutions for refractive errors.
4. Corneal refractive surgery

Refractive errors can be corrected by means of corneal refractive surgery. Wearing glasses or contact lenses will no longer be needed after performing surgery. Corneal refractive surgery includes refractive surgery methods that can be applied at the level of the cornea. They correct the focus of the light beams by altering the refractive parameters at the level of the cornea. Currently, the most frequently applied techniques of corneal refractive surgery are Trans-PRK, Femto-LASIK and ReLEx Smile.

LASIK surgery (laser-assisted in situ keratomileusis) involves cutting a flap of 90-130 microns at the surface of the cornea (through epithelium and Bowman’s layer). The stroma will be exposed.
The Femto-LASIK method is based on the most advanced current technology. Respondents to a survey from 2018 shows that the patients’ willingness to pay for corneal refractive surgery varies from zero (for patients preferring spectacles or contact lenses) to over 3,000 euro.
The PRK technique (photorefractive keratectomy) is the predecessor of Femto-LASIK in refractive surgery. PRK has been in use for ca. 30 years. The patient’s discomfort is higher during the first days after surgery, compared to Femto-LASIK, and the recovery process after performing Trans-PRK is longer. The surgery is however performed in a single stage, and the associated costs are lower.
Unlike Trans-PRK and Femto-LASIK, the ReLEx Smile technique employs solely the femtosecond laser. The procedure is not painful and lasts for 15 – 20 minutes for both eyes. Though after performing ReLEx Smile the incision heals faster, the optimal vision parameters will be reached after a longer while, compared to Femto-LASIK. The costs incurred by the hospital in performing the surgery are lower (which doesn’t necessarily mean that the price paid by patients is lower).

Chapter 4 provides a general description of the main corneal surgery methods, as well as an analysis of the direct and indirect costs associated to each procedure. Prices of the three procedures in different countries are also displayed.
5. Other therapies

A further possible solution for correcting myopia and astigmatism is ortocheratology. Ortocheratology is a modern technique for refractive correction and requires a special lens, to be worn at nighttime. Vision is subsequently improved for a short time (ca. 12 hours), so that the lens needs to be worn every night. The technique is recommended for myopia below -6.5 diopters, or astigmatism below -2.5 diopters. Wearing lenses at nighttime can slow down, or even stop the progression of myopia, by limiting the growth of the eyeball along the anterior/posterior axis. It may be used for children over the age of 12. The procedure is not recommended for patients with injuries, inflammations or anomalies of the cornea, allergies at the level of the cornea, infections of the cornea, or dry eye syndrome.

For patients who need large refractive corrections, as well as for patients with a thin cornea, laser surgery is less efficient or can’t be performed. A permanent correction solution in such instances can be the implant of PIOL (Phakic Intraocular Lens). Intraocular lenses enable the correction of large refractive errors, that can’t be corrected by laser surgery. The lenses can be removed, if necessary, the surgery is rapid (15-30 minutes) and the associated costs are lower than the costs of laser surgery.

IOL surgery is performed in hospitals and requires the subsequent administration of antibiotics and anti-inflammatories. Intraocular lenses shall be monitored for the rest of the patient’s life.

Compared to contact lenses or spectacles, intraocular lenses don’t require daily maintenance and are not detectable. There is however a very low risk of vision loss, as a result of possible infections. Further drawbacks are light sensitivity and the risk of cataract.

Chapter 5 describes other therapies meant to correct vision problems.
6. Choosing the therapeutical solution

Refractive errors are the main cause of vision problems globally. They decrease the patients’ productivity and general quality of life. The most frequently applied solution is wearing spectacles, but even these solutions are not available for some social classes, who don’t afford ophthalmological monitoring and the purchase of spectacles.

A common alternative to spectacles is provided by contact lenses. Neither spectacles, nor contact lenses alter the refractive power of the eye, or have permanent effects on vision. They merely contribute to providing a correct focus of the light while being worn (through the own refractive power). Corneal refractive surgery is the only option for patients looking for therapies with permanent effect.

Children and young people, up to the age of 21, can choose orthokeratology (wearing night lenses).

Patients and physicians will select the most adequate therapeutical solution considering the refractive error, the general health of the patients, as well as their personal characteristics, the cost of the alternative therapies and their associated risks, the durability of the effects and their impact on the quality of life. Yet, locally available medical technologies, the prior training of the treating physician and the awareness of the patient are relevant factors in the decision-making process.

Chapter 6 describes the general framework and relevant factors to be considered in choosing the most appropriate therapeutical solution.