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Patient with cataract – observations after 2 years of the pandemic and future prospects

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HIGHLIGHTS

The pandemic has contributed to a decrease in cataract procedures performed, and some patients are now presenting at a more advanced stage of the disease, which is associated with higher intraoperative risks and longer recovery after surgery.

ABSTRACT

Cataract is a disease in which the natural lens becomes completely or partially cloudy. During the pandemic, there was a significant decrease in the number of cataract surgeries performed compared to previous years, due to fear of the disease and the safety of the procedures performed. Cataract surgery should be performed in patients whose visual acuity deterioration has an impact on the performance of life or work activities. Due to the pandemic, some patients report to a more advanced stage of cataract, which leads to a reduction in their quality of life. Such surgery can be associated with a higher risk of surgical complications and longer recovery time. The development of new intraocular lens technologies, increased life expectancy, as well as changing lifestyles and increased activity of the elderly contribute to the increasing choice of premium intraocular lenses by patients. These lenses enable patients to achieve satisfactory uncorrected visual acuity not only for distance, but also for near and intermediate distances.

Key words: cataract, pandemic, intraocular lenses, EDOF, multifocal lenses

INTRODUCTION

Cataract is a disease involving complete or partial opacity of the natural lens of the eye. It is the most common reversible cause of blindness in the world. According to the estimates, in Poland there are 800,000 people with cataract. During the pandemic period, we observed a significant decrease in the number of cataract surgeries in comparison to previous years. In 2020, the number of procedures dropped by nearly 30% compared to 2019.

This decrease was observed mostly among patients above 70 years, but it also affected other age groups. People were afraid of contracting COVID-19 and that cataract procedures were not safe. Postponing surgery is not only associated with decreased patient comfort, but it also leads to further disease progression, which may result in more difficult surgery and longer recovery time [1].

In addition, intumescent cataract can lead to secondary glaucoma and uveitis. Poor insight into deeper structures of the eye due to severe lens opacity can delay diagnosis and treatment of other ocular diseases such as age-related macular degeneration (AMD), glaucoma, or diabetic retinopathy.

Cataract surgery should be performed in patients whose decreased visual acuity affects their daily or occupational activities despite wearing glasses or contact lenses. The Polish Society of Ophthalmology (PTO) and the Association of Polish Ophthalmic Surgeons (SCOP) have developed the following criteria for qualifying patients for cataract surgery:

- best-corrected binocular near visual acuity of less than or equal to 0.6
- best-corrected monocular near visual acuity of 0.3 or less.

The above criteria do not have to be met in case of urgent indications, such as rapid disease process or worse postoperative visual acuity due to prolonged surgery waiting, or if the cataract significantly impairs patient's daily functioning or occupational performance [2].

In the case of preoperative regular astigmatism above 2D, patients can undergo toric lens implantation as part of the Polish National Health Fund reimbursement [3].

During the pandemic, cataract removal procedures did not differ from the ones performed before. However, to increase patient's safety, special procedures related to the use of personal protective equipment and disinfectants were implemented, increased distance between patients was provided, and efforts were made to schedule patients for specific times. Due to appropriate sanitary regime cataract removal procedures were safe during the pandemic [1].

The pandemic period has meant that some patients now present at a more advanced stage of cataract and the procedure carries a higher risk of intraoperative complications. In addition, the pandemic period may have slightly increased the waiting time for cataract surgery, but thanks to the procedures being performed mainly on a same-day basis and the removal of limits on cataract procedures funded by the Polish National Health Fund from 1 April 2019, waiting time has been significantly reduced. The last few months have seen a renewed increase in the number of cataract removal procedures performed compared to the first months of the pandemic.

MODERN TECHNOLOGIES IN CATARACT SURGERY

Intraocular lenses (IOLs) have undergone significant development in recent years. IOLs are used in cataract surgery to replace the cloudy lens and in refractive lens exchange (RLE). Under the Polish National Health Fund, the patient has the option of cataract surgery with the implantation of a monofocal lens, which gives good visual acuity to one distance, mainly distant VA. Apart from the above, there are lenses of more advanced construction and different optical properties, called premium lenses.

Premium IOLs correct presbyopia, or insufficient accommodation, which occurs physiologically after about 40 years of age. Premium lenses include multifocal intraocular lenses (MIOLs), extended depth of focus (EDOF) and accommodative lenses. They increase patients' comfort after own lens removal and allow for full or partial independence from spectacle correction, but the associated costs are to be borne by the patient. Both the increase in the life expectancy as well as lifestyle changes and increased professional activity of elderly people contribute to the desire to become independent from spectacle correction, not only for distance but also for near and intermediate distances [4].

MULTIFOCAL LENSES

Multifocal lenses, particularly trifocal ones, were developed to provide better uncorrected distant, intermediate and near vision and have now virtually replaced bifocal lenses. Their principle of operation is based on the division of light energy into three foci. We can distinguish between diffractive, refractive and hybrid MIOLs. However, trifocal lens technology has its disadvantages. First, intermediate visual acuity is not as good as distant and near [5–7].

Second, due to the diffractive design of the lens, there is a reduction in contrast sensitivity [8, 9]. Third, diffractive optics and the presence of rings in the optical system of the lens result in photopic dysphotopsias such as halo and glare. Although trifocal lenses currently provide the greatest independence from spectacle correction, some patients may be dissatisfied due to the aforementioned side effects [10].

Diffractive multifocal lenses

Multifocal diffraction lenses work by interference of light. They are equipped with concentric diffraction rings on their surface that get closer together as they move away from the center. Their number and placement are responsible for the number of additional foci in the optical system and where they will form.

In general, these lenses provide good far and near vision, but in some cases intermediate distance vision is unsatisfactory. Their performance is not as dependent on pupil the width as that of refractive MIOLs and they are less sensitive to decentration. However, they decrease contrast sensitivity compared to monofocal lenses [11, 12]. This group include the following lenses: PanOptix (by Alcon), AT LISA tri (by Carl Zeiss), RayOne Trifocal (by Rayner), Sulcoflex (by Rayner).

PanOptix (Alcon)

PanOptix is a single-piece, diffractive, aspheric, non-apodized, hydrophobic lens built on the Acrysof IQ platform. It has a biconvex optical surface, UV and blue light filtering (fig. 1).

The lens is based on a quad-focal design and uses ENLIGHTEN optical technology to redistribute light from a focal point located at 120 cm to a point in the far field to enhance visual acuity to the far field. In addition, this technology provides high (88%) light energy utilization and low pupil width dependence in all lighting conditions [13, 14].

The lens has near addition of +3.25 D (40 cm) and intermediate addition of +2.17 D (60 cm).

RayOne Trifocal (Rayner)

A trifocal, preloaded, diffractive lens with near addition of +3.5 D (37.5 cm) and intermediate addition of +1.75 D (75 cm). Constructed of Rayacryl hydrophilic acrylic material. The overall diameter of the lens is 12.5 mm, the optical part covers 6 mm. It has a 4.5-mm diffraction zone with 16 diffraction rings (steps). The > 4.5 mm zone operates on the principle of monofocal optics. The lens is biconvex with aberration-neutral technology (fig. 2) [15].

Sulcoflex Trifocal (Rayner)

This is a unique diffractive trifocal lens docked into the ciliary sulcus. It has near addition of +3.5 D (37.5 cm) and intermediate addition of +1.75 D (75 cm). It is constructed of Rayacryl acrylic hydrophilic material. The overall diameter of the lens is 14 mm with an optical diameter of 6.5 mm. Its anterior surface is convex, while the posterior one is concave. The lens is aberration-neutral.

It can be implanted during the so-called DUET procedure, i.e., when a monofocal lens is implanted into the capsular bag with simultaneous implantation of a Sulcoflex trifocal lens in the ciliary sulcus (fig. 3). It can also be implanted in the presbyopia correction surgery or after previous cataract surgery with implantation of a monofocal lens. It can also be used to correct ametropia after surgery. Notably, Sulcoflex lens surgery is reversible [16].

FIGURE 1

Acrysof IQ PanOptix – a diffractive multifocal lens with ENLIGHTEN optical technology (courtesy of Alcon Poland).

Multifocal refractive lenses

Multifocal refractive lenses have zones of different refractive index based on Snellen's law. The effectiveness of refractive lenses depends on their centration and the pupil width. In addition, they can cause positive dysphotopsias, such as halo and glare, and reduce contrast sensitivity [11, 12]. This group includes the following lenses: Mplus (Oculentis), Mplus X (Oculentis), Precizon (Ophtec BV).

Hybrid multifocal lenses

Some MIOLs are hybrid lenses as they include both refractive and diffractive elements. This is intended to provide a smooth transition between successive foci. Lenses in this group include TECNIS Synergy (from Johnson & Johnson).

The optical system of MIOLs can be rotationally symmetric (all diffractive and most refractive models) or rotationally asymmetric (some refractive models). Aspheric designs also exist to reduce spherical aberrations and increase contrast sensitivity [11, 12, 17, 18]. Most multifocal lenses also come in a toric version to correct astigmatism.

EXTENDED DEPTH-OF-FOCUS (EDOF) LENSES

EDOF lenses fill the gap between monofocal and multifocal lenses as they provide very good distant and intermediate vision, but inadequate quality of near vision. They create a single elongated focal point to enhance depth of focus, which is intended to eliminate the over-

FIGURE 2

RayOne Trifocal (courtesy of Rayner Poland).

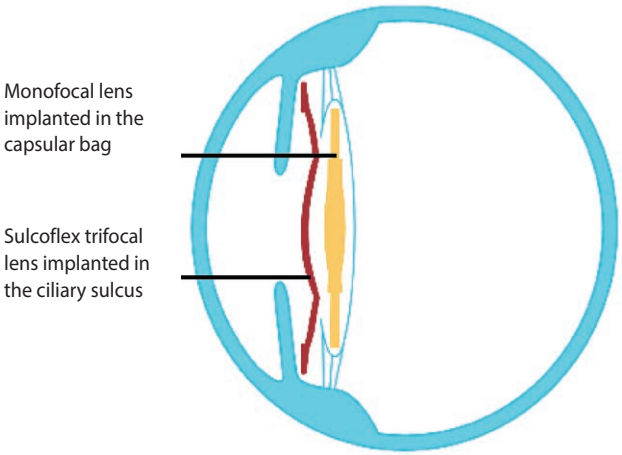
lapping of near and distant images caused by multifocal lenses, thus eliminating the halo effect.

In addition, EDOF lenses provide a continuous range of focus without asymmetric IOL power distribution, which helps avoid the presence of secondary out-of--focus images [19, 20]. Moreover, compared to multifocal lenses, they improve contrast sensitivity and are associated with a lower risk of positive dysphotopsias. The American Academy of Ophthalmology has developed criteria for classifying intraocular implants as EDOF.

There are many different EDOF lens technologies. Kohnen proposed to divide them into four categories: small aperture IOLs, bioanalogic IOLs, and lenses with diffractive and non-diffractive optics [21]. Many lenses classified as EDOF are actually hybrid lenses, because they combine EDOF with multifocality. For the purposes of this article, we have not included the difference between "pure" EDOF and hybrid IOL. The following

FIGURE 3

Placement of Sulcoflex trifocal lens – diagram.



lenses fall into this group: Vivity (Alcon), TECNIS Symfony (Johnson & Johnson), AT LARA (Carl Zeiss), Mini WELL Ready (SIFI Medtech), IC-8 (AcuFocus), WIOL--CF (Medicem), and TECNIS Synergy (Johnson & Johnson).

Vivity (Alcon)

Vivity (Alcon) is a single-piece, non-diffractive, aspheric lens with an extended depth of focus. It is based on non-diffractive wavefront-shaping X-WAVE™ technology, which creates a single extended focus without splitting light (fig. 4). With these properties, the lens reduces the risk of dysphotopsia and does not compromise contrast sensitivity. Moreover, it is less sensitive to decentering than multifocal lenses. It is constructed of Acrysof's hydrophobic material, has UV and blue light filtering, as well as a defocus of 1.5 D and negative anterior surface asphericity (-0.2 µm) [22].

RayOne EMV is a new lens on the market that is neither EDOF nor multifocal IOL. It provides an extended depth of vision and can be classified as an enhanced monofocal lens.

RayOne EMV (Rayner)

Developed in collaboration with Professor Graham Barrett, it is a preloaded monofocal+/non-diffractive EDOF hydrophilic lens that provides an extended range of vision by exploiting positive spherical aberration. The overall lens diameter is 12.5 mm and the optical diameter is 6.0 mm. The lens has an aspheric front and biconvex shape. It amplifies/compensates for the corneal natural positive spherical aberration, resulting in an increased range of visual acuity.

As it meets ISO standards for monofocal intraocular lenses, it is less dependent on variable pupil width, decentration and tilt. RayOne EMV can be used for bilateral emmetropia and is also optimized for use in a monovision system. For emmetropia, it allows for better intermediate vision than standard monovision lenses, providing approximately 1.25 D of extended visual range.

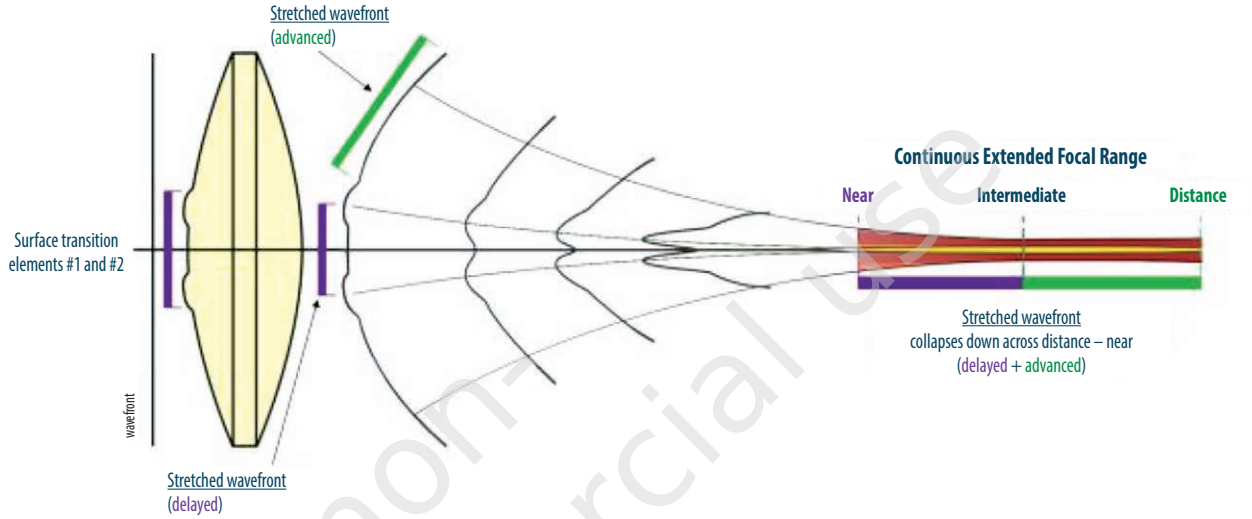
When used in a monovision system, the non-dominant eye can be set to minimovision (-0.25 to -0.75 D), micromovision (-0.75 to -1.50 D), or monovision (-1.50+ D) to provide patients with 1.50-2.00 D, 2.00-2.75 D, and 2.75+ D of extended visual acuity, respectively [23].

QUALIFYING PATIENTS FOR PREMIUM LENSES

When qualifying patients for a premium lens, one of the most important steps is the interview, which should address the patient's occupation and the distance of vision they use most often. A patient's unrealistic expectations for postoperative vision should be a reason for disqual-

FIGURE 4

EDOF Vivity non-diffractive lens based on X-WAVE technology with 2 visible zones – transition zone 1 responsible for stretching the wavefront and creating a continuous elongated focus, transition zone 2 responsible for shifting the wavefront from hyperopic to myopic to utilize all the light energy (courtesy of Alcon Poland).



ifying them from surgery with implantation of a certain type of lens.

Patients should be informed about the IOLs available on the market and possible side effects associated with their implantation. An important part of the interview should also include a question about driving in poor light or at night, as this is one of the arguments for choosing a lens other than MIOLs. We should also take into consideration the personality of the patient requesting the procedure and their desire to become independent from spectacle correction.

With multifocal lenses, which divide the incoming light into several foci, the brain perceives several images simultaneously. Processing these images requires central neural regulation of visual stimuli, and this process is called neuroadaptation and can take several months [24]. At the same time, these lenses provide the greatest degree of independence from spectacle correction. It has been found that individuals with certain personality types (neurotic personality), who are overly structured and controlling of themselves and their environment, are more likely to experience dysphotopsias such as halo and glare [25].

Failure of neuroadaptation after MIOLs implantation can lead to patient dissatisfaction and frustration. The most reported symptoms by patients that are indications for MIOLs explantation are blurred vision, glare, and halo [26, 27]. However, patient's dissatisfaction with ametropia is far more common than the need for IOL replacement [28]. Postoperative ametropia mainly depends on the accuracy of preoperative biometry and the effective lens position (ELP) [29].

The most common reasons for disqualification from multifocal lens implantation are concomitant ophthalmologic diseases and abnormalities involving the ocular optic system: retinal diseases such as AMD, diabetic retinopathy, optic nerve diseases, PEX, large κ and α angle, corneal diseases (dystrophies, ectasias, irregular astigmatism and higher order aberrations [HOAs], high refractive errors, dry eye syndrome, as well as visual impairment) [30].

Contraindications to implanting EDOF lenses are similar to those for implanting MIOLs; however, these lenses are less sensitive to the pupil width, decentration, residual postoperative refractive error, and tolerate greater κ and α angles. They represent a compromise between good intermediate and distant vision, with often inadequate near vision without spectacle correction, and a lower incidence of optical phenomena. It is possible to improve near vision with EDOF lenses by using a minimovision system.

These lenses are often recommended for patients who do not need precise near vision, work primarily at intermediate distances, drive in mesopic and scotopic conditions, want to become independent of spectacle correction, or had undergone refractive surgery.

Moreover, after cataract surgery with premium IOL implantation we should always consider the prognosis for vision improvement and the cost of the procedure to the patient. Premium lenses require particularly accurate preoperative measurements to best calculate IOL power in order to achieve postoperative emmetropia. With multifocal and EDOF lenses, it is very important to correct corneal astigmatism considering the influence of posterior corneal astigmatism. In MIOLs, postoperative astigmatism should be less than 0.5 D to maintain the best possible visual acuity. EDOF lenses are less demanding in this regard, but the best possible correction of astigmatism should be sought.

CONCLUSIONS

During the COVID-19 pandemic, some patients presented to ophthalmologists with a more advanced stage of cataract which is associated with a higher-risk procedure. In addition, the pandemic may have slightly increased cataract surgery waiting time. On the other hand, procedures were performed mainly in ambulatory settings and there were no longer any limits on cataract surgery reimbursement by the Polish National Health Fund, waiting time has dramatically decreased. In recent years, there has been a significant development of IOLs. Due to the prolongation of life expectancy as well as lifestyle changes and increased professional activity of elderly people, patients more often strive to become independent from spectacle correction not only for distant, but also for near and intermediate vision.

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