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Causes of disqualification from the laser vision correction surgery

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HIGHLIGHTS

The laser vision correction procedure has some limitations, which are partially dependent on the individual patient.

ABSTRACT

The aim of the article is to establish the reasons for disqualification from laser vision correction surgery and to compile data on the most common reasons for not qualifying for the procedure. The specific patients in which the procedure can be performed should be carefully considered. For people who are not qualified for surgery, there are many alternative methods of correcting vision defects.

Key words: laser vision correction, vision defects, interview, contraindications, alternative solutions

INTRODUCTION

An alternative to traditional methods of vision correction is laser vision correction, which consists of modeling the patient's cornea to eliminate the vision defect. The procedure itself is very safe, painless and takes a minute. Its effects are felt quickly and long-lasting [1]. Laser vision correction is a method of growing popularity. Modern surgical techniques allow for the correction of an increasing range of defects with minimal risk of complications [1]. However, patient deciding to undergo surgery should be aware of the possibility of their occurrence. The vast majority of patients interested in this form of correction are qualified for the procedure and obtain satisfactory postoperative refractive and functional results. However, not all patients can undergo laser vision correction. The initial qualification includes a detailed interview, a thorough examination of the refractive error and a number of diagnostic tests. Some patients do not meet the criteria and the use of this method of refractive correction in them is very risky or impossible [2].

AIM

The aim of the study was to list the most common reasons for disqualification from laser vision correction surgery and to present other alternative solutions for correcting vision defects.

METHODS

This study is a retrospective analysis of the reasons for disqualification from laser vision correction surgery, based on the documentation of the Oftalmika Ophthalmology Clinic. Patients, who had underwent qualifying examinations for laser vision correction surgery at the Oftalmika Clinic between January 1st, 2016 and September 28th, 2020, but had not qualified for the procedure, has been recruited to he study. The age of the patients ranged from 20 to 60 years (mean age 36.28). Documentation of patients who qualified for any method of laser vision correction was excluded. When collecting information, attention was paid to the basic data of patients, such as: sex, age, the refractive error, the main reason for disqualification from laser vision correction, comorbidities and the patient's expectations. In the case of each patient, before the qualifying examinations, a detailed history was collected and individual history and physical examinations were performed. It was also checked what alternative solution was proposed to a given patient.

RESULTS

Originally, the characteristics of patients reported for qualification for laser vision correction were presented (tab. 1). A retrospective data analysis was compiled on the basis of a study of 424 eyes (224 patients) who were disqualified from laser vision correction surgery. Subsequently, the reasons for disqualification from laser vision correction were specified (tab. 2). Most disqualifications from this procedure were related to refractive errors – 186 eyes (43.83%), and the least – to concomitant general diseases – 10 eyes (2.34%). Next, disqualifications from laser vision correction surgery related to the amount of the refractive error are listed (tab. 3), and then related to a specific reason related to refractive error (tab. 4). The last table (tab. 5) contains information on disqualification from laser vision correction surgery for reasons related to qualifying measurements.

TABLE 1

Characteristics of patients reported for qualification for laser vision correction surgery.

Number of patients	Number of disqualified patients	Number of eyes	Number of disqualified eyes	Age	Sex (number of people with a specific dominant refractive error)
606	224 (36.96%)	1188	424 (35.69%)	20–60 years (mean 36.28)	F 123 (myopia – 59, hyperopia – 36, astigmatism – 28) M 101 (myopia – 42, hyperopia – 34, astigmatism – 25)

TABLE 2

Reasons for disqualification from laser vision correction surgery.

Cause of disqualification	Refractive error	Measurements results during qualification exam	Concomitant general diseases	Concomitant eye diseases	Unrealistic expectations of the patient
Number of eyes	186 (43.83%)	107 (25.27%)	10 (2.34%)	66 (15.6%)	55 (12.96%)

TABLE 3

Disqualifications from laser vision correction surgery related to the amount of the refractive error.

Refractive error	High myopia (9 D < x)	Low myopia	High hyperopia	Low hyperopia
Number of eyes	25 (24.21%)	29 (28.02%)	32 (30.58%)	18 (17.19%)
Alternative treatment	ICL – 12 eyes (48%) CL – 5 eyes (20%) RLE – 6 eyes (24%) RGP – 2 eyes (8 %)	CL – 22 eyes (75.86%) Glasses – 7 eyes (24,14%)	RLE – 16 eyes (50%) CL – 8 eyes (25%) Glasses – 8 eyes (25%)	CL – 6 eyes (33.4%) Glasses – 12 eyes (66.6%)

CL – *contact lenses*; ICL – *implantable collamer lens*; RGP – *rigid gas permeable*; RLE – *refractive lens exchange*.

TABLE 4

Disqualifications from laser vision correction surgery related to refractive error.

Cause	Number of eyes	Alternative
Unstable refractive error	27 (32.38%)	Delayed laser vision correction – 24 eyes (88.88%) CL – 1 eye (3.72%) Ortho CL – 2 eyes (7.4%)
Presbyopia without refractive error	4 (4.89%)	PAL – 4 eyes (100%)
Low add presbyopia with refractive error	32 (38.64%)	PAL – 16 eyes (50%) Multifocal CL – 9 eyes (28.12%) RLE + mIOL – 7 eyes (21.88%)
Visual needs	20 (24.09%)	PAL – 4 eyes (20%) Glasses for far vision– 11 eyes (55%) Multifocal CL– 5 eyes (25%)

CL – *contact lenses*; CXL – *cross-linking*; ICL – *implantable collamer lens*; RLE – *refractive lens exchange*.

TABLE 5

Disqualifications from laser vision correction surgery for reasons related to qualifying measurements.

Qualifying measurements	Number of eyes	Alternative
Abnormal keratometry	15 (13.58%)	Glasses – 13 eyes (86.6%) CL – 2 eyes (13.4%)
Too thin central cornea	24 (22.83%)	CL – 14 eyes (58.33%) Glasses – 6 eyes (25%) ICL – 4 eyes (16.67%)
Too large pupil diameter	11 (9.87%)	CL – 6 eyes (54.54%) Glasses – 5 eyes (45.46%)
Shallow anterior chamber	18 (17.28%)	Glasses – 8 eyes (44.44%) RLE – 8 eyes (44.44%) CL – 2 eyes (11.12%)
Questionable corneal topography and tomography	14 (12.96%)	Glasses – 8 eyes (57.14%) CL – 4 eyes (28.57%) CXL – 2 eyes (14.29%)
≥ 4 pts. according to Randleman scale	16 (14.81%)	ICL – 10 eyes (62.5%) Glasses – 4 eyes (25%) CL – 2 eyes (12.5%)
Large kappa angle	4 (3.74%)	Glasses – 2 eyes (50%) CL – 1 eye (25%) RLE – 1 eye (25%)
Astigmatism (mainly internal)	5 (4.93%)	RLE – 2 eyes (40%) Toric CL – 3 eyes (60%)

CL (*contact lenses*); CXL (*cross-linking*); ICL (*implantable Collamer lens*); RLE (*refractive lens exchange*).

DISCUSSION

The study examined the most common reasons for not qualifying for laser vision correction and checked what other alternative solutions were proposed to patients. Analyzing the above data on the age of patients and based on Pniewski's 2019 article on presbyopia, it can be concluded that this is the time characteristic of the onset of presbyopia – a physiological process that occurs in the eye with age and requires much greater accommodation effort, to see objects clearly, regardless of how far they are from the eyes [3]. Due to the growing need for correct vision at close distances, people at this age attach great importance to eye check-ups and are more aware of the existence and development of eye diseases [4]. Disqualifications from laser vision correction surgery were divided into groups after collecting a detailed preliminary interview and after conducting subjective and objective examinations. In the case of most patients, disqualifications took place after qualifying measurements. Often, patients were not aware that they had, for example, keratoconus. Some diseases were detected in the qualifying tests, which is why a detailed analysis of the results obtained is so important [5]. The rest of the patients were not qualified on the basis of the initial interview. It is important to analyze the contraindications to laser treatment and to know the patient's visual expectations [6].

Most disqualifications from laser vision correction were related to refractive errors. An important part concerned the height of the visual defect and the thickness of the cornea and the width of the pupil. The laser method enables the correction of: myopia from -0.75 to -12.00 Dsph, hyperopia from +0.50 to +6.00 Dsph and astigmatism up to 6.00 Dcyl [3]. In the high refractive errors, the proposed correction methods should take into account the presence of aberrations – then glasses are not recommended, because in glasses these distortions are noticeable and can cause dissatisfaction with use. The above statement can be based on the article by Czaińska from 2016, which contains information that the advantage of contact lenses is the lower number of peripheral distortions, i.e. spherical aberrations, caused by the use of high-power spectacle lenses [7]. Despite the fact that patients are not qualified for laser treatment, the alternative proposed methods will equally favorably correct a large vision defect. In turn, patients with high hyperopia were recommended refractive lens replacement, because in the hyperopic eyes, in addition to correcting the refractive error, this method of correction also has a beneficial effect on reducing the risk of glaucoma – by increasing the space in the eyeball that is too short. Cases of patients with low myopia and hyperopia have also been reported. The average age of these people was about 39 years. Complete removal of the defect at this age would have negative consequences in the approaching presbyopia age. The patient's refraction should also be examined very carefully. Sometimes the reason for dissatisfaction with the current correction is its inappropriate selection or parameters, e.g. incorrect measurement of the distance between the pupils. Such patients need, for example, a higher correction value for near work. The remaining part of this group are people who were also disqualified for reasons related to the refractive error, but they did not concern only the amount of the defect. A frequent reason for not qualifying for laser treatment was the instability of the defect. During the development of the eyes, a number of changes occur, including: an increase in the axial length of the eyeball and an increase in the diameter of the eyeball at the equator, an increase in the depth of the anterior chamber, an increase in the radius of curvature of the cornea, a decrease in the thickness of the retina, choroid and sclera [6]. Then, during adolescence, the vision defect changes all the time. The progression of the refractive error is additionally accelerated by not using the appropriate optical correction. Stabilization of the defect occurs after the eyes reach full maturity – approx. age 21–23 [8]. In the conducted study, this reason usually concerned young people whose visual impairment increased by > 0.50 Dsph within 6 months.

When deciding to perform a laser procedure, we must have accurate and stable data on the patient's refractive error. Thanks to this, we are able to predict the result of the procedure and meet the patient's expectations. It is also necessary to determine what factors influence the development of the defect. In addition, it must be remembered that the procedure does not inhibit the progression of the refractive error, only the starting point to the final value changes – after the progression stops. An alternative solution for such patients is orthokeratology, which models the cornea during sleep and allows you to enjoy normal vision during the day without the need for other correction methods. Orthokeratology is a method that most closely imitates a laser treatment.

People in the presbyopic age who did not have distance refractive error were also not qualified for laser vision correction. Correcting the vision in such a way that a patient in this group can see correctly at close distances will result in blurred vision at intermediate and far distances. In this case, multifocal glasses were recommended, which ensure adequate visual acuity at all distances. A similar situation occurred in presbyopic patients with distance refractive error and low addition. When you need a different one correction for different distances, laser vision correction is able to provide us with the best compromise, but it will not completely eliminate every defect. Not all patients will be satisfied with the result. That is why it is so important to present them the real result of the procedure. With too high expectations of the patient, he is not qualified for this

method of vision correction, because as a result patient will not be satisfied.

The last reason for disqualification from the laser procedure, concerning refractive errors, were the dominant visual needs. Such needs usually have people who use their eyesight mainly for hobbies, precise work and leisure activities. Most of these people were of presbyopic age. It should be taken into account that laser vision correction is a compromise. If we require perfect visual acuity for close distances, e.g. in the work of a watchmaker, we will not be satisfied with sharp vision only at intermediate and long distances. Therefore, it is necessary to very carefully ask about the patients expectations.

In the article by Wieczorek-Wojtaszek et al. (2017), we find confirmation that the use of laser vision correction has limited range of corrected refractive errors: myopia up to -10 D, hyperopia up to +6 D and astigmatism up to 6 Dcyl [9]. In such cases, another, alternative correction method should be used. The authors report a high percentage of patients satisfied with refractive lens exchange and implanted additional corrective lenses [8]. In our study, many patients were not admitted to the procedure also for reasons related to qualifying measurements. Careful analysis of the results will allow you to decide on the safety of the laser treatment for a given patient and predict the final result.

Keratometry, so non-invasive diagnostic test enabling the measurement of the radius of curvature and the breaking power of the cornea in individual meridians, is a method of great importance. Using keratometry, we can analyzed it together with a topographic map of the anterior surface of the eye. To fulfill cornea functioning, its anatomical relationships should be similar to natural ones. Therefore, people with keratometric results outside the normal range, i.e. not in the range of 32.0–49.0 Dsph, were disqualified from laser vision correction.

Another very important measurement is pachymetry, i.e. the examination of the thickness of the cornea of the eye. This measurement determines what type of laser correction procedure can be performed.

If the thickness of the cornea is too low – less than 500 µm – we should consider another form of vision correction. It should be noted that the estimated thickness of the cornea after surgery must be large enough to ensure the stability of the eye surface. An alternative method for such patients was the implantation of a phakic corrective lens, which will be permanently placed inside the eye. Phakic lenses work with the optical system of the eye and allow the correction of vision refractive error. This is an ideal method for people who want to avoid the use of basic vision correction methods [9].

Subsequently, the depth of the anterior chamber was determined. After laser vision correction surgery, glucocorticoids are given to speed up healing. If the anterior chamber is too shallow, administration of these drugs may cause steroid glaucoma and acute angle closure, which in turn poses a risk of damage or loss of vision. Implanting an artificial, thinner lens, we gain more space in the eye and the risk of glaucoma decreases. Proper correction relaxes the accommodation and supports the intraocular lens, which causes it to stretch less.

The standard qualifying measurement for laser vision correction is also the measurement of the width of the pupil. The diameter of the pupil is measured both in total darkness and in full light. Thanks to this, the specialist planning the procedure can perfectly adjust its parameters to the dynamics of the pupil in a particular patient. This is especially important in people with a tendency to dilate pupils at night. Too small ablation zone would result in strong halo effects and glare as well as unsatisfactory visual acuity after dark and at night.

Another reason for disqualification from laser vision correction was also the questionable image of the topography and corneal tomography. These are tests in which we receive a virtual model of the cornea, which reflects every depression and elevation with micrometer accuracy. The camera creates a detailed distribution of corneal thickness at each analyzed point, as well as its curvature in different sections. Tomography also takes into account the posterior surface of the cornea. Thus, with such a model, one can predict the severity of astigmatism in a patient or determine the location, size and depth of scars and preoperative opacities. The unclear picture from this examination does not allow to precisely determine the result of the procedure, e.g. the laser will misread the defect, because it will include islands caused by an abnormal tear film in dry eye syndrome (DES).

The patient's qualification assessment also includes the number of points on the Randleman scale. This scale assesses the risk of corneal ectasia after refractive procedures. The score is based on topography, corneal stroma thickness, patient age, total corneal thickness, and spherical equivalent. ≥ 4 points according to the Randleman scale predicts a high risk of corneal ectasia after the procedure; in such case the laser method of vision correction is not performed. Interesting are the results of observation of patients with ectasia after LASIK surgery, carried out by Brenner et al. [10]. Patients with mild ectasia and no change in visual acuity or a slight decrease in visual acuity lost an average of 2 lines of best-corrected visual acuity after the next procedure, which was the implantation of intracorneal rings, and therefore should not be qualified for this type of surgery [10, 11].

Another measurement taken into account was the kappa angle, i.e. the deviation between the visual axis and the anatomical optical axis of the eye [12]. Patient with too high kappa angle was not qualified for laser treatment.

The last qualifying measurement taken into account was astigmatism, mainly lenticular. Laser vision correction models the cornea appropriately to correct the refractive error. In older patients – if most of the asymmetry concerns the intraocular lens – the laser treatment will not be able to eliminate the defect in a satisfactory way for the patient, because the defect will be variable. In 2019, Saxon, Rah and Reindel conducted a study on i.a. to determine the level of satisfaction of patients with astigmatism wearing Nesofilcon A toric contact lenses. As many as 96% of patients indicated that their overall opinion of Nesofilcon A toric lenses was good or excellent. The lenses were also found to perform well in all aspects of vision and comfort tested ($P < 0.001$) [13].

The task of a specialist qualifying for laser vision correction surgery is, among others: determining the safety of the method for a given patient, and in the event of disqualification – proposing an alternative method that will provide the patient with the highest possible comfort [14].

In the qualification for laser vision correction, information was obtained on the occurrence of coexisting general diseases in patients that may affect the outcome of the procedure. Such diseases include uncontrolled diabetes, which in later stages leads to hypertension, as well as damage to the kidneys or retina. In addition, as a result of variable glycemia in a patient with this disease, it is difficult to perform a correct refraction test. Then laser vision correction must not be performed. Diabetes may also be associated with a higher risk of injection complications after surgery [15].

Other diseases that could affect the effect of the treatment were rheumatoid arthritis (RA) and psoriasis. Due to the risk of abnormal corneal healing, laser vision correction surgery could not be performed. In these cases, corrective glasses were also proposed. The last recorded general disease was epilepsy. In the article by Jędrzejczak, one can find information that epilepsy is not a disease in the classical sense, but rather a complicated pathophysiological process, the numerous and complex symptoms of which are the result of various disorders of brain function [15]. The presence of epilepsy in a patient is a contraindication to laser treatment, because the laser light may cause an epileptic seizure [16].

Subsequently, data on disqualification from laser vision correction surgery due to the presence of concomitant eye diseases were also compiled. The most common diseases were: cataract, uncontrolled glaucoma, impaired lacrimation, keratoconus, retinitis pigmentosa, Fuchs corneal endothelial dystrophy, central serous chorioretinopathy. Due to the need to treat the above diseases, laser correction was not recommended. The proposed alternative was other visual aids, e.g. corrective glasses.

In Mielczarek's article from 2004, all the above eye diseases, which are considered contraindications to laser treatment, were listed [17]. The use of this form of vision correction with such coexisting diseases is risky. It is worth using alternative methods of vision correction, removing the cause of the disease or introducing its appropriate treatment [17]. In the qualifying examination for laser vision correction, it is also important to recognize the patient's motives for using this method. It often turns out that the patient sees poorly in glasses because they were incorrectly selected. As a result, such a person looks for other methods to improve vision. However, after an optimal refraction test, a patient who notices an improvement in visual acuity decides to stay with corrective glasses and resign from laser treatment. Find out exactly what the patient expects from the operation and together consider the most beneficial solution.

In the conducted study, the main reasons for laser correction were to get rid of the vision defect and additionally eliminate strabismus. It should be remembered that this method of correction will not eliminate strabismus in most cases, except for accommodative strabismus. Planned correction of the defect in a patient with strabismus requires a strabological consultation, because the position of the eyes may change after the procedure, not always to a more favorable one. Another reason for the interest in laser treatment was the desire to remove amblyopia. Laser vision correction surgery is not able to eliminate amblyopia, because it shapes the cornea in such a way that the rays of light correctly fall on the retina. Amblyopia is a condition where the eye has limited vision due to abnormal development of the visual pathways. When the brain receives unclear information, it starts to ignore the eye and gradually turns off its function [18]. This must be mentioned to the patient in order to dissuade him from the misconception. If the patient sees monocularly, there is another reason for disqualification from the procedure, because any intervention in the only seeing eye carries a high risk of vision loss [19]. Often in the laser treatment there is also a chance to create binocular vision. However, this is a misconception. The task of laser vision correction is to remove refractive errors, we will not create proper cooperation between one eye and the other. Patients who required laser vision correction to have sharp vision at all distances without the need for glasses were also disqualified. They were usually presbyopic patients. A small amount of monovision was used for some patients who were able to accept some compromise. In some centers, multifocal ablation profiles are also used in these situations. Such patients were offered appropriate corrective glasses, RLE with the use of artificial lenses correcting presbyopia, contact lenses.

Referring to the above, after a 2-year analysis of 12,500 surgeries, Russian scientists Pershina and Pashinov concluded that a thorough and detailed discussion with the patient about the indications and contraindications for a particu-

lar refractive surgery: the patient's understanding of how and what the specialist is going to do; making the patient aware that also bears some risk related to complications independent of the surgeon and the equipment; identification of the patient's unreasonable expectations regarding the result of the laser procedure – all this will help to avoid dissatisfaction with the procedure and conflict between the patient and the doctor [20].

CONCLUSIONS

The laser vision correction procedure has some limitations that are partly dependent on the individual characteristics of the patient and even the specific eye. Most people are disqualified from laser vision correction at the stage of measurements performed during the qualifying visit. It is worth remembering that there are many alternative methods of vision correction. The patient should be recommended such solutions that will be safe, effective and meet his expectations to the greatest extent.

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Bartłomiej J. Kałużny: idea and design of the manuscript, critical review, final approval; Ilona Piotrowiak-Słupska: idea and design of the work, critical review, final approval; Dominika Kalwa-Grabowska: literature collection and analysis, writing, critical review, final approval.

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