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Laser vision correction and binocular vision – case reports

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HIGHLIGHTS

Patients with big latent strabismus, who only wear glasses may have double vision with contact lenses or after laser vision correction. Vision Therapy can help with binocular vision problems in patients who are candidates for laser vision correction.

ABSTRACT

Laser vision correction (LVC) is the removal of refractive errors, by changing the geometry of the cornea. It doesn't directly affect binocular vision. However, the condition of the patient's binocular vision is a very important. That affects the quality of life, which also indirectly translates into the patient's satisfaction with the LVC procedure. Based on the presented cases, this article proves how important it is to examine binocular vision before laser vision correction. The influence of the prismatic effect of spectacle lenses on the control of binocular vision and the risk of strabismus decompensation, which is most often associated with double vision. The described cases are people with problems with binocular vision. The article includes methods of treatment (contact lens test, vision therapy) to check and eliminate the above-mentioned problem.

Key words: laser vision correction, binocular vision, strabismus, visual defects and correction, optometry

INTRODUCTION

Strabismus (Greek: *strabismos*) means "to look at from the side, at an angle". It is a condition of uneven alignment of the eyes. It can be caused by abnormalities of binocular vision, abnormal control of eye movements in terms of neuromuscular connections, pathological conditions of the eyeball or orbit, or neurological diseases [1]. Two types of strabismus can be distinguished: latent (heterophoria) – remains in a latent form thanks to the fusion mechanism, and manifest (heterotropia) – a condition in which the eye remains in a constant deviation, can affect a particular eye or both eyes (alternate tropia). We can distinguish between different ocular deviations: exo- (deviation toward the temple, divergent), ezo- (toward the nose, convergent), hyper- (upward), hypo- (downward), or mixed oblique deviations, such as one eye pointing downward and toward the temple [1].

The numerical measure of strabismus is the prism diopter (PD). It determines the angle of deflection of a ray of light. A prism power of 1 PD means that the ray is deflected by 1 cm at a distance of 1 m from the prism [2]. This is shown in figure 1.

Eyeglass lenses are prismatic. A negative lens consists of 2 prisms folded with their bases outward, while a positive lens consists of 2 prisms folded with their bases inward [3, 4] (fig. 2).

FIGURE 1

Definition of prismatic diopter.

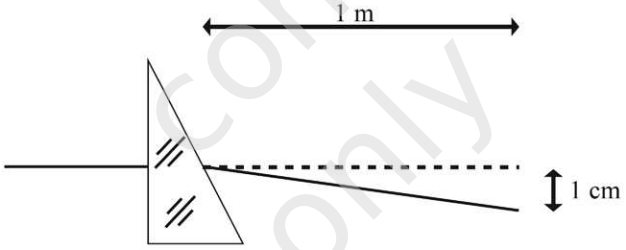
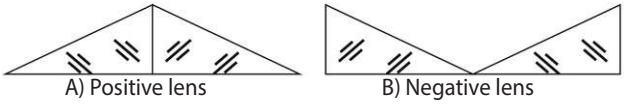


FIGURE 2

Prismatic design of eyeglass lenses.



This is very important for people with latent strabismus, because the prismatic effect of the spectacle lenses can affect the patient in a positive or negative way.

The patient looking at the distance is looking through the optical center of the lens, where the light ray does not refract, but it should be taken into account that the eyes perform micro-movements. The situation is different when the wearer looks up close. At this point, the eyes make a convergent movement and look through the paranasal part of the lens. The visual system is then subjected to prismatic actions. In a negative lens, the prism acts with its base toward the nose (BN), while in a positive lens it acts with its base toward the temple (BS) [3, 4]. In the case of divergent strabismus, the action of the BN prism is beneficial because the visual system does not have to converge as much as it theoretically should, while the opposite is true in the BS situation. It is positive for convergent strabismus. The greater the visual defect and the greater the spectacle correction, the greater the power of the prism. This is a very important aspect for people with latent strabismus who only use glasses. It is possible that after the surgery, in a situation where no prism works, there is a so-called strabismus decompensation. Latent strabismus becomes manifest and the patient begins to see double. Ambivalence can manifest itself at certain distances, near or far, or at all distances. Therefore, this is a very important consideration that must be taken into account before performing laser vision correction (LVC). For example, in situations where a patient has significant divergent strabismus, does not wear contact lenses, and has a large refractive error, the optometrist must perform appropriate testing to assess the risk of strabismic decompensation following LVC procedure.

The first option is a contact lens test. Such lenses simulate the conditions the patient will have after LVC surgery. In contact lenses, the image is natural and not subject to prismatic effects. Patients can wear lenses with powers corresponding to their ametropia for a month, for example, and assess whether double vision occurs in any situation.

The second option is to take appropriate measurements to make an assessment. The first step is to determine the extent of the latent strabismus. The alternating cover test (CT) can determine the type of deviation, whether the strabismus is divergent or convergent. However, the numerical measurement in the above mentioned patients was performed using CT in combination with a prism bar, i.e. prism cover test (PCT) [5]. Knowing the numerical value of latent strabismus, the risk of double vision should be assessed. This is done by measuring the fusional reserve (RF), which is the ability of the visual system to perform convergent (positive fusional reserve) and divergent (negative fusional reserve) movements [6] while maintaining a single image. The fusional reserve can be measured with a prism bar: positive – with a BS prism, negative – with a BN prism. Both latent strabismus and fusional reserve are measured separately for distance and near vision. An example of the notation of positive fusional reserve for myopia is as follows:

RF near BS -/ 12/ 10

The first value determines the prism power at which the blurred image occurs and was not taken into account, so it

is marked "-". The second value is the prism power at which the patient has double vision (12). The last value is the prism power at which a single image appears again (10).

The most important principle in this evaluation is that the value of the latent strabismus must be at least equal to or less than the value of the opposite fusional reserve [6]. For example, in a myopic divergent strabismus of 12 PD, the opposite (positive) fusional reserve, i.e., the value at which the patient sees double, must be 12 PD or more.

Additional tests, such as the Worth test, were performed to assess visual function and binocular vision. It evaluates binocular vision to determine whether manifest strabismus and fusion are present. The Schober test can help determine the type of deviation and whether latent strabismus is present. The near stereoscopic test, known as the Fly stereo test, measures spatial vision up to 40", and the distance spatial polarization test measures up to 60". The near point of convergence (NPC) was also assessed, and 6 cm or less was considered the norm [5]. Accommodation was also taken into account, the parameters of which were described in simplified terms, most often as "normal" or "impaired". Primarily, the amplitude of accommodation and the accommodative response were measured.

CASE DESCRIPTIONS

All cases described below are patients who presented for a qualifying examination for laser vision correction. The refraction study included a post-mydriasis examination. In one case, it was included under a separate heading because of the discrepancy between the pre- and post-mydriasis results. A 1% tropicamide solution was applied three times. Binocular vision was most often assessed at an additional visit.

The first case was a man, 35 years old, who used only spectacle correction. He wanted to undergo laser vision correction. Table 1 shows a comparison of the examined refractive defect with the currently worn correction and an assessment of binocular vision.

The binocular vision parameters can be read as correct. Included are the results of the Worth test (for distance), the Schober test (for near), stereoscopic vision for distance (STEREO distance), and stereoscopic vision for near (STEREO near). The values of strabismus for distance and near vision were measured with a strip (PCT, distance and near). The patient never noticed double vision, nor did he have asthenopic problems, but manifest divergent strabismus of the left eye was observed in the PCT, both for distance and near vision.

Since the patient had stable binocular vision, it can be concluded that this is an intermittent manifest strabismus. However, due to the large angle, especially at near, a trial

TABLE 1

Refractive test results and binocular vision.

	SPHERE	CYLINDER	AXIS	VISUS
Current correction	OP: -5.75 OL: -4.75	OP: -0.25 OL: -0.75	OP: 178 OL: 163	OP: 0.4 OL: 0.4
Refraction test	OP: -6.00 OL: -5.25	OP: -1.00 OL: -1.00	OP: 180 OL: 160	OP: 1.0 OL: 1.0

OL – left eye; OP – right eye.

WORTH	NORM
SCHOBER	NORM
STEREO distant	60"
STEREO near	40"
PCT distant	6 PD
PCT near	16 PD
PBK	3 cm
RF distant BS	-/6/4
RF near BS	-/6/4
ACCOMMODATIVE PARAMETERS	NORM

PCT – prismatic cover test for distant and near vision; RF BS – fusional reserves for convergence for distant and near vision; STEREO distant – spatial distant vision; STEREO near – spatial near vision.

of lenses with parameters consistent with those tested was recommended. The patient was asked to wear them for 1 month and evaluate visual comfort. The evaluation consisted of observing for double vision and asthenopia. The patient was scheduled for an optometric examination wearing the contact lenses, at which time the binaural visual acuity test was repeated.

The patient presented as scheduled one month later. He noticed periodic twitching of the lenses at near. Binocular vision parameters were the same as at the first visit, and fusional reserves were also measured.

Since the opposite fusional reserves are far too small for the measured strabismus, decompensation of the strabismus and the occurrence of double vision is possible both with contact lenses and after laser vision correction. The patient was offered vision rehabilitation to increase fusional reserve and improve strabismus control.

The second case is a 39-year-old professional performer. On the day of qualification, an optometric examination revealed a myopic defect and latent divergent strabismus, but the visual parameters could be considered normal. The patient has never complained of double vision. A refraction test after mydriasis revealed that the patient was overcorrected – he wore glasses that were too strong in relation to his actual visual defect. The first step before the laser surgery was to prescribe a new, weaker correction to get the patient used to it and avoid problems with accommodative spasms. The refractive error values and binocular test results are shown in table 2.

TABLE 2

Refractive test results and binocular vision.

	SPHERE	CYLINDER	AXIS	VISUS
Current correction	OP: -4.50 OL: -4.50	OP: - OL: -0.50	OP: - OL: 155	OP: 1.0 OL: 1.0
Refraction test	OP: -3.75 OL: -3.75	OP: -0.25 OL: -0.75	OP: 38 OL: 148	OP: 1.0 OL: 1.0

OL – left eye; OP – right eye.

WORTH	NORM
SCHOBER	NORM
STEREO distant	60″
STEREO near	40″
PCT distant	6 PD
PCT near	16 PD
PBK	NORM
RF distant BS	-/16/12
RF near BS	-/16/12
ACCOMMODATIVE PARAMETERS	NORM

PCT – prismatic cover test for distant and near vision; RF BS – fusional reserves for convergence for distant and near vision; STEREO distant – spatial distant vision; STEREO near – spatial near vision.

When the patient started wearing new spectacles and contact lenses, he began to experience intermittent double vision at near. He finally returned for an additional optometric consultation 3 months later. He continued to use the recommended correction.

Accommodative parameters can be considered normal. However, it is noteworthy that the fusional reserve in near vision is reduced relative to the strabismus. This can actually result in double vision at near. However, the patient did not experience these symptoms (or experienced them to a much lesser extent) with his older and stronger correction. The overcorrection is decompensated by the visual system through accommodation. Accommodation itself causes increased tension in the ciliary muscles, which results in stimulation of convergent eye movement. This is a positive stimulus in the case of divergent strabismus, as accommodation helps to parallel the eyes. However, in its chronic form, the condition can cause asthenopic symptoms, worse near vision, accommodative problems, and even double vision in later stages, as fusional reserves and accommodations weaken with age. One solution was to return to overcorrection, but this would in no way prepare the patient for the LVC procedure. The patient was advised to undergo home vision rehabilitation to increase fusional reserves and improve strabismus control. He is currently in therapy.

The third case is a 27-year-old patient, a software developer. He had no history of binocular or double vision problems. Refraction and binocular visual acuity tests are shown in table 3.

TABLE 3

Refractive test results and binocular vision.

	SPHERE	CYLINDER	AXIS	VISUS
Current correction	OP: +4.50 OL: +5.00	OP: -4.50 OL: -5.00	OP: 15 OL: 177	OP: 0.7 OL: 0.5
Refraction test	OP: +5.00 OL: +5.50	OP: -5.50 OL: -6.50	OP: 10 OL: 172	OP: 0.9 OL: 0.8

OL – left eye; OP – right eye.

WORTH	NORM
SCHOBER	NORM
STEREO distant	100″
STEREO near	100″
CT distant	exophoria with a vertical component
CT near	exophoria with a vertical component
PBK	>6 cm
RF distant BS	-
RF near BS	-
ACCOMMODATIVE PARAMETERS	-

PCT – prismatic cover test for distant and near vision; RF BS – fusional reserves for convergence for distant and near vision; STEREO distant – spatial distant vision; STEREO near – spatial near vision.

At the first qualifying visit, the patient underwent refraction and binocular vision testing. The patient had a very complex defect (hyperopia and high astigmatism), as well as divergent strabismus with a vertical component, which is much easier to decompensate. Undercorrection in plus diopters has a similar beneficial effect in divergent strabismus as overcorrection in minus diopters, so in this case correcting a hyperopic defect that turned out to be greater than the patient's correction after the refraction test could have created a serious risk of strabismic decompensation. Therefore, we decided to perform the lens test. However, soft lenses with converted powers did not fit the patient well and he complained of worse vision. It was decided to use other soft contact lenses with lower dioptric powers along with the patient's spectacles. He wore them for 1 month. After a one-month follow-up, the patient noted that double vision was occurring periodically, both at distance and near. They recommended a return to self-correction and additional evaluation for possible vision therapy or selection of prism glasses if intermittent double vision persisted. The LVC procedure was abandoned for the time being.

The final case is a 32-year-old woman. She is an office worker and has never experienced double vision. Strabismus was previously diagnosed by a physician. The results of the refraction and binocular visual acuity test are shown below (tab. 4).

TABLE 4

Refractive test results and binocular vision.

	SPHERE	CYLINDER	AXIS	VISUS
Current correction	OP: +2.75 OL: +2.75	OP: -0.50 OL: -	OP: 127 OL: -	OP: 1.0 OL: 1.1
Refraction test	OP: +3.25 OL: +3.75	OP: -0.75 OL: -	OP: 130 OL: -	OP: 1.0 OL: 1.25
Post-mydriasis examination	OP: +6.00 OL: +5.25	OP: -0.75 OL: -	OP: 130 OL: -	OP: 0.9 OL: 1.0
Prescribed glasses	OP: +3.75 OL: +3.25	OP: -0.50 OL: -	OP: 130 OL: -	-

OL – left eye; OP – right eye.

WORTH	NORM
SCHOBER	NORM
STEREO distant	60″
STEREO near	100″
CT distant	1 PD
CT near	6–12 PD
PBK	6 cm
RF distant BS	-/6/4
RF near BS	-/20/18
ACCOMMODATIVE PARAMETERS	REDUCED

PCT – prismatic cover test for distant and near vision; RF BS – fusional reserves for convergence for distant and near vision; STEREO distant – spatial distant vision; STEREO near – spatial near vision.

Based on the presented results, it can be concluded that the patient has latent hyperopia. She also has latent divergent strabismus and reduced parameters of binocular vision, including fusional ranges. Since the priority is for the patient to adopt a larger correction consistent with her visual impairment, there is concern that this may lead to strabismus decompensation. As a first step, a larger correction was prescribed to gradually relax accommodation. In the second stage, vision therapy was initiated, which is carried out in two ways: it is aimed at relaxing accommodation and accelerating the adoption of the correction, and at improving the parameters of binocular vision. The patient is very determined and mobilized. She is undergoing visual training and making good progress. The prognosis is very good. She recently returned for a follow-up visit after a series of in-office vision therapy sessions. The patient made good progress. The parameters of binocular vision can be considered very good, both strabismus control, fusional reserve, accommodation and level of binocular vision. The correction was also increased by +1 D in the spherical component. The patient accepted the new ocular correction very well. In this case, the easier acceptance of the plus correction was influenced by the ongoing visual rehabilitation. The final step will be to increase the power of the glasses and check whether the parameters of binocular vision have remained at the same good level.

SUMMARY

All of these cases clearly demonstrate that binocular testing should be an integral part of the optometric examination prior to LVC. The majority of patients have normal binocular vision, but it is these individual cases that should be watched for, because if symptoms of strabismus decompensation occur after the procedure, it may have the opposite effect of the clear vision without the need for glasses or contact lenses that the patient is hoping for.

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References

1. Hered RW (ed.) Basic and Clinical Science Course, Section 6: Pediatric Ophthalmology and Strabismus", American Academy of Ophthalmology 2019. Polish Edition. Hautz W, Loba P, Rękas M (eds.). Edra Urban&Partner, Wrocław 2021.
2. Styczyński A. Korekcja wad wzroku – procedury badania refrakcji. α- medica Press, 2009.
3. Zając M. Optyka Okularowa. Dolnośląskie Wydawnictwo Edukacyjne, Wrocław 2007.
4. Broddie SE. Basic and Clinical Science Course™ (BCSC), Section 03: Clinical Optics. American Academy of Ophthalmology, 2020-21.
5. Oleszczyńska-Prost E. Zez. Edra Urban&Partner, Wrocław 2019.
6. Grosvenor T. Optometria. I Polish Edition. Tokarzewski T, Ożóg M (eds). Elsevier Urban&Partner, Wrocław 2011.

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