

# Visual rehabilitation strategies for patients with glaucoma and low vision: A literature review

Estratégias de reabilitação visual em pacientes com glaucoma e baixa visão:  
Revisão de literatura

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## KEYWORDS:

Glaucoma; Low vision; Low vision assessment; Visual rehabilitation; Low vision devices.

## PALAVRAS-CHAVE:

Glaucoma; Baixa visão; Avaliação de baixa visão; Reabilitação visual; Dispositivos para baixa visão.

## ABSTRACT

A significant number of people are being treated for glaucoma, and many of these patients have symptoms that meet the criteria for low vision. Ophthalmologists tend to focus on objective measures to monitor the progression and severity of the disease; however, the functional impact of glaucoma must also be considered. Loss of visual capacity impairs mental and physical functioning limit activities of daily living. The most common problems faced by patients with glaucoma are related to mobility, driving, sensitivity to glare, reading, and distance vision. Low vision rehabilitation aims to maximize patients' independence in everyday life by addressing these difficulties. This literature review highlights a set of strategies for the assessment and visual rehabilitation of patients with glaucoma and low vision.

## RESUMO

Há um número significativo de pessoas em tratamento de glaucoma e, desses pacientes, muitos apresentam sintomas que atendem aos critérios para baixa visão. Os oftalmologistas tendem a concentrar esforços em medidas objetivas para monitorar a progressão e a gravidade da doença, mas o impacto funcional do glaucoma também deve ser considerado. A perda da capacidade visual prejudica o funcionamento mental e físico, limitando as atividades da vida diária. Os problemas mais frequentemente enfrentados por pacientes com glaucoma estão relacionados à locomoção, dirigir, ofuscamento, leitura e dificuldade para enxergar de longe. A reabilitação para baixa visão visa maximizar a independência do paciente em seu cotidiano, abordando essas dificuldades. Este artigo de revisão de literatura reúne um conjunto de estratégias para a avaliação e para a reabilitação visual dos pacientes com glaucoma e com baixa visão.

## INTRODUCTION

In 2013, the number of people aged between 40 and 80 years with glaucoma worldwide was estimated at 64.3 million, with projections of 76.0 million for 2020 and 111.8 million for 2040<sup>1</sup>.

Patients with glaucoma may experience visual impairment with major functional limitations due to

loss of peripheral vision and visual field, resulting in difficulties in activities of daily living (ADLs) such as eating, dressing, reading, writing, mobility, and interpersonal communication, as well as increased morbidity and mental health impacts<sup>1</sup>.

While the progression of the disease is managed with medication and surgery, visual impairments can be addressed through low vision services<sup>2</sup>. These

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include assistance in adapting work or home environments to maintain the patient's autonomy and self-esteem, as well as guidance and prescription of optical and non-optical aids. Most glaucoma patients undergoing low vision rehabilitation are functionally monocular but not legally blind<sup>3</sup>.

The aim of this study was to review the literature on visual assessment and rehabilitation strategies for patients with glaucoma and low vision, with an emphasis on functional impact and improvement in quality of life.

### Assessment of patients' needs

The patient's profile should be considered in terms of age, education, profession, and lifestyle.

The history of visual impairment is important, as it helps to define the patient's goals and the tasks they want or need to perform<sup>4</sup>. Different aids can be used for different situations, tasks, and activities.

It is also necessary to determine the best distance for performing the intended tasks and whether the patient needs to move while using the aid<sup>4</sup>.

### Functional observation and functional response profile

Functional observation can be analyzed by performing visual tasks such as:

- Reading and writing: reading quality, reading speed, font size, and errors in certain field locations during reading and writing;
- Walking: walking speed, head and eye movements (scanning), observation of the environment, failure to perceive objects, bumping into objects, falls, and difficulty going up or down stairs<sup>4</sup>.

In a didactic approach, Faye (1984) defined three groups of visual response profiles according to the relationship between ocular disease and visual functionality and proposed the most appropriate resources<sup>5</sup>:

- Decreased transparency of the ocular media of the eyeball;
- Central visual field defect;
- Peripheral visual field defect.

Glaucoma patients with peripheral visual field defects may present functional alterations such as difficulty recognizing and orienting themselves in the environment, reduced visual response under low-light conditions, and reduced contrast sensitivity<sup>4</sup>.

### Assessment of visual acuity, contrast sensitivity and visual field

The study of visual acuity combined with contrast sensitivity provides a comprehensive overview of a patient's visual capacity and functionality<sup>4</sup>.

- Loss of contrast sensitivity at high spatial frequencies affects near tasks that involve finer details and may require adjustment of lighting levels.
- Loss of contrast sensitivity at mid frequencies is more likely to be associated with difficulties in tasks involving mobility.
- Loss of contrast sensitivity at low frequencies is related to the discrimination of large objects such as buildings, cars, and people.

Although reading ability and visual acuity are important for the quality of life of glaucoma patients, mobility problems and glare are also common complaints. Nelson et al. reported that more than 70% of glaucoma patients experienced disabling glare when adapting to different levels of lighting<sup>6</sup>.

Due to reduced peripheral vision, patients are at a greater risk of accidents and falls. Turano et al. found that patients with glaucoma walked 10% more slowly than those without glaucoma. In addition, glaucoma patients experienced almost twice as many stumbles, falls, and orientation problems compared with individuals without glaucoma<sup>7</sup>.

Kaleem et al. described the common demographic and clinical characteristics of glaucoma patients attending visual rehabilitation programs, reporting the greatest difficulties with reading (88%), writing (72%), and mobility (67%)<sup>3</sup>.

### Selection and adaptation of low vision aids

Colenbrander correlates visual acuity values with the use of aids to improve the visual performance of patients with low vision, stating that image magnification devices are the most suitable for moderate to severe low vision. In cases of severe low vision, magnification is typically restricted to short-duration tasks, and compensatory resources – such as auditory aids and Braille – are used<sup>8</sup>.

After a comprehensive assessment of the patient, the appropriate aids are selected, presented to the patient, and tested.

The ophthalmologist must be attentive to the patient's reactions, including resistance to the use of devices, depression, acceptance, and attitude toward the disability. These observations help guide the adaptation process, including determining the time

and explanations required for adaptation, identifying the best time to begin the process, and deciding when referral to other professionals is necessary<sup>4</sup>.

### Nonoptical aids for low vision

Nonoptical aids are resources that do not use optical systems; instead, they modify materials and the environment to promote better visual performance for people with low vision<sup>4</sup>.

These aids are intended for several purposes: magnification, positioning and posture, writing and reading support, and lighting control (improving ambient lighting conditions). They may also include features that condense or reposition the image, increasing the amount of visual information within the viable visual field and improving contrast.

Magnification is determined by the ratio of observed visual acuity to the target visual acuity. For example, if a patient can read letters of 4M but needs to read letters of 2M for a specific task, the required magnification would be  $2\times$ .

The magnification of the retinal image is limited to resources with relatively low magnification power because a very large image may fall on non-functional retinal areas, thereby reducing the amount of useful environmental information available.

When calculating the working distance, the visual angle represents the relationship between the patient's current visual capability and the visual demands of the task. For example, if a patient reads 3M at 30 cm, they will be able to read 1M at 10 cm. Thus, by bringing text with 1M letters to a distance of 10 cm, the patient may be able to read it.

Once the distance required for reading and the letter size are known, Kestenbaum's rule can be used to calculate the necessary near addition by using the inverse of the distance visual acuity. For example, if the corrected distance visual acuity is 20/400, the required addition would be  $400/20$ , corresponding to +20 diopters.

After calculating the required addition, the most appropriate aid for the patient can be determined to provide the necessary magnification according to the patient's functional visual characteristics and the activities they wish to perform.

### Optical aids for low vision

Optical aids are devices that, according to their optical characteristics, improve the visual performance of individuals with low vision<sup>4</sup>.

These devices may be used to: magnify and/or shift the retinal image, selectively filter the visible spectrum of light, condense the retinal image.

To select the correct aid, it is essential to calculate the required magnification.

Near vision optical aids include convex lenses fitted into binocular or monocular eyeglass frames, handheld magnifiers, stand magnifiers, and telescopic systems (telemicroscopes). Many currently available low-vision aids are primarily designed for reading<sup>9</sup>.

Patodia et al. demonstrated in a clinical study the capabilities of currently available low vision devices for glaucoma patients with moderate to severe visual loss. The most frequent goal among these patients was maximizing reading function<sup>10</sup>.

Handheld magnifiers are generally used for short-term tasks, such as reading labels, product prices in stores, menus, medicine leaflets, and correspondence. They may be indicated in cases with remaining peripheral visual fields, as they allow proper positioning for efficient use of vision. Some models include a built-in light source that improves illumination of the reading material.

Stand magnifiers consist of convex lenses mounted on a rigid support that rests on the reading material. They are often used by patients with significant visual field contraction and reduced visual acuity because they provide greater image stability, such as in cases of advanced glaucoma and retinitis pigmentosa.

Telescopic systems are the only aids capable of magnifying images at long, intermediate, and near distances, depending on their design.

Near vision telescopic systems (telemicroscopes) are afocal devices with fixed focus for objects at optical infinity or beyond approximately 6 meters. They are used when greater reading distances are required compared with convex lenses fitted into eyeglass frames.

Distance telescopic systems enlarge the image of an object through angular magnification. They are used when optical correction of ametropia is insufficient to improve visual resolution and when other retinal image enlargement strategies, such as reducing the viewing distance or increasing the object size, cannot be used.

Filter lenses, or medical filters, are used to control lighting and reduce glare.

Their prescription should be based on clinical testing with different filters, considering effects on visual functions such as color perception, contrast sensitivity, visual acuity, reading speed, and light adaptation,

as well as the patient's perception of comfort, visibility, and assistance in performing daily activities.

In the study by Patodia et al., glaucoma patients with low vision reported that yellow-tinted lenses were more effective than orange-tinted lenses in reducing glare and facilitating adaptation to varying lighting conditions<sup>10</sup>.

### Optical aids for displacing or condensing the retinal image

To obtain information lost due to changes in the visual field, eye movements are systematically performed to scan the environment. This process can transform a visual field of 3° into a dynamic field of approximately 20°. When scanning is inefficient, uncoordinated head movements may occur erratically, resulting in no effective functional gain<sup>4</sup>.

Visual field defects are commonly classified into two groups: hemianopsias or sectoral defects, and generalized visual field constriction<sup>4</sup>.

- Aids designed for hemianopsias or sectoral visual field defects bring information from the non-functioning area to the functioning area of the visual field. These aids primarily include prisms and mirrors.

Prisms displace the image that would normally fall on the defective field into the functioning visual field. Full-field prisms can improve reading dynamics and reduce compensatory head movements. However, Fresnel prisms are often poorly tolerated because of reduced optical image quality and decreased resolution as their dioptric value increases.

Sectoral prisms reduce the amplitude of compensatory eye movements within the defective visual field. Fresnel prisms are typically used bilaterally and placed over the spectacle lens in the region corresponding to the field defect, usually 1–2 mm from the boundary of the functioning field.

Mirrors provide the functioning visual field with a reversed image of the defective field. They may be designed as sectoral mirrors or wide-field plane mirrors.

Sectoral mirrors are positioned in the nasal region of the spectacle lens, with the reflective surface facing the field defect. Common models include clip-on mirrors, mirrors fixed directly to the lens, mirrors fixed to the nasal portion of the frame, and miniaturized mirrors positioned behind the lens.

Wide-field mirrors are mounted on the spectacle frame, with partially reflective mirror surfaces oriented toward the non-functioning field.

- Visual aids for generalized visual field constriction are designed to condense peripheral information within the remaining functional visual field and enhance scanning. The most commonly used method is image minification, achieved with aids such as reverse telescopes and negative lenses. The main limitation of this approach is the reduction in visual acuity secondary to image minification.

### Electronic aids for low vision

Electronic aids consist of optical systems integrated into electronic devices, including video magnification systems and computer-based resources<sup>4</sup>.

The main electronic aid used for image magnification is closed-circuit television (CCTV), also known as video magnification systems (VMS) or video magnifiers. These systems typically combine a camera, a light source for illumination, an optical system, and a monitor with adjustable features and functions<sup>4</sup>.

Common types include: desktop systems, portable stand systems, and head-mounted systems.

Matsuhara and Fernandes published a comprehensive review discussing new perspectives in low-vision rehabilitation using assistive technologies and information and communication technologies<sup>11</sup>. Their work is recommended as a complementary reference to the present article.

Due to reduced peripheral vision, patients are at greater risk of accidents and falls. Individuals with glaucoma walk approximately 10% more slowly than those without glaucoma. Furthermore, glaucoma patients experience almost twice as many stumbles, falls, and orientation problems compared with individuals without glaucoma<sup>7</sup>.

Orientation and mobility specialists can provide training in the use of mobility aids such as the long cane, helping patients maintain autonomy and independence<sup>4</sup>.

Robinson et al. reported that patients with visual field loss secondary to glaucoma showed reduced perception of safe crossing distances between vehicles, increasing the risk of injury when crossing roads. Overall, the group made 23% more errors in identifying a traffic gap as safe to cross when it was actually too narrow<sup>11</sup>. Taken together, these and other studies suggest that individuals with reduced visual fields due to glaucoma experience: more frequent falls, a higher rate of traffic accidents, greater difficulty with mobility-related activities, and reduced overall quality of life<sup>12,13</sup>.

In conclusion, the monitoring of patients with glaucoma by an ophthalmologist should extend beyond the control of intraocular pressure and visual field testing (campimetry), as additional limitations and functional difficulties associated with low vision may be present. Low vision services can significantly benefit these patients and should be considered an essential component of glaucoma management.

However, barriers to accessing these services exist at multiple levels. Greater awareness and integration of low-vision rehabilitation into routine ophthalmic care are necessary to ensure comprehensive patient management. It should be emphasized that the goal of low vision rehabilitation is not to restore lost vision, but rather to maximize the use of remaining vision. By doing so, patients can regain independence in ADLs and improve their autonomy, independence, and overall quality of life.

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