Chapter

Evidence-Based Practice and Trends in Visual Rehabilitation for Patients with Age-Related Macular Degeneration

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Abstract

Age-related macular degeneration (AMD) is a common, chronic, and progressive eye disease that is considered the leading cause of visual loss among the elderly in developed countries. Advanced AMD, including choroidal neovascularization (CNV) or geographic atrophy (GA), is associated with substantial and progressive visual impairment that can lead to a significant reduction in functional independence and quality of life (QoL) for affected individuals, whose number is expected to increase in the coming years in line with population growth and ageing. In this context, while an important part of medical care is focused on preventing the progression of the disease, Visual Rehabilitation (VR) aims to address its consequences by providing these patients with a number of strategies to achieve their goals and participate autonomously, actively and productively in society. This chapter aims to provide an update on evidence-based practices in the field and how modern technologies play an important role in the development of new VR approaches.

Keywords: age-related macular degeneration, visual rehabilitation, management, technology, practice, trends

1. Introduction

Age-related macular degeneration (AMD) is a prevalent, progressive eye disease that is characterized by a late-onset neuro-degeneration of the photoreceptors (light-sensitive retinal cells) and their supporting tissues [1].

It is considered a highly disabling disease, as the macula (part of the eye responsible for sharp, clear vision) is the most damaged area of the retina, causing a gradual loss of central vision with subsequent difficulties in many activities of daily living (ADLs) for those affected, such as reading, driving, mobility or face recognition.

Globally, AMD is responsible for approximately 7% of blindness and 3% of visual impairment, making it the third most common cause of vision loss worldwide, and the first in industrialized countries [2, 3].

In economic terms, the total cost due to AMD is estimated to be approximately $343 billion, including $255 billion in direct healthcare costs (due to scheduled medical visits, treatment, rehabilitation, vision-related equipment, etc.) and $88 billion in indirect costs (due to injury, depression, loss of productivity, and social dependence as a consequence of blindness caused by the disease) [4]. Furthermore, the progressive growth and ageing of the population suggests that the magnitude of this issue will increase in the coming years, with the global prevalence of AMD expected to rise from 199 million people in 2020 to 288 million in 2040 [5].

From a clinical perspective, AMD can be classified into early and late stages. Patients with early AMD are usually asymptomatic and present yellowish drusen and pigmentary alterations in the macular area on fundus examination (**Figure 1**), while late stages of the disease, responsible for most visual loss attributed to AMD, are defined by the presence of signs indicating choroidal neovascularization (CNV) or geographic atrophy (GA) [6].

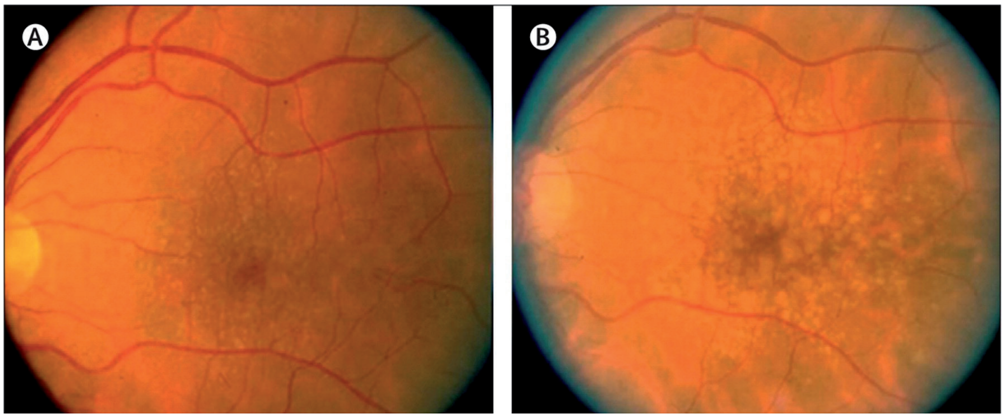


Figure 1.
Large drusen appearing as yellowish subretinal spots present in a patient with early AMD from the Blue Mountains Eye Study [7] (A) and progression of both drusen size and area involved over 5 years (B) [6].

In CNV (wet) AMD, abnormal blood vessels grow and break through to the neural retina (**Figure 2**). These new blood vessels are fragile and tend to leak blood, fluid and lipids, which can accumulate under the macular area, elevating it and distorting vision and eventually leading to the formation of fibrous scarring.

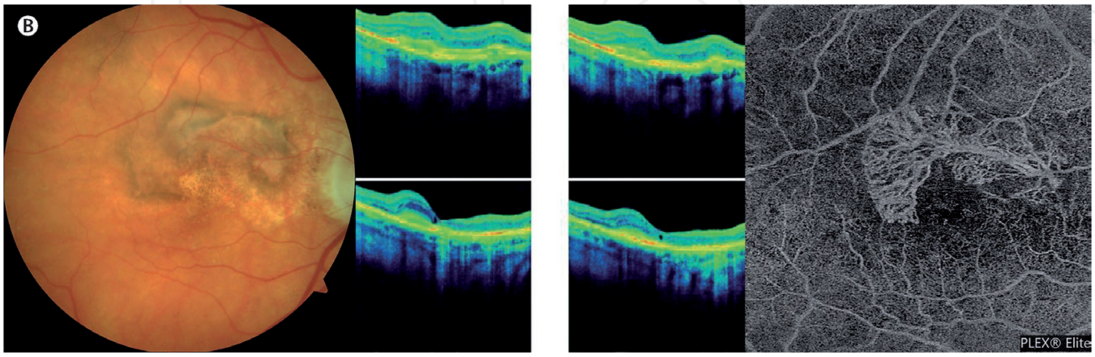


Figure 2.
Recent-onset neovascular AMD on colour photography (left), spectral-domain optical coherence tomography (middle), and optical coherence tomography angiography showing appearance of choroidal new vessels (right) [8].

On the other hand, in atrophic (late dry) AMD, a gradually deterioration of the retinal pigmentary epithelium (RPE), choriocapillaris, and photoreceptors occurs (**Figure 3**). As both AMD forms progresses, detail in front of central visual field is lost and over time a blind spot (scotoma) may appear in the central visual field of the patient [8].

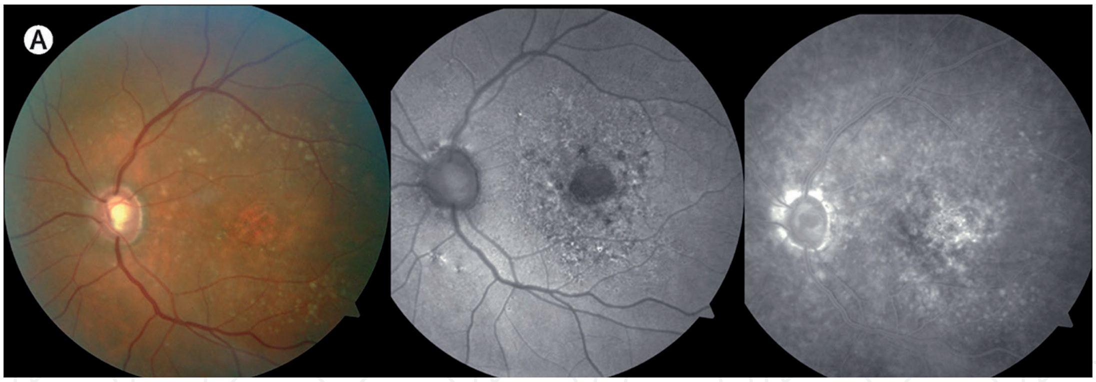


Figure 3.
Large soft drusen surrounding an area of GA on colour fundus photography (left), fundus autofluorescence imaging (middle), and fluorescein angiography (right) [8].

Although the initial cause of AMD remains unclear, several risk factors have been linked to the development of the disease, such as age (>60 years), lifestyle (smoking, diet), cardiovascular disease and genetic markers [9].

This suggest that the pathogenesis of AMD is the result of a complex multifactorial interaction between environmental, functional, genetic and metabolic factors involving multiple biological pathways, including inflammation, angiogenesis, remodeling of the extracellular matrix, lipid metabolism and transport regulation, etc. [10–12].

In recent years, several epidemiological studies have reported a decrease in blindness and visual impairment associated with AMD [13, 14], which is likely to be attributed to improved diagnostic procedures, earlier diagnosis, slowing disease progression through micronutrient supplementation [15, 16], and the introduction of new therapies based on suppression of vascular endothelial growth factor (VEGF) [17].

Unfortunately, despite all this progress in AMD management, there is currently no effective treatment to cure the disease or reverse its course. However, in most patients, peripheral vision is preserved, allowing them to retain a certain level of autonomy.

On this basis, visual rehabilitation (VR) aims to provide these people with a range of strategies and behaviors to achieve the full potential of their remaining vision, improving their self-confident and independence and enabling them to return to a visually active life as much as possible. This philosophy aims at increasing awareness in low-vision patients, so they do not just focus on their loss or their impairment.

2. Visual rehabilitation as part of AMD care

People who do not have AMD (e.g., family members, caregivers, and even some healthcare providers) often underestimate the effect of this condition, particularly in terms of visual function and quality of life (QoL) [18].

According to the World Health Organization' (WHO), disability must include both the impairment of bodily structures or functions and the difficulty or limitation in performing a task and in participating in life situations [19].

This approach implies that the rehabilitation process cannot only focus on the aspects that directly affect the person, but must also deal with the society in which they live and the context that makes it possible for them to develop, in order to have a successful life.

Paying attention to this, comprehensive AMD care should give attention not only to the structural and functional condition of the eye, but also to the patient's functioning in his or her specific surrounding. In this sense, the main difference between VR and other ophthalmic sub-specialties is that most of these sub-specialties are anatomically defined, while VR is functionally defined (**Figure 4**) [20].

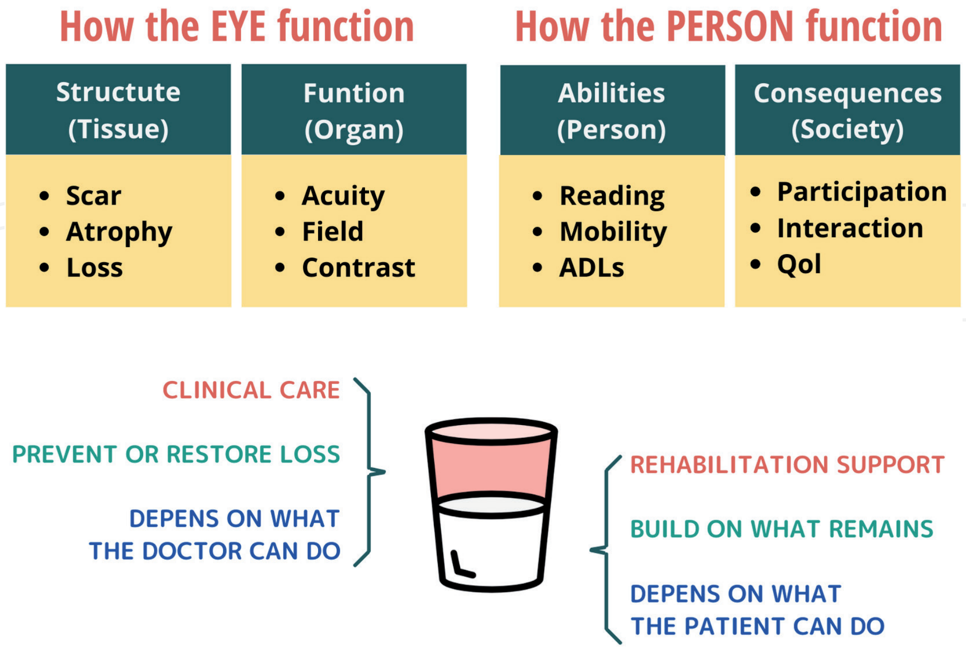


Figure 4.
Comprehensive AMD care diagram showing the areas of influence and differences between medical and rehabilitative care. Adapted from: [20].

To adequately cover all these aspects, the participation and collaboration of different professionals is necessary, since different goals often require different interventions [21]. This can be observed in the US and Europe models, where a wide range of professionals, varying from continent to continent, work together to achieve a successful rehabilitation.

Multidisciplinary low-vision teams usually require an ophthalmology, an optometrist, an occupational therapist and a rehabilitation teacher among other professionals specially trained in the evaluation of the patient's remaining vision and the prescription of different low-vision aids (LVAs) [22]. However, prescription of these aids is only the first step in learning how to use them effectively, as training and continuous practice are essential to help the patient feel comfortable and get the most out of them [23]. To this end, different techniques can be employed, often using both office- and home-based exercises with the device while performing a specific activity for a few hours in different sessions [24–26].

Besides prescription of LVAs and training on their correct use, VR also contemplates assessment of the home environment, as well as psychological and social worker support. Despite this, it should not be ignored that, according to the Veterans Affairs Low Vision Intervention Trial II (LOVIT II), basic low vision services are sufficient for most people with low vision, although basic services combined with VR programs are most effective for people with a visual acuity of 20/200 or less [27].

3. Visual rehabilitation for AMD patients

VR in AMD patients has largely focused on reading [28] and for this purpose many LVAs have been used. But, today, individuals with AMD demand wider objectives that include, apart for reading, being able to participate in other activities and carry out their daily life and travels independently. If we add to this the fact that modern technologies have greatly expanded access to information for people with low-vision, we get that VR encompass a variety of resources to ultimately fit the person's goals, needs and demands.

Reading is a sophisticated activity of great importance for the life of the individual in its personal, educational or professional aspects. Conditions compromising the condition of the macula, such as AMD, can greatly affect this ability, which adequate performance largely depends on the reception of central visual information. Depending on the degree to which the scotoma is affected, the reading speed in these patients can be between 25 and 130 words per minute (wpm), while the average reading speed of a person without visual impairment is usually around 200-250 wpm [29].

In everyday life, everyone needs to be able to read texts whose size covers a range from newspaper print to headlines. People with normal vision perform this task with a speed that favors comprehension and comfort. However, AMD patients find that reading speed is compromised as the font size becomes smaller. In general, this population needs magnification of the text to achieve a reading speed that allows them to read effectively, although this will always be lower than that of people without AMD.

In individuals with central field loss (CFL), eccentric fixation is necessary, and the oculomotor pattern differs when reading. Eye movements in people with severe visual impairment tend towards continuous refixation, i.e., fixation stability is weak, and not always stable and functional [30]. Consequently, letter recognition is slower and more difficult [31]. Sometimes, it is difficult to recognize a word with a single fixation, being necessary several saccades within the same word [32]. Visual field loss close to fixation can also affect everyday activities, such as face recognition or shopping [33].

With this in mind, most functional adaptations in these cases are based on training in the use of a preferred retinal locus (PRL) to make eye movements remain in a functional area of the peripheral retina. This PRL is empowered to assume the macular function and thus restore the lost vision-related skills, so assessing its location and characteristics is an essential part of any reading rehabilitation program [34]. In this context, microperimeters offer the most accurate method for PRL assessment (**Figure 5**).

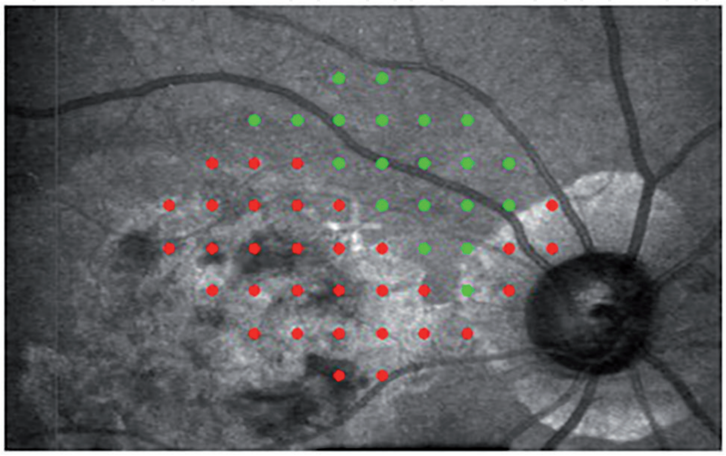


Figure 5.
Microperimetry using a standard grid (52 points) in a study of ranibizumab effects on functional vision in patients with advanced AMD [35] showing the non-visual area of the retina (red points), the normal sensitive retina (green points) and the patient's fixation target (cross) [36].

The subject's ability to make visual movements so that the target is held in the PRL correlates with reading speed, as do more intense saccadic movements and stability of fixation [37]. In addition to holding the target on the retina, the eye must move rapidly towards objects further away in the field of vision (saccadic movements). The angle at which the movement to fix the image in the PRL must be made will affect the fixation, the stability of which is crucial for reading and proper perception.

After eccentric viewing training, the location of the retinal area used for fixation may change, but not the fixation stability [38]. Moreover, the person does not always use the same PRL, and may use several depending on the target position. Some authors report that these PRLs may appear untrained in patients in the first six months of disease [38]. Many patients with AMD adopt an PRL on the left area of the scotoma, although more information is obtained from the right area during reading. For this reason, Rubin [39] suggests that it is preferable to use the right area of the scotoma to the left.

The benefits of eccentric viewing training on the reading performance of patients with AMD have been supported by several studies. For example, Nilsson et al. [40] trained 20 patients with neovascular AMD, an absolute central scotoma, and a mean best-corrected visual acuity (BCVA) of 20/475 in the use of a new and more favorable PRL for reading, observing that, after a mean training time of 5.2 hours, 90% of the participants learned to use eccentric viewing, which correlated with a significant improvement in reading speed from 9.0 ± 5.8 words per minute (wpm) to 68.3 ± 19.4 wpm.

A larger sample study evaluating the influence of eccentric viewing training in 242 individuals with a central scotoma concluded that, after an average training time of 3.8 hours, reading speed increased from 48.0 wpm to 71.9 wpm, the size of Arial font that could be read fluently could be reduced from 14.3 to 11.5, the duration of comfortable reading improved from 1.7 to 15.8 min, and the mean percentage of material that was understood by patients could be increased from 73.7 to 92.7% [41].

In addition, when compared with other interventions in the literature, such as a microperimetric biofeedback and microscope teaching program, eccentric viewing training has been found to offer greater benefit in terms of improved reading speed among patients with AMD [42].

It can be said that reading is significantly slower in patients who have not been trained in the use of the retinal locus, but, according to the findings of Watson et al., this does not mean that PRL training should not be further investigated [43].

But different oculomotor pattern is not the only factor that explains the lower reading speed in patients with macular degeneration. Cheong et al. concluded that in patients with AMD the visual processing of letter recognition is also lower, thus negatively influencing reading speed, reading comprehension and enjoyment while reading, as well as resistance in avoiding visual fatigue [44].

Another factor that can determine the efficiency of reading in patients with AMD is the number of characters that can be recognized in each fixation or visual span. This, in addition to the slower visual processing observed in these patients, forces more frequent eye movements. According to Chung [45], training can lengthen the visual lag in normal peripheral vision, although this benefit is less pronounced in older people.

For some researchers, contrast sensitivity is shown to be a critical factor in explaining the future reading efficiency of the patient with AMD over other factors such as scotoma size or BCVA [46]. In general, it can be said that individuals with AMD require contrast enhancement to achieve their optimal reading speed level [47, 48].

Lighting is another key component involved in the reading rehabilitation process for people with AMD, as the negative effect of uncontrolled illumination hinders vision. In this context, it is known that people with AMD often require high levels of illumination [49]. According to Bower et al., [50] at least 2000 lux are necessary to improve reading performance in patients with AMD, although Seiple et al. [51] indicate that this benefit can only be considered for small font sizes.

Finally, it should be pointed out that various studies have tried to establish the degree of importance the way the text is presented has on reading performance in AMD patients.

Chung is one of the researchers who has dedicated her work to this, although she states that there is not enough evidence that typography or text formatting (e.g., page formatting, Rapid Serial Visual Presentation: RSVP, scrolling text) improves reading speed, except in some cases of RSVP [52, 53]. In clinical practice, these are factors that may affect visual comfort and the subjective perception of improved reading or reduced visual fatigue differently from person to person.

4. Low vision aids for AMD patients

4.1 Non-optical aids

Environmental adaptations such as adequate illumination (by the use of light flexes or lecterns) and glare reduction and light with specific wavelengths preferred by the patients (by the use of prescription filters) are two well-known beneficial strategies for improving functional outcome measures in CFL patients.

These interventions result in apparent improved contrast sensitivity and better visual acuity for AMD patients [54, 55], so ensuring these optimal conditions is a fundamental step prior to the prescription of any additional aid.

Increasing the amount of light has demonstrated to have a significant positive effect on sentence reading acuity, reading speed and critical letter size for AMD patients [50].

In addition, some authors who have investigated the effects of making light adjustments in the homes of people with visual impairment have found that higher lighting levels led to greater well-being and a significant improvement in certain instrumental ADLs [56].

The use of filters has also been shown to improve vision-related QoL in patients with AMD, with the success rate of filter placement being better for those patients with visual acuity less than 0.25 and those with advanced AMD [57]. Nevertheless, although various tests exist to determine the best color, tint, lens material or frame type for a given patient, to date no specific protocol has been developed to assist in prescribing tinted or selective transmission lenses [58].

4.2 Optical aids

Optical aids for near vision involve the use of lenses to reduce the viewing distance of an object, making it easier to see, and are primarily used to tasks requiring near resolution acuity, such as reading, writing, personal care (i.e., make-up, nail polishing) and different leisure activities, such as sewing or drawing.

These optical LVAs broadly include the use of high-plus reading lenses and different magnifiers (including clip-on, hand-held, or stand devices), which power will ultimately depend on the patient's remaining vision and on the size of the object or printed material to be seen by the patient [59, 60]. In a consecutive sample of 100 individuals with AMD, these optical LVAs was shown to improve near BCVA from 0.13 (decimal) to 0.39 [61].

When reading with a hand-held magnifier, the magnifier has to move along the line and at the same time keep a constant distance from the text to ensure a clear image [62].

Clip-on magnifiers overcome this disadvantage, but can nevertheless scratch the lenses and reduce the visual field to further distances. In this context, stand magnifiers are the choice preferred by patients, as they offer ergonomic advantages such as a comfortable viewing angle, the possibility of both reading and writing, better illumination, a wider field of view, variable power and magnification, and a greater working distance [63].

Magnification can also be achieved with the use of telescopic devices, which are used to recognize objects that are outside the near vision range. These optical aids can be used for tasks such as reading street signs, road signs, and transport timetables, making them a great ally for outdoor mobility. Furthermore, additional magnifying devices can easily be applied to these devices to improve near vision as well.

In recent years, advances in surgery have allowed intraocular implantation of these devices. Implantable miniature telescopes (IMTs) are visual prosthetic devices usually implanted monocularly depending on the eye with BCVA and, once implanted, are used to magnify objects in the patient's central visual field and focus them onto healthy areas of the retina, allowing them to recognize objects they would otherwise not be able to see [64]. In this way, the implanted eye is responsible for detailed vision, and the fellow eye will be responsible for peripheral vision tasks, including ambulation.

The safety and efficacy of these devices has been evaluated in different clinical trials that have found similar improvements in BCVA after one year of implantation (≈60% of participants gained three or more lines in either distance or near BCVA), with no serious adverse events reported [65, 66]. In addition, a follow-up study showed that substantial visual improvements achieved with the intervention were maintained at two years [67].

4.3 Electronic aids

Electronic vision enhancement systems include closed-circuit television (CCTV) systems and other systems incorporating a monitor or a liquid-crystal display (LCD) screen in which the image or the print is projected after being digitized.

These systems provide increased magnification and an enlarged field of view than traditional optical aids, with the possibility of controlling relevant parameters, such as brightness, glare or contrast, so they can be appropriate for individuals which vision is greatly reduced or in which the use of optical aids have failed in achieving their goals.

For example, in a retrospective study of 530 patients with different stages of AMD in which participants were provided with different LVAs, successful VR (reading ability in 94% of patients when only 16% could read before) was achieved with optical visual aids in 58% of patients, whereas 42% needed electronic CCTV systems [68].

A clinical trial in which 37 subjects with central field loss were randomized to receive standard VR (group A = 18 subjects) or standard VR plus electronic magnifiers (group = 19 subjects) showed that, at 1 month, group B read faster and was better at two spot reading tasks such as reading continuous print and finding a number in a phone book, but did not differ from the group A in terms of functional capacity or well-being [69].

In another crossover study comparing the near vision activity performance of 84 experienced users of optical aids when using portable electronic vision enhancement systems plus optical magnifiers or optical magnifiers alone, it was observed that, at 2 months, the use of electronic systems allowed longer duration of reading. In addition, participants reported less difficulty performing a range of near vision activities when using these systems and were able to perform more tasks independently [70].

In addition to CCTV systems, these LVAs include the use of head-mounted displays (HMDs) [71], which enhance vision by coupling digital image processing directly to the patient's retina, and the use of portable electronic devices (such as tablets, smart-phones and electronic readers), which combine the portability of hand-held magnifiers with the high-resolution displays of electronic magnifiers (CCTV) and incorporate basic features for handling optical characteristics that can be useful to improve functional measures in patients with AMD, such as image enlargement or contrast polarity [72, 73].

5. Emerging trends in the field

Traditionally, VR in AMD patients includes training in eccentric vision and learning to use different optical and electronic magnifiers. However, some authors have recently studied the effects of new strategies, such as Barraza-Bernal et al. [74], who conducted a study with fifteen subjects with normal vision under simulation conditions, showing that PRL can be induced in a specific area by systematic relocation of stimuli.

Similarly, Morales et al. discuss improving the fixation stability in the PRL through biofeedback fixation training (BFT), which consist of slightly moving the gaze towards the training locus during different sessions [75]. Another training paradigm integrating oculomotor control and pattern recognition has also been evaluated, demonstrating that these strategies combined are capable of inducing a PRL over a short period of time in eight subjects with normal vision and a simulated central scotoma [76].

There are several studies that have been carried out to determine the effectiveness of repetitive, perceptual learning as an intervention approach for VR. This approach refers to the improvement in the execution of perceptual tasks as a consequence of training.

Perceptual learning has been found to have neural correlates in visual cortex, which declines with age. Learning effects in older adults are shown to be less than in younger people and are transferred only for the typeface and the retinal location trained. Causes may be a lower visual base span, decreased attention when exercising eccentricity, and less retention of what is learned over time.

People with AMD have a lower visual span, which contributes to a lower peripheral reading speed. According to Legge et al. [77], peripheral reading speed may improve if the size of the peripheral visual span is enlarged, and training based on letter-recognition trials has shown to extend the visual span, contributing to improve reading speed among older adults [78]. These studies [79] were carried out using trigrams, while Bernard et al. [80] sough to find out if a greater benefit can be obtained by using trigrams based on the most commonly used combinations in the English language, determining that the effects of perceptual learning may not be linked to the type of related letters.

Among several studies that have tried to determine the benefits of perpetual learning, some differentiate the way in which texts are presented. Among those using RSVP, there are differences between the vertical and horizontal presentation of text. For example, Yu et al. [81] found that lower speed in vertical presentation corresponds to a decrease in the visual span for vertical reading.

Chung demonstrated that perceptual learning can improve RSVP reading speed in people with AMD after training [82]. Face discrimination and recognition can also be reliably improved in patients with AMD using perceptual learning on face discrimination tasks [83]. Furthermore, Liu et al. [84], who trained people with severe visual impairment (due to different conditions, including AMD) on a visual search task, observed that both search speed and accuracy of the search improved after training, with the improvements being maintained for a period of time at least one month.

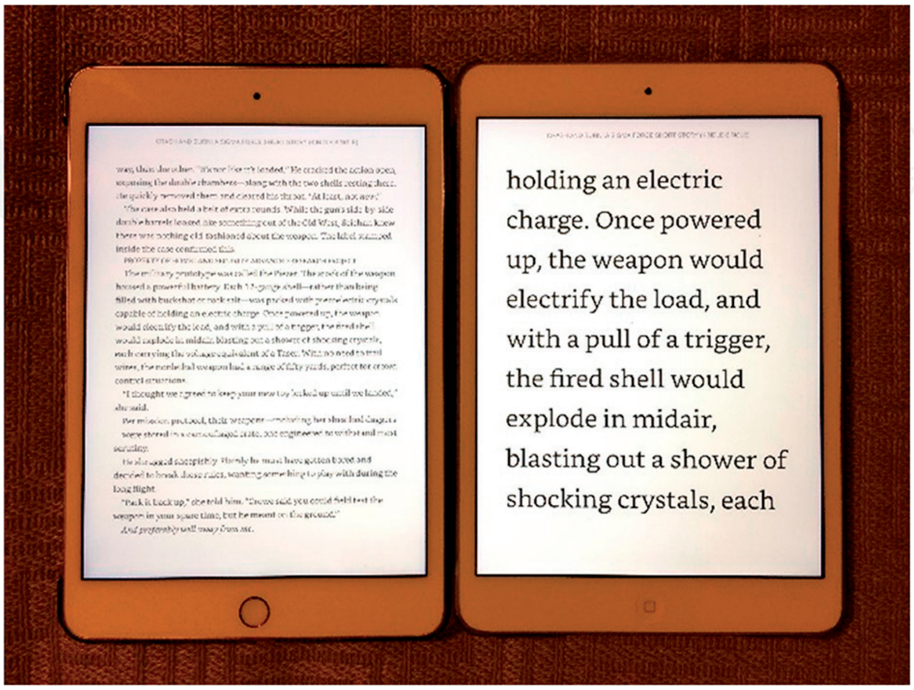
Pijnacker et al. [85] proposed to evaluate whether perceptual learning obtains similar results compared to eccentric vision training and oculomotor training, finding in all these interventions effective methods for reading rehabilitation in AMD patients. On the other hand, Seiple et al. [86] supported the efficacy of ocular movement control over eccentric viewing training and RSVP when compared to people with AMD, which does not imply considering the other methods as ineffective.

6. Modern technologies in VR

Digital technologies have improved reading opportunities for AMD patients, first by transferring the text to video screens where it can be manipulated and, more recently, in digital representations that can be personalized [87].

In this sense, several devices that such as CCTVs, tablets, smartphones, or electronic readers have shown a great potential to improve reading ability in individuals with CFL.

One of these technologies whose effectiveness in improving reading between CFL patients has been clinically proven is the iPad (**Figure 6**). This was demonstrated by a study in which, with the help of the character magnification provided by the iPad, 64 out of 73 patients with AMD (88%) were able to read standard size text (N8) or smaller [88].



holding an electric charge. Once powered up, the weapon would electrify the load, and with a pull of a trigger, the fired shell would explode in midair, blasting out a shower of shocking crystals, each

Figure 6.
Character magnification provided by the iPad [20].

Another study conducted in 100 patients with low vision (of whom 57 had AMD) found that the iPad offers read speed improvement performance comparable to CCTV systems and home magnification devices, making it a less costly and bulky option for visually impaired people seeking VR [89].

Within this line of work, several applications are being developed for implementation on such devices, such as the MD_evReader application, which scrolls text in a single line to improve reading performance by reducing the demands on the eye movement system and minimising the effects of perceptual crowding [90], proving to reduce reading error rates in individuals with CFL [91].

Modern technologies relevant to VR also include HMDs, which comprise a miniature electronic display in close proximity to one or both eyes which causes a highly magnified virtual image of the miniature screen to appear at a comfortable distance for the viewer. At the present moment, these devices have only demonstrated significant improvements in distance and intermediate visual acuity when compared to conventional optical LVAs in patients with AMD [92], but with the rapid evolution of virtual and augmented reality technologies, innovative approaches are making their way in this field.

For example, in a study which tested the effectiveness of a virtual bioptic telescope and a virtual projection screen implemented with an HMD, improvements in functional ability outcomes estimated from visual information, targets difficulty ratings and reading were observed in a sample of 30 patients with AMD and bilateral central scotomas [93].

Other noteworthy technologies in this area include portable artificial vision devices, such as The OrCam MyEye, which employs a miniature television camera mounted on the frame of the spectacles to recognize text, monetary denominations, faces, and other objects if activated by the patient pressing a trigger button, allowing people with visual impairment to understand text and identify objects through audio feedback. The device, which has recently been commercialized, has proven to be an effective tool for different low-vision patients, leading to contrasted improvements in several visual activities even superior to those achieved with previously used optical aids [94].

7. VR for mobility and ADLs

There is little scientific evidence of the impact of the use of eccentric viewing on ADLs and safe mobility. Some researchers have determined that development of PRL can occur naturally and that there may even be several PRLs used by the subject [95].

Vukicevic et al. conducted a study with 48 people diagnosed with AMD, aged 60 or over with visual acuity equal to or less than 20/200 (1.0 LogMAR unit) with the aim of investigating the impact of eccentric viewing training on daily self-care activities. To this end, two groups were formed, of which one received eccentric viewing training while the other did not [96]. The results show that even if the subjects had already established their PRL, the execution of daily life tasks improved.

In the case of ADLs, in addition to eccentric viewing training there are other factors that can significantly affect the performance of ADLs, such as lighting, familiarity with the environment, and contrast in materials and surroundings [97].

Illumination is an important method for improving the use of remanent vision, but there are differences between people as to what they consider adequate or comfortable. This is why specialists have to take into account not only the intensity and type of light, but also the surface on which it is to be applied and its position in relation to the subject, adapting it to the preferred viewing area [98].

In other words, being familiar with an environment, with the organization in space of its elements and the appropriate use of lighting can favor the use of PRL, and, hence, the execution of ADLs in an efficient manner.

Liu reviews interventional therapies to improve ADL performance and highlights that patients with AMD can benefit from vision training and the use of optical AVLs, but they need more than that; such as developing skills, using devices or learning problem-solving strategies, so intervention should be multidisciplinary and carried out in multiple sessions to give people enough time to adapt to new devices and skills [99].

Safe mobility for AMD patients is clearly conditioned by the risk of falls, which in the older population can lead to other serious consequences. Displacement in the elderly population is characterized by the involvement of different factors like balance, hearing, reaction capacity and decision-making. From the perspective of vision, the effects on the visual field, contrast sensitivity or the way in which lighting conditions affect the subject are determining factors in how the person will be able to travel [100]. It can be seen that, once again, there are multiple factors involved in the performance of this activity, which implies a multidisciplinary intervention and training in multiple sessions until adaptation to the new skills is achieved.

It is important to properly assess the visual field and information processing in this area in people with low vision, since the processing itself is more complex in detecting objects in the mobile environment while when using the microperimetry test only simple items are detected [101].

Eye and head searching movements when crossing are more difficult in AMD than in normally-sighted people, and there are no stable patterns as in reading. They also involve decision making such as the right time to cross, where the speed of walking among other aspects is crucial for safe movement and good decision making. To this must be add that, as mentioned, the ability to react in older people is diminished. Geruschat et al. confirms that patients with AMD present a higher risk due to increased latency when identifying the right moment to cross a street [102].

The optical devices that patients with AMD mainly use for mobility are telescopes; so are the filters as mentioned above. As for other activities, training and perceptual learning are presented as a decisive factor for the successful rehabilitation of patients with the aim of safe movement.

8. Conclusions

Although most researchers usually focus on studying eccentric viewing training in individuals with AMD, mainly for reading purposes, it cannot be forgotten that there are many aspects that explain visual functioning for any task. Therefore, research in VR has to consider the multifactorial intervention of characteristics such as the use of eccentric viewing training, the effect of crowding, the improvement of certain visual skills thanks to training during a certain period of time, as well as that of other factors that, although they are currently being studied in depth by authors such as Chung, still need more information to understand their real importance in VR.

Although there are few studies on the transfer of learning and training for reading to other ADLs and mobility, it can be said that visual training guarantees improvements in visual functioning for reading and other tasks, like face discrimination, recognition.

In addition to perceptual learning, oculomotor control and eccentric viewing training, other strategies that may improve reading ability in AMD patients include environmental changes (such as better lighting) and the prescription of filters and optical LVAs, such as high-plus reading lenses and different magnifiers (including clip-on, hand-held, or stand devices). Furthermore, many patients can also benefit from the use of electronic reading aids, including tablets, smartphones, electronic readers, HMDs or CCTV systems.

The widespread presence of accessible portable devices and software has led to a breakthrough in access to information and travel assistance for people with low vision. Some studies are therefore looking at the evidence for the use of such digital devices by the population, in contrast to the use of optical aids.

In fact, there is no such dilemma, because, as initially discussed, AMD patients are increasingly demanding a wider and more varied range of objectives to meet their needs, and the availability of a wider range of resources is only intended to meet these demands.

On the other hand, there are multiple factors involved in the visual skills that a person with AMD must perform, so a greater variety of resources offers the possibility of finding those best suited to their visual conditions.

Conflict of interest

The authors declare that there is no conflict of interest on the devices or technologies described in this chapter.

Abbreviations

ADLs	Activities of Daily Living
AMD	Age-Related Macular Degeneration
BCVA	Best-Corrected Visual Acuity
BFT	Biofeedback Fixation Training
CCTV	Closed-circuit Television
CFL	Central Field Loss
CNV	Choroidal Neovascularization
GA	Geographic Atrophy
HMDs	Head Mounted Displays
IMTs	Implantable Miniature Telescopes
LCD	Liquid-Crystal Display
LVAs	Low-Vision Aids
PRL	Preferred Retinal Locus
QoL	Quality of Life
RPE	Retinal Pigment Epithelium
RSVP	Rapid Serial Visual Presentation
VEGF	Vascular Endothelial Growth Factor
VR	Visual Rehabilitation
WHO	World Health Organization

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