Optical Low Vision Hardware, what's currently available

Abstract

Despite recent advances in electronic low vision aids and technology, such as tablet computers, optical low vision aids remain the most commonly prescribed aids in low vision clinics across the United Kingdom. Apart from the obvious advantage that a majority are available at no charge to the patient on extended loan from the National Health Service (NHS), there is support from the literature suggesting that optical aids improve reading ability and quality of life. There are several different types of optical aids available for the low vision practitioner to prescribe and these fall into various different categories: magnifiers, which include hand and stand magnifiers; spectacle magnifiers, which include high dioptric power reading glasses or near adds in bifocal glasses (above +4.00 D); telescopes or binoculars; and prisms for expansion of the field of vision. This article aims to apprise the practitioner of recent advances linked to optical low vision aids, mainly from these four categories, and the advantages and disadvantages of each.

Summary

Despite recent advances in technology, optical low vision aids remain the most commonly prescribed aids in low vision clinics. There are several different types of optical aids available for the low vision practitioner to prescribe and these fall into different categories: magnifiers, which include hand and stand magnifiers; spectacle magnifiers, which include high dioptric power reading glasses or near adds in bifocal glasses (above +4.00 D); telescopes or binoculars; and prisms for expansion of the field of vision. This article aims to apprise the practitioner of recent advances linked to optical low vision aids mainly from these four categories and the advantages and disadvantages of each.

Learning objectives

- To gain an understanding of the advantages and disadvantages of commonly prescribed optical low vision aids
- To gain an understanding about recent developments in optical low vision aids

Authors clinical/research role in relation to the topic of the paper

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Introduction

Despite recent advances in electronic low vision aids and technology such as tablet computers optical low vision aids remain the most commonly prescribed aids in low vision clinics around the United Kingdom. Apart from the obvious advantage that a majority are available at no charge to the patient and on extended loan from the National Health Service (NHS), there is evidence from the literature suggesting that these aids improve reading ability. Margrain (2000) investigated the effectiveness of optical low vision aids in improving reading ability in a low vision clinic and found that prior to providing the aids, 23% of patients were able to read newspaper print (N8) whereas afterwards 88% of patients were able to read N8 or smaller text. Other studies (Virgili et al, 2013; DeCarlo et al, 2012) have also found optical low vision aids to be beneficial for visually impaired adults.

There are several different types of optical aids available for the low vision practitioner to prescribe and these fall into various different categories: magnifiers, which include hand and stand magnifiers; spectacle magnifiers, which include high dioptric power reading glasses or near adds in bifocal glasses (above +4.00 D); telescopes or binoculars; and prisms for expansion of the field of vision (Table 1). Although filters to reduce glare are optical aids, they will not be reviewed in this article. Instead we will mainly focus on the categories described above and seek to apprise the practitioner of recent advances linked to these aids. It should be noted that nearly all of the aids described in this article should be available on extended loan through the NHS commissioned services., However, there is some variability depending upon the location of the clinic and clinical commissioning group the clinic comes under.

Hand Held Magnifiers

Hand held magnifiers are the most familiar of all low vision aids. They are frequently prescribed in the low vision clinic and have been reported to account for approximately 40% of low vision aids supplied (Margrain, 2000). They can be illuminated or non-illuminated and dioptric powers available range from as low as +6.00 D to approximately +56.00 D in steps of + 4.00 to +10.00 D depending on the manufacturer. Hand held magnifiers are extremely versatile and have several advantages such as availability in different sizes including pocket versions, are relatively inexpensive, can be used at any distance from the eye and in lower powers have a reasonably good field of view. One of the major disadvantages is that for higher powered lenses the field of view reduces rapidly and users need a steady hand and ability to maintain a fixed working distance. Modern Illuminated hand magnifiers predominantly use LEDs as the light source and as a result battery life is greatly improved with some manufacturers claiming a battery life of approximately 50,000 hours. Illuminated hand held magnifiers are now available with light sources of different colour temperature ranging from 2000K-8000K (see for example the Okulux plus Mobil range, Schweizer (Forchheim, Germany) and Powerlux range, Eschenbach (Nuremberg, Germany)) allowing practitioners and patients to choose the colour temperature that are best suited to the user's needs. In fact Wolffsohn et al (2012) suggest that practitioners should offer a range of colour temperatures to all visually impaired people to optimise the benefits of these devices. Some manufacturers (see for example Mobilux LED range, Eschenbach) offer filters that can be attached to the LED light (Figure 1) on the magnifier to achieve comfortable light intensity and colour temperature. Hand held magnifiers are also available (see for example the ERGO-Lux MP Mobil, Schweizer) that have two brightness levels, which allows patients to adjust the colour temperature according to their needs and the environment. The magnifier also has an audible switch that helps patients determine when the magnifier has been switched on/off. This is an advantage as not all users recognise when their magnifier is off/on and the audible signal helps reassure the user that the magnifier is switched off. Hand held magnifiers are also available

(see for example Powerlux, Eschenbach) that automatically switch off after 30 minutes, conserving battery life.

The ergonomics of hand held magnifiers have also been greatly improved (see for example ERGO-Lux MP Mobil, Schweitzer and Mobilux LED range, Eschenbach) and allow both right and left handed individuals to use the magnifier effectively by providing a good grip. Many hand magnifiers can readily be converted into stand magnifiers by using a special base that the hand magnifier slots into. For example the ERGO base (Schweizer) (Figures 2a and b) converts the ERGO-Lux MP hand magnifier into a stand magnifier. Similarly the Mobase (Eschenbach) (Figure 3a and b) allows the Mobilux LED hand magnifiers to be converted into stand magnifiers.

Pocket magnifiers deserve a mention as they can be useful for individuals when they go outdoors and do not want to carry their regular low vision aids with them because of size. A large variety and powers of pocket magnifiers are available with some of the lower powered ones, such as the easyPOCKET (Eschenbach) and Optima Go LED (Optima, Totnes, Devon, UK), offering illuminated options. The easyPOCKET magnifier uses a diffractive aspheric lens and is in the format of a credit card. The XL version, which is marginally larger than the standard one, can also be used as a stand magnifier by using the flexible stand built into the magnifier (Figure 4).

Stand mounted magnifiers

Stand mounted magnifiers are also very popular and many of the developments described above, such as availability in various colour temperatures (Figure 5), ability to auto switch off after 30 minutes and improved ergonomics, apply to them. Similar to hand held magnifiers, they come in a range of powers and can be illuminated (battery operated) or non-illuminated. Perhaps one of the biggest advantages of stand magnifiers is that the distance between the lens and the task is fixed, which may be useful for people who are unable to use their hands, have poor or uncontrolled grip, or hand / body tremor. Stand magnifiers are also useful in young children when the concept of focus is less familiar but they have good accommodation making it easier for them to use these magnifiers. Additionally stand magnifiers offer users a hands-free option in lower powers allowing them to carry out tasks underneath the magnifier. The biggest disadvantage is that they can be bulky and can sometimes be tricky to prescribe because of the need for an appropriate reading addition whilst using them.

Bar and bright field (dome) magnifiers are a type of stand magnifier and are particularly popular with children in the low vision clinic because of their cosmetic appeal (Charlton et al, 2011). They are available in various diameters (bright field) and lengths (bar and bright field) and some of them feature a guiding line to help with reading. The main advantage of bright field magnifiers is that they have good light gathering properties. The main disadvantage is that they are only available in low magnifications and do not allow access to material underneath the magnifier. It is however possible to combine bright field or bar magnifiers with others forms of magnification such as high reading additions. Some bright field magnifiers such as the Menas Zoom (Eschenbach) (Figure 6) have a zoom option, which allows the magnification to be adjusted, in the case of the Menas Zoom from 2.2-3.4X. Others such as the Makrolux (Eschenbach) incorporate a bright LED light, with an automatic light-off function after 30 minutes, allowing for greater illumination of the reading material, which can be beneficial for some patients.

Spectacle Magnifiers

Several different types of spectacle magnifier are available to the low vision practitioner and they may be monocular or binocular, spherical or aspheric, single vision, bifocal or multifocal. The main

advantages of these types of magnifier are that they are cosmetically acceptable, hands free and allow for a larger field of view than hand or stand magnifiers. The main disadvantage is their short working distance and for higher powered magnifiers, the inability to maintain binocular vision. In such cases the practitioner should consider occluding the patient's non-dominant eye. One of the most commonly available and successfully prescribed spectacle magnifiers are prismatic half eye spectacles. These are available from several manufacturers such as COIL (Buckingham, UK), Optima and Eschenbach and are available in powers ranging from +4.00 D to +14.00 D typically in steps of +2.00 D. Base in prisms are added to encourage binocular vision and range from 5 to 16 Δ depending on the power of the spectacles. Eschenbach Noves Bino range (Eschenbach) magnifiers are lightweight and utilise diffractive optics which gives them good cosmetic appearance. Although high powered bifocals are not commonly prescribed in the UK they should be kept in mind. They are available from several manufacturers such as Norville and Zeiss and depending on the spectacle prescription, additions can be available up to +25.00 D (For example Norlite Round 22mm lenticular, Norville). Practitioners should also bear in mind that Franklin split bifocals can in theory be made up to any power. It is also worthwhile considering the UniVision hyperocular system (Eschenbach), a versatile magnifying system that can easily be put together in the low vision clinic. This system (Figure 7) has a lens diameter of 22mm and is available in powers ranging from +6.00DS to +36.00DS (Eschenbach). The lenses can be mounted easily onto spectacles using an adhesive tape ring, allowing for any prescription to be included into the magnifying system.

Hyperocular lenses are aspheric, high powered lenses and are available ready glazed in full aperture or half eye frames from a number of manufacturers such as COIL UK and Eschenbach with powers ranging between +12.00 D to +48.00 D. The lens is ready glazed either in the right or left eye piece (with the other eye frosted) or in both eye pieces depending on the power of the lens and the manufacturer. Similar to high powered bifocals these are not commonly prescribed because of the reduced working distance but they can be useful for certain patients particularly if a hands free option is required.

Spectacle mounted reading aids can sometimes be useful. These aids can either be clipped onto a pre-existing spectacle frame (see for example laboCLIP, Eschenbach) (Figure 8a) or they can be used with a customised frame (see for example laboMED, Eschenbach) (Figure 8b) allowing them to be worn by patients with or without spectacles. Both binocular and monocular options are available and lenses can easily be interchanged or flipped up when not required. The main advantage of these aids is that they provide a more comfortable working distance even at higher magnifications. Binocular versions are available with magnification from 1.7X-3X and monocular versions are available in 4X and 7X magnification.

Telescopes

A large variety of telescopes are available from several different sources including specialist low vision companies. These include Astronomical (Keplerian) or Galilean, monocular or binocular, distance, intermediate or near, variable or fixed focus, manual or auto focus telescopes. Telescopes can either be hand held (with or without a finger ring) or spectacle mounted although the spectacle mounted options tend to be suitable for lower magnifications up to approximately 6X due to issues with weight. A good range of magnifications are also available for practitioners to prescribe, ranging from approximately 2x to 12x magnification. The main advantages of telescopes are that magnification can be achieved for remote objects such as train departure boards and several telescopes can be focused to achieve magnification at different distances. They can also be used for education including access to interactive boards, lectures/presentations, notice boards and displays The main disadvantages are that the fields of view of telescopes are small particularly at higher

magnifications, they cannot be used continuously whilst mobile due to safety issues and the users require training before they can be used successfully. They can be conspicuous. Although in theory telescopes appear to be a good option, they are frequently not supplied because of the disadvantages mentioned above. Additionally, many practitioners and patients often focus on reading tasks and access to distance magnification may be neglected or offered in hindsight

Lowe and Rubinstein (2000) found that telescopes were dispensed at a rate of 5.3% (of all LVAs) over a 9 year period in a hospital low vision clinic in Nottingham. A slightly higher rate of dispensing of 15% (of all LVAs) was found for the Welsh low-vision scheme (Court et al. 2011). Of all the telescopes available, the most frequently prescribed in the low vision clinic are those with low magnification (2 to 2.5X) that can be used to watch television and events such as theatre and sports. These include but are not limited to MaxTV and Event (Eschenbach) and Optima TV (Optima). These are binocular telescopes with a good range of PD tolerance and dioptric compensation of approximately +/- 3.00 D. Eschenbach have recently introduced the MaxTV clip (Figure 9a), which can be attached to a patient's current prescription and can be flipped up when not in use. This can be very useful for patients who have significant refractive errors. The MaxDetail system is also very useful and has a working distance between 35-40 cm for close work. It is available both as a spectacle mounted or clip on version. All the Eschenbach Max aids can be used with a small clip on headlight LED (Figure 9b), which can be particularly useful if extra illumination is required. Another low magnification telescope that is sometimes prescribed is the Galilei 2.0 GF (Eschenbach), which is a monocular fixed focus light- weight telescope with a field of view of 22 degrees. The working distance and magnification can be altered by using appropriate reading caps ranging in power from +3.00 to +12.00 D. These can be flipped out of the way without being removed. The ML focus (Multilens, Mölnlycke, Sweden), available through Fife Society for the Blind, Fife,UK, should also be considered as it offers a good field of view with magnification ranging from 1.6x-2.4x.

Many manufactures such as Keeler, Eschenbach and Multilens offer the option of mounting telescopes either onto a system carrier frame for patients with insignificant prescriptions or onto the patient's own glasses if the patient has a significant prescription using specialist fitting and mounting kits. In some cases this can be carried out in a clinic without glazing facilities using specialist adaptors that can be affixed to the lens surface with adhesives. For example the Eschenbach telescope mounting adapter 627-03 (Eschenbach) allows Galilean monocular telescopes Galilei 2.2x, 2.5x and 2.0 GF to be mounted in this fashion. The manufacturer states that the system is suitable for most single vision spectacle lenses.

In the moderate to high magnification telescopes (~4x or greater), practitioners should consider Keplerian systems with adjustable focus available from a variety of manufacturers such as Schweizer, Carson (New York, USA) and Eschenbach. It is possible to 'lock' the focus of some variable focus telescopes so that they can either become fixed focus or their focusing ability can be limited to a small range. In the Schweizer system this is achieved either by using a focus stop ring or by locking the screws in the housing system. This can be helpful for individuals who find adjusting telescopes difficult but need a high magnification telescope that is only available in the variable focus variety. Other monocular telescopes which practitioners may want to consider prescribing because they are reasonably compact and can focus from intermediate to far distances are the Eschenbach's club M (available in 6x-8x magnification) and Start Monofold 8x21 (available in 8X magnification). Many patients also find Eschenbach's Microlux (Figure 10) very useful due to its compact size, although it is fixed focus for distance. It is available in magnifications of either 4x or 6x. Binoculars are also available, (for example Carson Tracker and Scout Plus, Optelec UK (Watford, UK)), although these are not prescribed as often as monocular telescopes except for the ''TV'' variety described above. They

can be useful for patients who have approximately equal acuities in both eyes or for patients with nystagmus. Children and young people may also benefit from the prescription of binoculars as often these devices require less fine- tuned fine motor skills and combat difficulties with some of the issues with the concept of focus. They may also be useful for adults who have difficulty with fine motor skills and grip.

Bi-optic systems utilise telescopes and are another option that are available to low vision practitioners. In certain countries, but not in the UK, these systems allow users to drive (Luo and Peli 2011). A bi-optic system consists of a compact telescope that is mounted within a spectacle lens and is positioned above the user's visual axis and angled upwards. These telescopes are only available privately in the UK and are not available via the NHS. Commonly prescribed Bi-optics in the UK include Ocutech (VES-K, sports and mini) and Designs for Vision (wide angle and standard) which are available in either a manual or fixed focus version. Magnifications typically range from ~2X-6X. Autofocus telescopes such as the Ocutech VES Autofocus (4X) are also available that allow for automatic focusing using an infra-red pulse. This can allow continuous focusing at a variety of different distances. It should be noted that the Ocutech VES Autofocus is currently being re-designed and is therefore currently not available. For a detailed review of bi-optic telescopes the reader is referred to an article by McClure (2013).

Implantable ocular telescopes are also available, although these are not available from the NHS and because surgery is required they cannot be dispensed by an optometrist. It is still worthwhile knowing about these aids as they are sometimes reported in the media and patients may enquire about these devices. There are currently 3 types of implantable intraocular telescopes available for use, all of which are for the anterior segment (Singer et al, 2011). These include the Implantable Miniature Telescope (IMT, VisionCare Ophthalmic Technologies, Saratoga, CA) (Hudson et al, 2006), the IOL-VIP system (IOL-VIP system, Soleko, Pontecorvo, Italy) (Orzalesi et al, 2007) and the Lipschitz Mirror Implant (LMI, Optolight Vision Technology, Herzlia, Israel) (Agarwal et al, 2008). The IMT system is an all in one system, which incorporates wide angle micro-optics that together with the cornea, functions as a fixed focus telescope. It is able to produce magnification ranging from 2.5-3X with a field of view of approximately 20 degrees. The IOL-VIP system uses two IOLs that act as a Galilean system, a high minus IOL in the lens bag and a high plus anterior chamber IOL. The system is able to produce magnification of approximately 1.3X. The LMI system is a modified conventional IOL that follows the Cassegrain telescopic configuration, using two miniature mirrors. The system is able to produce a magnification of 2.5X. Of the three telescopes, only the first two (IMT and VIP-IOL system) are available in the UK to our best knowledge. The main advantages of these devices are that they offer a large field of view, they are not limited by head and eye movements and offer excellent cosmesis. An American study looking at the human value gain and cost effectiveness of implantable telescopes in end stage age related macular degeneration (AMD) found a 12.5% quality of life gain over 12 years. They concluded that therapy with the telescopes considerably improves the quality of life and is cost effective by conventional measures (Brown et al, 2011). The main disadvantages are that surgery is required, they only offer low magnification, are fixed focus, expensive and not available from the NHS commissioning bodies. The effectiveness of these devices has not been tested using randomised clinical trials (RCTs). Most published research studies relate to the IMT device and conclude that the IMT telescope improves quality of life and visual acuity in individuals with AMD (Boyer et al, 2015). Research studies are limited for the other devices and mostly consist of case studies. The lack of RCTs and the need for careful patient selection for these devices means that low vision practitioners should be cautious about recommending them.

Prisms for visual field expansion

Prisms have been used for some time to help in the management of field loss such as hemianopia. They can work in two ways by either relocating the field of view or expanding the field of view. Sector prisms are most commonly used to help in hemianopia where the prism is placed in the sector corresponding to the field loss. The prisms have no effect when the patient is looking through the non-prismatic part of the lens since the prisms and their effect falls within the scotoma. To gain any benefit, the patient has to make intentional scans to use the prisms since they are normally unaware of this section of their visual field. It should be noted that a similar benefit could be achieved by larger head movements. Monocular prisms can avoid some of these disadvantages by placing a sector prism in front of one eye. When using the sections of the spectacle lens not involving the prism, there is no effect on the field of view. However, when gaze is directed through the monocular prism, confusion and diplopia occur since different images are evident for the same gaze direction. Although this can be alleviated for primary gaze by removing a small area of the prism, it fundamentally fails to solve the problem (Peli, 2000). Peli built on these ideas to develop a peripheral monocular prism design, which exploits the fact that physiological diplopia is rarely noticed in the periphery because of lack of attention to peripheral objects. The prisms are placed on one spectacle lens superiorly and inferiorly with a clear section of the carrier lens available horizontally and including the primary gaze position. The base of the prism is directed towards the field loss and the effect is to shift the image of objects in the superior and inferior field from the blind field towards the seeing field. If an object of interest becomes visible in the upper or lower visual field, the patient is instructed to use vertical head movements to bring it into the carrier section of the lens. Binocular field expansion of about 20 degrees can be expected by using 40Δ prisms and 30 degrees using a 57Δ (Bowers et al, 2012). Temporary prisms (40Δ) can easily be fitted in a low vision clinic using either standard Fresnel prisms, (which need to be sized down), available from a variety of sources such as Haag Streit (Haag Streit, UK) or customised Fresnel prisms, (which do not need to be sized down), available from Chadwick Optical. Patients should be trained appropriately and carefully selected to ensure success. It is advisable to select patients with visual acuity better than 6/15, with no visual neglect (attention disorder that prevents the patient from attending to stimuli on one side), seizures or balance problems. If patients are successful with temporary prisms, permanent prisms can be considered (Figure 11). These are available in 40Δ and 57Δ□□□□□can be sourced from either Chadwick Optical (US based) or Fife Society for the Blind (UK based, only 40Δ available). Practitioners should bear in mind that customs duty will normally need to be paid for any prisms ordered from outside the UK, there may be issues with CE marking on permanent prisms and that usually only temporary prisms are available through NHS commissioned services; patients will need to pay for permanent prisms themselves. Approximately 47% of individuals fitted with Peli prisms find them useful and continue wearing them for a period of at least 12 weeks or more post dispensing (Bowers, 2008). Although peripheral prisms are predominantly fitted horizontally, permanent oblique prisms (57Δ) may also be considered. There is some evidence that the use of oblique prisms may improve blindside hazard perception without affecting other features of driving performance. However, the authors of this study noted the lack of evidence for the effectiveness of oblique prisms (Bowers et al, 2012). Prisms have also been suggested as a way of encouraging eccentric viewing in AMD by relocating the retinal image away from the scotoma on to a preferred retinal location. E-Scoop lenses have recently been introduced in the UK (Norville website) and are essentially prismatic tinted glasses. Currently there is limited evidence to suggest that prisms are beneficial to patients with AMD. A randomised controlled trial by Smith et al (2005) found that prisms are no more effective than conventional glasses in AMD.

In summary there are a variety of optical low vision aids available to the low vision practitioner. Although many of these low vision aids have been available for a long time, advances in technology mean that a great majority of these modern aids are more compact, have better ergonomics and offer a better field of view than their predecessors. Although major advancements have been made in electronic low vision aids and mainstream technology such as tablets, which also benefit individuals with visual impairment, optical low vision aids continue to play an important role in the management of people with - .

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