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Reducing vision loss in chronic eye disease

Background
Ocular disease in its early stages may be asymptomatic and insidious. Three of the leading causes of visual loss are cataract, age related macular degeneration and glaucoma.

Objective
This article discusses the presentation and treatment options for, and the management of, cataract, age related macular degeneration and glaucoma.

Discussion
Few primary prevention strategies are available as these ocular diseases are degenerative. The focus for reduction of visual loss is early detection and regular ophthalmic examination. The aim of management is to improve or maintain vision so as to preserve patient quality of life.

Vision loss can be defined in two categories of severity: 'legal blindness' and 'visual impairment'. Legal blindness is defined as 'a visual acuity (VA) worse than 6/60 and/or a visual field of <10 degrees in the better eye'. Visual impairment is defined as 'a VA worse than 6/12 and/or a visual field of <20 degrees in the better eye or a homonymous hemianopia'.[1]

In 2004, vision impairment and blindness affected almost 500 000 Australians at a cost of $9.85 billion.[1] This figure will continue to rise as the population ages. The number of Australians over 65 years of age has more than doubled since 1965, reaching 2.7 million in 2006 and representing an increase from 8.4 to 13% of the population total.[2] Furthermore, the average life expectancy of Australians is 81.4 years, second in the world only to Japan. Given these trends, it appears inevitable that the burden of visual loss faced by society will increase.

In Australians aged over 40 years, the most common causes of visual impairment are refractive error, cataract, age related macular degeneration, glaucoma and diabetic retinopathy. These five causes account for 91% of visual impairment and 88% of legal blindness.[1]

Cataract

Cataract is defined as an 'opacification of the crystalline lens within the eye'. The prevalence of cataract rises from about one in 5 in the 65–74 years age group to about three in 4 in those aged over 85 years. Cataract extraction is the most common ophthalmic surgery.

Cataract may present with loss of visual acuity, loss of contrast sensitivity (especially with reading), glare (especially around lights at night) and/or monocular diplopia (*Figure 1*). In general terms, cataract may be classified according to aetiology into primary (congenital and age related) and secondary forms (caused by trauma, medication use such as corticosteroids, and systemic disorders such as diabetes mellitus, irradiation and ocular inflammation).

A number of grading systems for the severity of cataract have been described, including the Lens Opacities Classification System and the Oxford Clinical Cataract Classification and Grading System.[3] In clinical practice, different patterns of cataracts are found: cortical (*Figure 2*); nuclear, graded from early (1+) to advanced (4+) (*Figure 3*); and posterior subcapsular (*Figure 4*). The type of cataract does not usually improve the way the cataract surgery is performed (except in very advanced forms of cataract).

Most epidemiological data on cataracts stem from three large cross sectional studies conducted in the 1990s – the Blue Mountains Eye Study, the Melbourne Visual Impairment Project and the Beaver Dam Eye Study. Apart from increased age, the other known strong association lies between ultraviolet B exposure and the development of cortical cataract. Only a weak association has been found between smoking and nuclear sclerosis. It is well known that corticosteroid use, diabetes mellitus and trauma are associated with posterior subcapsular cataract formation.

Prevention strategies are listed in *Table 1*.

Figure 1. A patient's view through a moderate cataract. Colours are faded and adopt a yellow-brown hue. There is loss of contrast and acuity

Figure 2. Slit lamp photograph showing cortical cataract changes. Note the wedge shaped or spoke-like shadows involving the whole lens

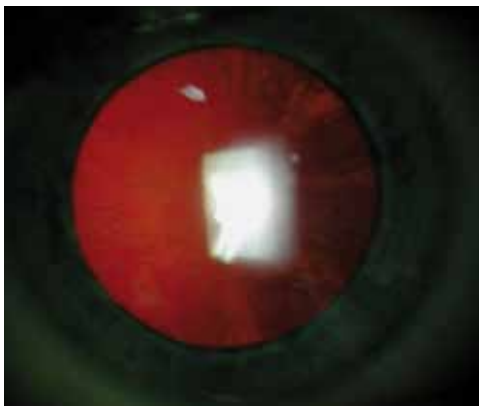


Figure 3. Slit lamp photograph of advanced nuclear sclerosis. As the light beam passes through the eye (left to right in this photograph), reflections are seen from the cornea, iris and the lens. Note the yellow-brown colour of the lens that reduces vision

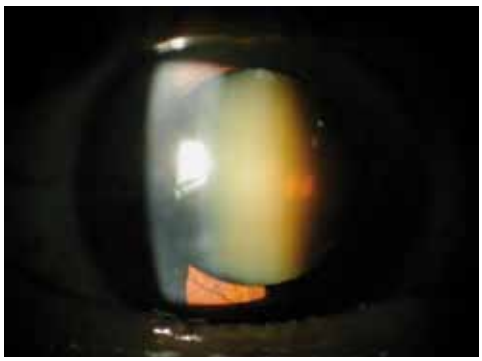
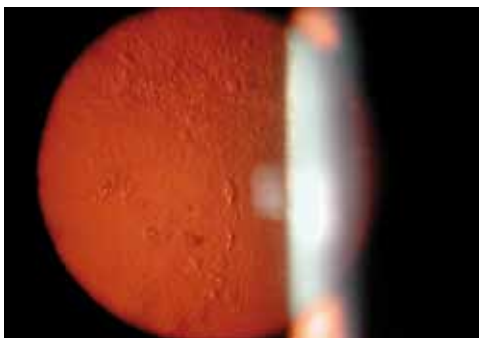


Figure 4. Slit lamp photograph under high magnification showing a bright red reflex marred by posterior subcapsular cataract. Note the granular appearance with some cystic changes when the slit lamp is focused on the posterior capsule



Treatment

Surgery is the only treatment option for cataract. Indications for surgery are:

- significant functional visual impairment
- advanced cataract that poses a high risk of secondary complications such as lens capsule rupture and corneal decompensation
- if cataract extraction will aid in the management of ocular comorbidities, in particular, narrow angle glaucoma and retinal disease.

Over the past 20 years, cataract surgery has evolved from wide incision intracapsular extraction to small incision extracapsular extraction with ultrasound (phacoemulsification) and intra-ocular lens implant insertion (*Figure 5*). Success rates for visual improvement are over 98%.

Table 1. Prevention strategies for cataract

Primary prevention strategies

- Protection from UV exposure – the wearing of hats and sunglasses may prevent the development of cortical cataract, although cortical cataract is the least visually debilitating
- The role of antioxidants in preventing cataract formation is being investigated, with some trials having positive results,[5] and others negative results[6–8] depending on the formulations used

Secondary prevention strategies

- Early detection may not necessarily prevent any morbidity as this may not translate to early surgical removal
- Regular screening of the elderly population (recommended every 1–2 years) will prevent visually significant cataract from passing undetected[1]

Age related macular degeneration

More than half of visual blindness in Australia is attributable to age related macular degeneration (ARMD). It is the leading cause of legal blindness in developed countries.[1,4] The aetiology of macular degeneration is largely unknown, although current theories suggest that photo-oxidative stress is a key process involved in its development. Age related macular degeneration is characterised by progressive loss of central vision. The prevalence of ARMD rises sharply with age. There are two distinct types of ARMD: 'dry' and 'wet' forms. In dry ARMD (85–90% of cases) (*Figure 6*), gradual degeneration of the retinal pigment epithelium (RPE) underneath

the macula results in the step wise degradation of vision over many years. The RPE undergoes mixed atrophy and hypertrophy, and end stage disease is clinically described as 'geographic atrophy'.

Wet ARMD (10–15% of cases) (*Figure 7*) refers to the development of a choroidal neovascular membrane underlying the RPE. Leakage of fluid from new vessels into or under the retina causes distortion of the photoreceptor alignment, with an accompanying precipitous drop in VA. End stage disease is characterised by contraction of the fibrovascular membrane and the formation of a disciform scar. The conversion of dry to wet forms is about 2% per year. Early ARMD is asymptomatic. Distortion and/or scotomata in the central vision (*Figure 8*), along with reduced visual acuity, are late symptoms of disease. Fortunately, peripheral vision, and hence independent living, is generally preserved.

A diagnosis is made on clinical appearance of the retina. Fundus fluorescein angiography and optical coherence tomography (*Figure 9a, b*) aid in the evaluation of choroidal vasculature and the extent of fluid leakage. Prevention strategies are described in *Table 2*.

Treatment

There are currently no treatment options available for dry ARMD. Patients may benefit from a healthy diet rich in omega-3 fatty acids, vitamin supplements, and the avoidance of smoking. The treatment for wet ARMD is aimed at preservation of vision rather than cure. Early detection of the conversion from dry to wet forms, or the progression of wet ARMD, is crucial for preservation of vision. In the past, focal laser applied to areas of neovascularisation was the only available treatment. More recently, intra-ocular injections have become widely used in the treatment of ARMD. The Australian government now subsidises the use of ranibizumab for wet ARMD demonstrable on fluorescein angiography (under select criteria).

Figure 5. Slit lamp photograph under high magnification showing the intra-ocular lens implant postcataract surgery. The intra-ocular lens lies within the capsular bag, the anterior rim (a) of which can be seen as an irregular circular line within the intraocular lens edge

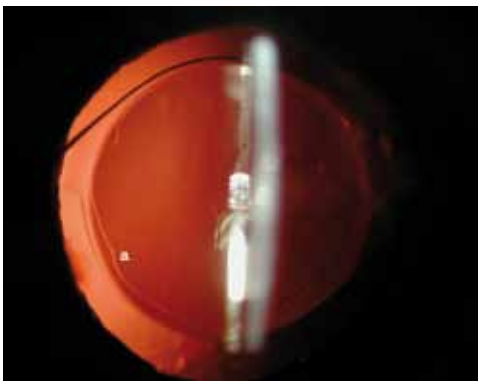


Figure 6. Fundus photograph of the left eye. Drusen (lipofuscin deposits under the retina) (a) are seen as distinct yellow lesions scattered within the macular region. These occur as the retinal pigment epithelium (most posterior layer of the retina) undergoes degenerative change

Figure 7. This fundus photograph demonstrates the wet form of macular degeneration. There is an intraretinal haemorrhage (a) at the fovea and an area of subretinal fluid; leakage from a choroidal neovascular membrane (b); and underlying drusen (c)

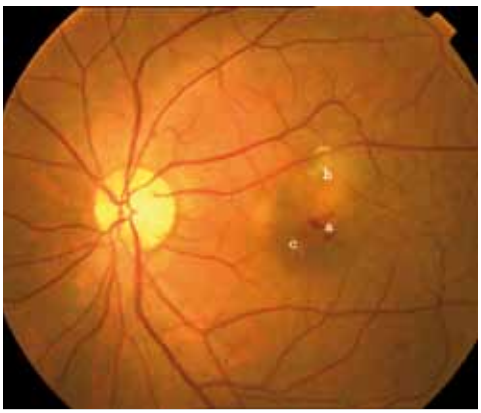


Figure 8. Simulated view of a patient with advanced wet ARMD. There is a central scotoma with surrounding metamorphopsia (distortion of vision). Peripheral vision is normal

Glaucoma

Glaucoma affects 2–3% of the population aged over 40 years (and it is suspected that there are many more patients that remain undiagnosed). Glaucoma is a chronic progressive form of optic neuropathy with characteristic visual field (VF) loss (*Figure 10*) and optic nerve changes (*Figure 11*) often associated with raised intra-ocular pressure (IOP). In simplified terms, glaucoma may be understood as an IOP that is too high for the mechanical structure of the eye.

There are many categories of glaucoma including:

- primary open angle glaucoma – this is the most common form of glaucoma characterised by raised IOP with VF and optic nerve changes (*Figure 11*) in the presence of a open drainage angle of the eye and the absence of underlying ocular pathology
- narrow angle glaucoma – this occurs when the outflow of aqueous fluid from the eye is impeded by an anatomically narrow drainage angle
- secondary glaucoma – these glaucomas arise secondary to an underlying disease process (eg. inflammation, trauma, pigment dispersion, pseudoexfoliation, haemorrhage, neovascularisation)

- acute angle closure glaucoma is a syndrome that occurs when the drainage angle is acutely occluded. It may be associated with some structural characteristics inherent in the eye (eg. narrow angles or iris plateau syndrome), or with some of the causes of secondary glaucoma. This condition causes acute vision loss rather than chronic vision loss.

The symptoms of glaucoma depend on the degree and rate of rise in IOP. Primary open angle glaucoma patients may not notice vision loss

Figure 9A. This black and white fundus photograph is part of a series of photos taken during a fundus fluorescein angiogram (FFA). In the late stage of FFA, a bright hyperfluorescence (a) may be seen, representing leakage from the choroidal neovascular membrane. The retinal vessels (b) appear dark after the bolus of fluorescein has passed through the circulation. Multiple drusen (c) fluoresce lightly with fluorescein as well. Figure 9B. This is the corresponding optical coherence tomography scan of the retina in Figure A. The appearance is of a cross section of the retina, displaying a number of retinal layers. The foveal pit would normally lie in the center of the image (d). In this case, intraretinal fluid (e) has raised the contour of the retina. The hyaloid membrane (f) of the posterior vitreous is also seen

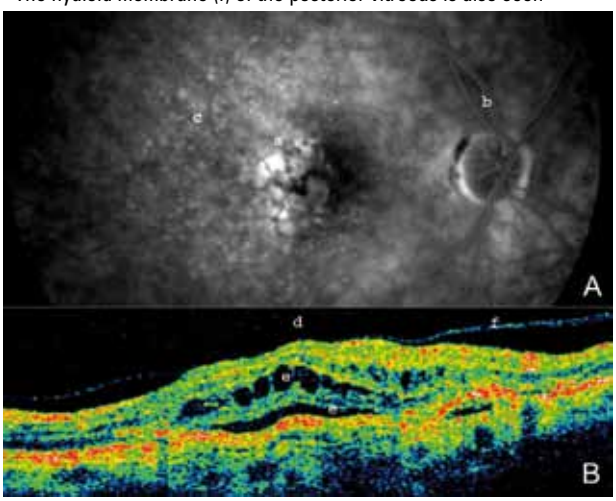


Figure 10. This greyscale image represents the visual field, as measured by a Humphrey Visual Field Analyser, of the left eye in a patient with advanced glaucoma. It is divided into quadrants centred on the fovea (a). This test measures the visual field out to 24 degrees from fixation in all quadrants and to 30 degrees nasally. Each division of the scale represents 10 degrees of visual field. The anatomical blind spot (b) is seen to the left of fixation. An inferior arcuate scotoma (c) is demonstrated with a characteristic nasal step (d). The scale denotes the p values of the patients measured threshold of vision (in dB) compared to age matched normal data

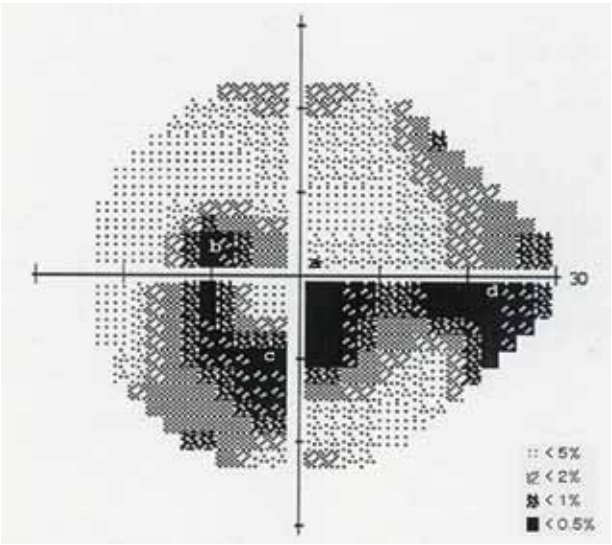


Table 2. Prevention strategies for age related macular degeneration

Primary prevention strategies

- Encourage smoking cessation: the only clinically accepted risk factor for the development of ARMD is smoking. Smoking affords a 2–3 times higher risk for developing ARMD
- Associations have been found between:
  - cardiovascular disease and ARMD (the relative risk ratio for the presence of cardiovascular disease and detection of early ARMD is 1.57[9])
  - omega-3 fatty acids may have a role in reducing the risk of ARMD development and progression by 38% based on a meta-analysis of observational studies[10]
  - dietary antioxidants have not been shown to prevent the development of ARMD[11]
  - photo-oxidative stress and ARMD; therefore UV protection has been advocated

Secondary prevention strategies

- Routine examination of the elderly population may detect early disease
- The Amsler grid for self monitoring is useful for early detection of disease progression, ie. a change from dry to wet ARMD

Tertiary prevention strategies

- Referral to low vision services (eg. Vision Australia, Guide Dogs Australia)
- Supplementation with a combination of vitamin antioxidants and zinc reduces the risk of progression and visual loss (odds ratio 0.68). This is based largely on the Age-Related Eye Disease Study (AREDS) trial using β-carotene, vitamins C, E and zinc[11,12]
- Supplementation with zeaxanthin and lutein (pigments found in high concentrations at the macula) may play a role in prevention of progression of disease, although no definitive evidence has been found

until severe damage has occurred (*Figure 12*). Acute angle closure glaucoma patients present more dramatically with acute visual loss, haloes surrounding lights, severe ocular pain, headaches, nausea and vomiting.

Glaucoma is diagnosed clinically. Features suggestive of glaucoma include progressive changes in the appearance of the optic nerve and visual field. Risk factors for glaucoma include:

- increasing age
- family history of glaucoma, especially first degree relative
- ocular hypertension
- myopia
- African-Caribbean ethnicity.

Prevention of glaucoma is discussed in *Table 3*.

Table 3. Prevention strategies for primary glaucoma

Primary prevention strategies

- There are no clinically applicable strategies available
- Treatment of hypertension and good control of diabetes has not been shown to prevent the development of glaucoma

Secondary prevention strategies

- Early detection of glaucoma affords the best prognosis for preventing visual loss[1]
- More research is required to show whether treatment of systemic risk factors delays progression of the disease

Tertiary prevention strategies

- Referral to low vision services (eg. Vision Australia, Guide Dogs Australia)

Figure 11. A high magnification fundus photograph of a glaucomatous optic nerve head – akin to the view from a direct ophthalmoscope. The cup is increased from the loss of nerve fibres. (a) The retinal vessels disappear as they pass under the shelf in the cup. As the cup:disc (C:D) ratio (here 0.7) enlarges, the orange-pink neuro-retinal rim (b) thins

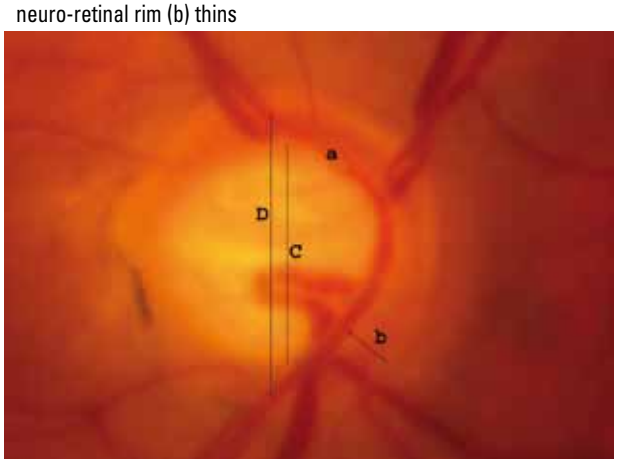
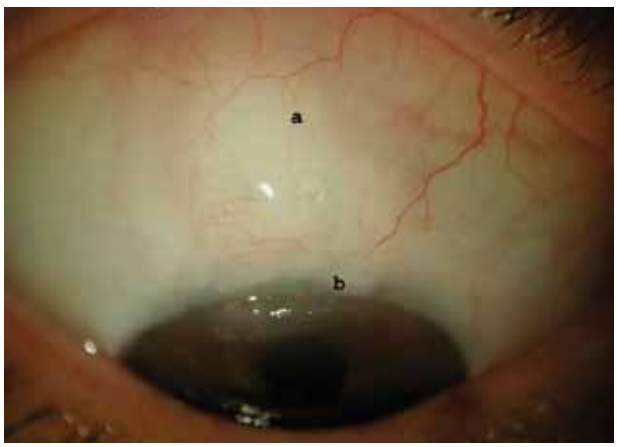


Figure 12. Simulated view of a patient with advanced glaucoma. Peripheral visual loss is progressive until the central vision is finally lost when the disease is end stage

Figure 13. Slit lamp photograph of the superior conjunctiva demonstrating a trabeculectomy. A scleral trapdoor is fashioned surgically that allows the outflow of aqueous under the conjunctiva. This forms a bleb (a) and is drained by conjunctival vessels. One releasable nylon stitch (b) is just visible at the superior corneal edge



Treatment

Medical therapy is the accepted first line in the treatment of open angle glaucoma. These include topical prostaglandin analogues, beta blockers, alpha 2 agonists, carbonic anhydrase inhibitors and cholinergic agents.

If the IOP cannot be lowered to a level where the visual field loss is minimised, further options are laser and/or drainage surgery. Laser trabeculoplasty involves applying laser to the drainage angle to improve outflow of aqueous. Trabeculectomy (*Figure 13*) and glaucoma filtration devices provide an alternative conduit for aqueous flow from the anterior chamber back to the circulation.

Summary

Increasing age is the common risk factor in cataract, macular degeneration and glaucoma. As this factor is not modifiable, early detection of disease and signs of progression afford the best outcomes and may prevent advanced loss of VA. It is recommended that the general population, especially those over 40 years of age,

have a general ocular examination every 5 years, more frequently in high risk individuals. General ocular examination every 2 years is recommended for those aged 75 years or over, Aboriginal people and Torres Strait Islanders, those with a family history of glaucoma, and those with diabetes mellitus. These examinations, carried out by optometrists or ophthalmologists, have been found to be cost effective in identifying and treating the causes and burden of vision loss in the community.

Conflict of interest: none.

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