CONFERENCE REPORT

Loss of vision in the ageing eye

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The purpose of this multidisciplinary workshop was to set out the present state of knowledge of the common causes of visual loss in elderly people and their management, and to explore the best lines for future research. The meeting, convened by Research into Ageing, and held under the chairmanship of Professor A. J. Bron, Professor of Ophthalmology in the University of Oxford, was hosted by British Telecom.

Ageing and visual function

Professor R. Weale (Honorary Senior Research Fellow, Age Concern Institute of Gerontology, King's College London) indicated that many or most measurable ocular functions, anatomical, biochemical and visual, decline linearly with age, but the rate of decline is such that the function [e.g. melanin in the retinal pigment epithelium (RPE) or photoreceptor pigment concentration] would not reach the threshold for affecting vision until extreme old age, nor reach 0 until the age of 120 years on average. Since 120 years is thought to be the maximum human life span, the implications are that the visual system is built to last, and that ocular senescence keeps in step with the senescence of the body as a whole.

One exception is presbyopia, one of the best-known age-related eye disorders, but its development can be traced to events which start in infancy, and reach their conclusion halfway through the lifespan, before most other ocular functions have begun their decline. Thus the accommodative process may have lagged behind in the course of evolution and failed to keep up with our social needs.

There is evidence that climatic conditions may increase the rate at which yellowing and fluorescence of the lens develop. The former process alters the spectral quality of the light reaching the retina, and the latter may affect vision in some lighting conditions by producing haze [1, 2].

In discussion, the question of reduction in the prevalence of age-related macular degeneration (ARMD) by yellowing of the lens was raised. Professor Weale felt that, although there was some evidence for this, the answer was still uncertain.

The epidemiology of visual loss

Professor Ralph Rosenthal (Professor of Ophthalmology, University of Leicester) felt that Blind Registration statistics in the UK were the best anywhere, although inevitably not totally accurate. The register showed that visual loss was age-related, the great majority of registrations being over the age of 65, with a sharp increase with advancing age. In three studies (in the West of Scotland, Nottingham and Leicester), ARMD accounted for 39–47% of registrations, glaucoma for 12–13%, cataract for 11–20%, diabetic retinopathy for 2–8% and other causes for 19–26%. In Leicester between 1965 and 1985, there had been an increase in registrations for blindness due to ARMD from 71 to 110/10^5 and for glaucoma of 17 to 29/10^5; there had also been an increase in registration for partial sightedness.

In a study of 529 people over the age of 75 in Melton Mowbray, half had a visual acuity (VA) of 6/9 or more in the better eye. Fifteen people were registered blind (5%) and 11 (2%) partial sighted, but seven women (all over 80) had visual loss qualifying for registration as blind, and were not registered.

Of those living in institutions in the USA, 40% were visually impaired, as against 12% of the same age in the ambulant population of the same age [3–5].

In the discussion, it was remarked that the proportion of those registrable as blind who were not registered (30%) has not fallen in the past 25 years. Both this and the high proportion of visual impairment among older residents of institutions had implications for those caring for elderly people. In the future, there might be much more visual loss caused by diabetic eye disease in older people who were ethnically from the Indian subcontinent, who had not had the opportunity of close supervision in the past.

Chronic simple glaucoma

Mr John Salmon (Consultant Ophthalmologist, Oxford Eye Hospital) discussed primary open-angle glaucoma (POAG), the commonest form of glaucoma in old age, with a prevalence of 10% at age 80. It is the cause of one in eight registrations for blindness. This is a chronic and
insidious condition in which raised intra-ocular pressure (IOP) leads to progressive damage to the optic nerve, particularly in its upper and lower parts, with a resulting characteristic pattern of visual field loss, superiorly, inferiorly and nasally, with eventual tunnel vision.

In most cases progression can be prevented by lowering the IOP, but in as many as one in six subjects, IOP is never raised above normal, and other mechanisms may play a part in damage to the optic nerve. A factor in the pathogenesis of this condition is a nocturnal fall in blood pressure, which causes a reduction in optic nerve head perfusion.

Clinical recognition is often late, with one eye showing major field loss at presentation. Diagnosis is based on detection of raised IOP, demonstration of pathological cupping of the disc, and of characteristic field loss. Optometrists are well equipped to detect the disorder at an early stage, though those individuals with field loss and glaucomatous cupping of the discs, but persistently normal IOP, can be difficult to detect. A high index of suspicion is needed, particularly in those over 70 or with a family history of glaucoma.

There is evidence that the lowering of ocular pressure slows down the progression of field loss. Reduction in IOP can be achieved medically or surgically. Most patients are started on medical therapy, using a β-adrenergic blocker, which reduces aqueous inflow. Progressive optic nerve damage may result from poor compliance, spikes of raised IOP from intermittent dosing, or failure to reduce IOP far enough. There are side effects resulting from systemic absorption - increased airways obstruction in asthmatic patients; decreased exercise tolerance; postural hypotension and falls; and occasional psychiatric disturbances, such as confusion, insomnia and depression.

Surgical therapy by laser trabeculoplasty produces only a 25% fall in IOP and its effects are of limited duration. The most satisfactory method is surgical trabeculectomy, although this too has its problems [6-9].

In discussion, the importance and some of the difficulties of early detection were stressed, as were the future role of genetic approaches; the gene for one form of autosomal dominant glaucoma has already been located.

The ageing lens and cataract
Dr John Harding (University Research Lecturer, Nuffield Laboratory of Ophthalmology, University of Oxford) said that the unique properties and requirements of the lens make it susceptible to age-related damage. Because it must be transparent, most of its cells have no nuclei or mitochondria, which would absorb or scatter light. In the nucleus of the lens the usual energy-providing system is not present, nor is there any ability to synthesise proteins. This crucial restriction means that the proteins of the lens nucleus remain as they were formed in utero, and are vulnerable to damage by chemical changes (post-translational modification). The lens possesses several mechanisms to protect them.

The first line of defence is a number of small molecules which act as free radical scavengers, and mop up other reactive molecules. An example is glutathione, which protects against oxidation. The lens proteins themselves are physically tough, and α- and β-crystallins have blocked, and thus unreactive, N-terminal amino groups. α-crystallin also acts as a molecular chaperone, which inhibits undesirable interactions between proteins, and may preserve their structural and functional properties. It also prevents heat-induced aggregation and glycation-induced inactivation of the enzymes. Glycation is a form of post-translational modification.

Future research should identify the causes and mechanisms of cataract formation more clearly, and lead to drugs that might prevent or delay the progress of cataract. Research should concentrate on the common pathways of cataract formation, including protein modification, loss of glutathione, and loss of enzyme activity such as that of Na-K-ATPase, a most potent ion pump [10, 11].

In the discussion, the question was raised as to why the cornea can remain transparent without chaperones. It was suggested that this was because corneal collagen is a very tough protein, and corneal cells have nuclei which are all actively metabolizing, and thus the cornea has less need of chaperones.

The effects of ageing on the retina
Professor John Marshall (Frost Professor of Ophthalmology, UMDS, London) indicated that by the year 2050, about 3 million of the UK population and 15 million in the US will be over the age of 85 years. This very old population has a 30% risk of losing vision as a result of ARMD.

Genetic factors may be involved in all forms of ageing, but in non-dividing cells (such as those of the RPE) the effects of cumulative stresses are extremely important. For the retina, optical radiation in the wavelengths between 400 and 1400 nm provides a stress which generates oxidative changes in the tissue. The cones are more susceptible to chronic low levels of radiation, whereas the RPE is more vulnerable to short bursts of high intensity. For both, the blue end of the spectrum is the most damaging. In the visual process, light is absorbed by visual pigments in the outer segments of the rod and cone photoreceptors. The turnover of the discs which make up the rod outer segments is rapid, and is modulated by light. Rod discs are phagocytosed by the adjacent RPE in the early hours of the morning, and the complete stack of discs is turned over once every 2 weeks.
Figure 1. An Amsler grid. The patient looks at the centre of the grid at normal reading distance. If there is distortion of the surrounding lines, this may indicate the presence of early macular change and is a signal for the patient to consult an ophthalmologist.

With age, deposits (drusen) appear in Bruch's membrane in the region of the macula, and represent a risk factor for ARMD. It is thought that they stimulate invasion by macrophages, followed by new vessels which pass across Bruch's membrane into the subepithelial space. Fluid leakage, exudate and haemorrhage can then cause catastrophic loss of central vision.

More work is needed to determine the genetic and environmental factors responsible for ARMD. Ways are needed to stimulate the phagocytic capacity of the RPE or prevent build-up of hydrophobic materials within Bruch's membrane. Current clinical approaches include the prophylactic use of lasers, but pharmacological approaches are also being considered.
disability actually met World Health Organisation criteria for visual impairment (VA less than 6/18 and more than 3/60), when their VA was measured. Four percent of those who did not report any visual problems met these WHO criteria; they thus had a clinically defined 'need', which they themselves had not recognized or identified.

Although a subjective perception of visual decline in later life may compromise emotional well-being and functional status of elderly people, this population is not more likely to make greater use of formal health and social services than elderly people whose vision was good. Old people who are visually impaired also have poorer social contacts and physical function than blind people, and would appear to represent an under-served group within the elderly population [11, 12].

The management of blindness and partial sight

Miss Janet Silver (Principal Optometrist, Visual Assessment Department, Moorfields Eye Hospital, London) stressed that 'no cure does not mean no help', and that the main consequences of 'blindness' are a loss of independence for correspondence, newsprint, prices in shops, medication, and kitchen controls, and a humiliating loss of privacy in reading bills and bank statements. There is often a reaction very similar to bereavement, with denial, anger, and depression. She stressed the prevalence of myths which needed to be dispelled, that blindness is some sort of retribution, and that vision can be used up or worsened by its use.

Low vision aids (LVAs) cannot replace vision, have disadvantages, and require adaptation by the patient. They may be 'no-tech', like moving a TV set nearer, or employ magnification or better contrast. At all times aids must be customised to suit the needs of individual patients, and realistic aims, motivation, and good support are needed.

LVAs may be supplied on loan after testing by Health Service-employed optometrists, through schools of optometry, through private optometrists or opticians, or be self-selected.

At Moorfields Hospital, some 10% of patients at the low vision clinic achieve their targets with only refraction and advice on illumination, while 5% fail because of poor motivation or very severe visual impairment.

For the future the requirement is for improved awareness of the possibilities of helping patients, of appropriate methodology, and the cost-benefits of different methods.

Conclusions

Professor Bron concluded by going through the main point made: that the visual system was made to last, with a potential for adequate function up to 120 years; that not all blind people are recognized and that some can be helped by simple refraction; that IOP is not the whole story in glaucoma; that the lens is a model for ageing, with identified mechanisms of damage and defense; that optical radiation, particularly blue light, may be the main means of damage to the RPE; that ARMD remains the main problem in prevention and treatment, followed by glaucoma, diabetic eye disease, and cataract. He concluded that we should take into account more than visual acuity alone, and that there are many specific methods to help.

References