OCULAR PATHOLOGY AND LOW VISION

PART 2: MEDICAL, SURGICAL AND SCIENTIFIC TREATMENTS OF AGE RELATED MACULAR DEGENERATION

Anne Eyre discusses the increase in age related problems.

Advances in medical science and improvements in diet and social living conditions have all contributed to an increased life expectancy. As a result the prevalence of age related problems has also increased.

In low vision clinics the average age of patients has increased. In my own area, North West Wales, the vast majority of the patient base is over the age of 75. The prevalent presenting ocular pathology is age related macular degeneration, often compounded by the existence of additional age related problems, such as lens opacities, corneal dystrophy and pupil miosis.

What is the prognosis once age related macular degeneration is diagnosed?

As we saw in the previous article, much depends on the type of maculopathy present. With non-exudative degeneration the prognosis for the peripheral field is usually quite good. These patients often respond well to magnification and maintain the ability to read for short periods for many years. The presence of exudative maculopathy is more serious and is a greater threat to sight. In exudative maculopathy there is often an underlying leakage of fluid into the sub-retinal space, if untreated this can lead to a retinal detachment.

Treatment of ARMD

Identification of the area of leakage, through the use of fluorescein angiography is necessary, however, the options for treatment are limited. The most common treatment in exudative maculopathy is photocoagulation by laser. Here the degree of benefit to the patient needs to be weighed against the damage to the retina by the laser.

Photocoagulation was used extensively in the eighties, but there is considerable debate about its long-term effectiveness. The Macular Photocoagulation Study group findings indicate that the benefits may not be as promising as was first thought. **Table 1** shows the degree of visual loss over a period in patients who received laser photocoagulation, compared with those who did not.

The concept behind laser is sound. Visual acuity at the macula equates to 6/6, whilst the acuity in the peripheral field is only 6/36. Using laser near to the macula to contain any fluid preserves the peripheral field at between 6/12 and 6/18. In addition it is hoped that the central scotoma can be minimised.

In recent years there has been considerable investment in terms of research into both the causes of and possible treatments for ARMD. There are two areas that appear to offer interesting advances. The first is the possible link between age related maculopathy and life style and the second explores the potential for surgical treatment.

For many years there has been a belief that the progression of ARMD may be slowed by the use of anti-oxidants[1]. It has now been suggested that there are a number of risk factors for predisposition towards ARMD. These are shown in **Table 2**[2].

We know that age is the singularly most significant factor, but genetic transmission of ARMD occurs, as there is an increased incidence in monozygotic twins[3]. What is still not clear is the extent to which dietary and environmental factors affect the results.

In two major studies undertaken in the United States it appears that females are at greater risk than males[4,5].

Perhaps the most interesting risk factor, so far, is that relating to the dietary intake of anti-oxidants. Goldberg et al made the first association between the lack of anti-oxidant intake and ARMD[6]. They found that those who daily-consumed fruit and vegetables rich in vitamin A, had a significant protection against age related ocular change, when compared with those whose intake was less than once a week. More recent studies suggest that it is not vitamin A that is the protector, but the carotenoids

lutein and zeaxanthin found in the same vegetables.

It is now understood that the primary components of macula pigment are lutein and zeaxanthin. Whilst the pathophysiology of ARMD is still not fully understood, it is believed that the macula pigment has an important, protective role. Loss of pigment density in older people produces a loss of contrast sensitivity. Elderly people, who retain high levels of macula pigment, maintain contrast sensitivity levels comparable with young people. It is for this reason that contrast sensitivity tests appear to be a more accurate predictor of predisposition to ARMD, than other diagnostic tests.

Studies have also found that the density of macula pigment can be correlated with some of the other risk factors. People with light coloured irides have a lower density of macula pigment and are therefore at greater risk[7]. This may be due to the fact that the light coloured iris permits more light onto the macula pigment, causing it damage.

Similar correlations have been found between smoking and macula pigment density[8]. Carotenoid levels were significantly lower in those who smoked.

The protective role of the macula pigment is not yet fully understood, but two hypotheses have been suggested. The first, that the retinal pigment acts as a filter for blue light, which is known to have a detrimental effect both on itself and the underlying receptor layer. The second, that the carotenoids lutein and zeaxanthin, which are known to be able to absorb blue light, act as an antioxidant to limit the stress from the exposure to light[9].

If there is to be a beneficial effect of an antioxidant, it must be absorbed into the body and converted into useable molecules. Does an increase in dietary carotenoids produce a corresponding increase in the macula pigment? Whilst there is the need for more detailed trials there is evidence to suggest that the intake of foods high in lutein and zeaxanthin does increase the level of macula pigment[10]. The foods used in the research were broccoli, cabbage and its related vegetables, carrots, sweet potatoes and spinach. Of these only spinach was associated with the protection against ARMD. Perhaps the creators of Popeye were wiser than previously thought!

The research into these correlations is ongoing, and we must await its conclusions before the true benefits in relation to the protection against development of ARMD can be evaluated.

Surgical solution

The search for a surgical solution for ARMD has been ongoing since the early eighties, although it was only recently that newspaper headlines assured us in Britain that a cure had been found. Such headlines are, at best, misleading, and have given rise to great disappointment amongst the majority of sufferers.

As we explored in the previous article, the primary underlying cause of ARMD is the failure of the retinal pigment epithelium to function. Once this occurs, macula lesions develop.

It is evident that to avoid damage to the outer retina, any surgical intervention must take place at an early stage after onset, whilst there is still foveal function.

The use of photocoagulation leads to irreversible destruction of the retina. Similarly, removal of sub-retinal tissue via surgical means involves the removal of the epithelium, which again leads to a secondary degeneration of the retina.

In 1993 Robert Machemer[11,12] proposed moving the fovea to a new area of the retina thus translocating it towards an area of healthy epithelium.

We know that ARMD affects a limited area of the retina, usually centred in or around the fovea, although the reasons for this are not yet understood. From this knowledge evolved the concept that retinal recovery and survival might be increased if this area could be avoided.

The Japanese[13,14] continued work on translocation of the fovea, succeeding in relocating the retina and improving the visual acuity from 6/60 to 6/6.

Further development continued under Professor Eckhardt in Germany. He evolved a technique to rotate the retina, thus moving the fovea to a new, unaffected area of the retina. His initial operations rotated the retina by between 45 and 60 degrees. In each case the acuity increased, but the patients experienced problems with spatial orientation, due to the rotation relative to the visual axis of the untreated eye. To overcome this, he employed a technique used in squint surgery, advanced muscle translocation, in which all the ocular muscles were resected simultaneously. This is also referred to as 'windmill' surgery, as the eye is completely rotated. Although the results have been successful in terms of increased acuity, the drawback of the technique is its duration, some six to seven hours under general anaesthesia. This is prohibitive in terms of time and cost as a main line technique. It also presents an increased risk of pulmonary embolism in elderly patients.

In Britain, the Retinal Unit at Liverpool, under the direction of David Wong, has been undertaking a research programme to try and establish a better technique for foveal translocation.

Any surgery to the retina results in an adverse reaction of the epithelial cells. They respond to the trauma of surgery by alarming the body's defence mechanism and so behave more like macrophages or fibroblasts. This results in an increased risk of retinal detachment.

To try to overcome the trauma to the eye, the Liverpool team have developed a new technique called Relocation by Sustained Traction or REST.

	Laser	Untreated
Extrafoveal at 5 years	54%	46%
Juxtafoveal at 1 year	45%	35%
Subfoveal at 3 months	20%	11%
Subfoveal at 2 years	20%	37%

Table 1.

Age
Female gender
Hypertension
Current smoker
Physical inactivity
Blood carotenoids
Total cholesterol level
Hyperopia
Lack of oestrogen use (post menopause)
Parity
Cardiovascular disease
Low serum zinc
Low dietary intake of carotenoids
Excess alcohol consumption
Light coloured irides
Lifetime sunlight exposure

Table 2.

The aim of the surgery is to provide a quick, simple technique, which can be performed under local anaesthetic, thus reducing the likelihood of ocular complications, and less risk to the patient.

When developing a new technique, it is important to consider such factors as its effectiveness, the basis for patient selection and the possible long-term benefits to the patient.

The starting point for the research programme was an American concept of scleral plication surgery[15]. The primary advantage of this was that it only required a small incision in the retina, thus reducing the risk of trauma.

This surgery aims to produce a redundancy of tissue. The analogy that has been used to describe this is the realignment of a carpet from a larger to a smaller room. The resultant excess material can then be positioned to the best advantage.

Redundancy of the retina is achieved by compression of the sclera by suturing through it and tightening it to produce a groove. The use of multiple sutures means that it is possible to convert the eyeball from its spherical shape, to that of a 'D' and produced 4mm of redundancy.

In practice the research team found

that a maximum of 1mm redundancy was achievable by this method. Their experience showed that over half the retina needed to be plicated in order to produce sufficient redundancy, this in turn produced a retinal fold. The position of the fold relative to the macula also caused problems. A fold between the macula and the disciform failed to produce any improvement in acuity, whilst a fold at the macula meant everything was seen with a crease in it.

A more serious problem was that five out of eleven patients developed proliferative vitreoretinopathy, with total loss of acuity. The risks were deemed to be too high and plication surgery was abandoned.

The retinal team then tried a 180-degree retinotomy, they cut half the retina and moved it downwards without rotation. Instead of the expected gap at the top, they found that it was possible to stretch the retina. The initial problem was that once released the retina returned to its original position, however by sustaining traction by the use of heavy oil, the retina relocated to the new position after approximately fifteen minutes.

It is evident that any surgery to the retina will involve changes to the patient's vision. In addition to the improvement to the visual acuity, the patient sees the world as bigger and nearer, due to the increased separation of the photoreceptor layer that occurs as the retina is stretched.

At present this surgery is only carried out as part of a research programme. It is obviously experimental and carries a high degree of risk. For this reason the patient selection adheres to strict guidelines and both patients and relatives are counselled about the risks involved (see **Table 3**).

Patient selection for REST
All must undergo scotopic/ photopic micro perimetry
VA must be reduced to 6/24
Must be seen within 6-8 weeks from onset
Extensive counselling must be undertaken prior to surgery

Table 3.

The extensive research programmes into both the surgical possibilities and the dietary effects on ARMD indicate the complexity of this disease and its prevalence in our modern society. At present we must await the outcome of all the research before we are able to determine its effectiveness. Until such time as a cure is found these patients will form the bulk of the workload for the low vision practitioner. In the final article we will consider the assessment procedure for these patients and the management of their condition.

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