Lower macular pigment optical density in chronic open-angle glaucoma

Professor James Loughman explains how latest research suggests a link between macular pigment levels and glaucoma

Retinal neurodegenerative disorders such as glaucoma and age-related macular degeneration (AMD), are leading causes of worldwide blindness. Both diseases are associated with the ageing eye, where oxidative stress plays an important role. Glaucoma is characterised by gradual loss of the retinal ganglion cells and their axons that collectively makes up the optic nerve. Current treatment modalities are limited to halting disease progression and do not restore lost visual function. Glaucoma affects an individual's quality of life and it has been shown that disability glare is one of the contributing factors. Studies have shown that individuals with AMD have reduced macular pigments and that dietary macular pigment supplementation may confer a protective role.

There is growing evidence to indicate that the macula is affected even in early glaucoma and this can be demonstrated by macular visual field testing and optical coherence tomography (OCT). The macular pigment optical density (MPOD) in an individual's eye can be determined using customised heterochromatic flicker photometry (cHFP), measured using the macular metrics densitometer. The author recently investigated the relationship between MPOD and glaucoma and showed that individuals with open-angle glaucoma have reduced MPOD, an exciting new finding (40 glaucoma patients vs 54 age-matched normal controls). Median (interquartile range) MPOD for glaucoma was 0.23 (0.42) compared to 0.36 (0.44) for controls and the difference was statistically significant, (z=-2.158, p=0.031).

Two possible causative mechanisms have been proposed, whereby MPOD may be lower in cases of glaucoma. The first mechanism relates to glaucoma-induced changes in both the retinal microcirculation and macrocirculation sufficient to disrupt MP processing. Glaucoma-associated disruption of ocular blood flow may, in theory, disrupt the transport and deposition of dietary carotenoids to the macula. The second likely mechanism relates the increased oxidative stress associated with glaucoma to MP loss. There is strong evidence that oxidative processes damage the retina, which is susceptible to oxidative stress because of its high metabolic activity and consequential oxygen consumption, high proportion of polyunsaturated fatty acids and constant exposure to visible light. There is growing evidence that glaucoma causes significant free radical and reactive oxygen species (ROS) production, so it is plausible that the oxidative environment created by glaucoma may also cause MP loss. These interesting and potentially important findings warrant further study.

Future study

A placebo-controlled, double-masked clinical trial is being conducted whereby all glaucoma participants (n=120) are randomised into the treatment arm (dietary MP supplementation – MacuShield [10mg L, 2mg Z, 10mg meso-Z]) or placebo arm. This trial is being conducted by MD student We Fong Siah, at the Mater Misercordiae University Hospital and Mater Private Hospital, Dublin, Ireland, under the supervision of Professors Colm O' Brien and James Loughman. It is being jointly funded by the Howard Foundation, Downing College, Cambridge, and Macuvision Europe, Solihull, UK

Age-matched healthy controls will be recruited for baseline comparison to the glaucoma participants. The purpose of this trial is to determine the significance of MP in glaucoma. It has been shown that augmentation of MP is best achieved through supplementation with all three of MP's constituent carotenoids (L, Z and meso-Z), resulting in rapid enrichment of MPOD among healthy individuals and those with AMD. Here, the trial seeks to investigate whether such a desirable effect will be observed among the cohort of glaucoma patients, and whether increases in MP, if any, are associated with visual performance improvements, ie glare sensitivity.

Further, the effects of dietary MP supplementation on the visual function of glaucoma patients will be investigated, in particular glare sensitivity. Disability glare affects the quality of life of most patients living with glaucoma. The use of tinted glasses is of no benefit in disability glare, and may in fact cause further visual impairment. It is well recognised, for example, that vision impairment from glaucoma is a major contributing factor to falls and motor vehicle collisions. The impact of glaucoma on an individual's life can be assessed by the use of self-administered vision-related quality of life questionnaires, an assessment tool that can be invaluable to the eye health professional.

MP has been shown to play a role in visual performance including glare sensitivity.[1] The potential therapeutic benefit of dietary MP supplementation in glaucoma patients has not been studied. This trial is designed to investigate whether oral dietary MP supplementation in glaucoma patients will improve glare sensitivity as observed in its AMD counterparts. It will also study the relationship of MPOD in glaucoma patients to visual field and glaucoma-associated structural assessments as measured by OCT.

As there is evidence to suggest macular changes such as decreased central foveal thickness and retinal ganglion cell complex thickness in glaucomatous eyes, it is plausible that there may be associated MPOD loss as well.

This trial will focus particularly on in the effects of MP supplementation on visual performance such as glare sensitivity. To date, the cause of disability glare among glaucoma patients is poorly elucidated. Given the evidence of beneficial visual performances in AMD and healthy individuals following dietary MP supplementation, it is tenable to hypothesise favourable outcomes among glaucoma patients. When completed in December 2014, this trial will provide useful information with regards to the therapeutic role of MP replacement in glaucoma patients.

References

1 Loughman J, Nolan JM, Howard A, et al. The impact of macular pigment augmentation on visual performance using different carotenoid formulations. *Invest Ophthalmol Vis Sci,* 2012; 53(12), 7871-80.

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