

MINI REVIEW

Aetiology of myopia

Although clinicians are preoccupied with treating myopia and its complications, the causation is worth our attention, and particularly the results of experiments on animals in recent years. These have some implications for the treatment of patients.

Myopia's remarkable bilateral symmetry suggests a hereditary basis. This is supported by Sorsby's observation¹ that 78 pairs of identical twins showed close agreement in their refractions, whereas 40 pairs of non identical twins showed little more agreement than control pairs of siblings. Some families show a dominant hereditary pattern,² some a recessive,³ and perhaps some an X-linked,⁴ but probably most cases are multifactorial,² including environmental factors.

We would need no statistical evidence that glaucoma at birth or in early life often produces myopia because of a large eyeball. Is axial myopia in general the result of a slightly raised intraocular pressure in the early growing years?⁵⁻⁸ Not proven, because the higher ocular tension associated with myopia may result from the myopic process rather than cause it.

Hubel and Wiesel won a Nobel prize for their work on experimental amblyopia in kittens subjected to unilateral tarsorrhaphy. The up-market application of this work to young rhesus macaque (*Macaca mulatta*) and stump-tailed macaque (*M. arctoides*) monkeys produced a quite fascinating result: the eyes on the side subjected to tarsorrhaphy were almost all axially myopic, with the familiar fundus changes.⁹ (Such work usually attracts the description 'serendipitous'. There is a great need for a complementary word which describes much research - great and serious effort, with much diligent reading of the literature and painstaking experiments - resulting in very small discoveries.) Corneal opacities caused by injection of a fine suspension of polystyrene beads produced the same effect as lid fusion.¹⁰ Two young rhesus monkeys with unilateral lid fusion which were raised in the dark failed to show myopia.¹¹ Accordingly, unfocused light is a prime mover in producing this experimental myopia, not a mechanical or thermal effect of lid fusion.

Is there a human counterpart? The eyes of children with unilateral ptosis are more myopic or less hypermetropic on the affected side than on the other.¹² Cataracts in early life are also factors in causing abnormal elongation of the eyeball.¹³⁻¹⁵

Does optic nerve section prevent lid fusion myopia? Three rhesus monkeys developed the usual myopia in spite of 'intracranial section of the optic chiasm'.^{11,16} It is sometimes facile, however, to transfer observations in one species to another: the same procedure in one *M. arctoides* monkey did prevent lid fusion myopia.

Bilateral lid fusion produces bilateral axial myopia in monkeys.⁹ Removal of the striate cortex has no effect.¹⁶ Topical atropine (and removal of the ciliary ganglion) also had no effect in rhesus monkeys, but did prevent lid suture myopia in four *M. arctoides* animals, which suggests that accommodation is a factor in the latter species. A pharmacological blocker of acetylcholinesterase, isofluorophate, which produces excessive accommodation, had no effect on the experimental myopia in rhesus and stump-tailed monkeys.¹⁶ Sympathetic denervation and trigeminal section also failed to alter progression of this myopia.

The effect of these experiments is localised to the tarsorrhaphised eye, provided the animals are young. Surely the retina must be the source of the stimulus to the sclera? What chemical substance diffuses from the retina to affect the sclera? How can the substance manage to avoid being washed away by the fast flowing choroidal circulation? Is the rate of formation of cross linkages in scleral collagen reduced?

A surge of interest in growth factors in recent years may be relevant.¹⁷⁻²⁰ Indeed, the retina may not be the passive victim of scleral growth, but may conceivably be the author of its own destruction.^{21,22}

The latest instalment to this whodunnit is even more difficult to explain. Chickens,²³⁻²⁵ like tree shrews,^{26,27} also suffer from deprivation myopia. Several groups of chicks were subjected to deprivation of localised areas of retina.²⁸ In some, the 'nasal' (anterior) retina was deprived of patterned images by a white translucent occluder with a window anteriorly which allowed normal images on temporal (posterior) retina. In others the window in the occluder was positioned posteriorly to allow focused images on nasal (anterior) retina, leaving the temporal (posterior) retina deprived. Consistently, the half of the eyeball receiving unfocused light was axially longer and (more) myopic than the half receiving focused images. Are there human counterparts? Can we find here an explanation for localised staphylomata in human myopic eyes? Can we find patients with corneal or lens opacities from childhood restricted to one area and investigate with B-scan ultrasound whether the appropriate side of the eyeball is 'myopic'?

Are there any practical implications for the management of myopia in all this? We are already having to make up our minds on whether and in what circumstances to advise spectacles, contact lenses, radial keratotomy, Fukala's operation, insertion of an anterior chamber intraocular lens in the phakic eye, removal of the clear lens with or without insertion of an IOL, epikeratophakia, and the computer controlled regrinding of the air-cornea interface. We are all well aware of the importance of choosing our parents - but genetic engineering is beginning to mitigate the genetic imperative. Should we deprive our growing children of the comfort of a night light? Should they be punished for reading by torchlight under the bed clothes? Maybe the Japanese and Chinese will be the first to abandon their print in favour of audio texts, not just in waking hours but subliminally during sleep. There are other reasons to make us try to minimise the severity of corneal and lens opacities, and the duration of occlusion. Few of us would feel justified in prescribing bilateral atropine drops to children for months or years.²⁹⁻³³ There is good evidence in a reasonably well controlled but unfortunately only single-masked study that bifocals reduce the rate of progression of myopia in children.³⁴ Multifocals would probably be more acceptable.

CALBERT I PHILLIPS

University Ophthalmology Unit
Princess Alexandra Eye Pavilion
Chalmers Street, Edinburgh EH3 9HA

- 1 Sorsby A, Sheridan M, Leary G A. Refraction and its components in twins. *Med Res Council Spec Rep* ser 303. London: HMSO, 1962
- 2 McKusick VA. *Mendelian inheritance in man*. 6th ed. Baltimore and London: Johns Hopkins University Press, 1983: 365, no. 16070.

- 3 McKusick VA. *Mendelian inheritance in man*. 6th ed. Baltimore and London: Johns Hopkins University Press, 1983: 855, no. 25550.
- 4 McKusick VA. *Mendelian inheritance in man*. 6th ed. Baltimore and London: Johns Hopkins University Press, 1983: 1081, no. 31046.
- 5 Abdalla MI, Hamdi M. Applanation ocular tension in myopia and emmetropia. *Br J Ophthalmol* 1970; **54**: 122-5.
- 6 Tomlinson A, Phillips CI. Applanation tonometry and axial length of eyeball. *Br J Ophthalmol* 1970; **54**: 548-53.
- 7 Tomlinson A, Phillips CI. Unequal axial length of eyeball and ocular tension. *Acta Ophthalmol (kbb)* 1972; **50**: 872-6.
- 8 Deodati F, Fontan J, Mouldous J-M. Ocular tension in high myopia. *Arch Ophthalmol (Paris)* 1974; **34**: 853-62.
- 9 Wiesel TN, Raviola E. Myopia and eye enlargement after neonatal lid fusion in monkeys. *Nature* 1977; **266**: 66-8.
- 10 Wiesel TN, Raviola E. Increase in axial length of the macaque monkey eye after corneal opacification. *Invest Ophthalmol Vis Sci* 1979; **18**: 1232-6.
- 11 Raviola E, Wiesel TN. Effect of dark-rearing on experimental myopia in monkeys. *Invest Ophthalmol Vis Sci* 1978; **17**: 485-8.
- 12 O'Leary DJ, Millodot M. Eyelid closure causes myopia in humans. *Experientia* 1979; **35**: 1478-9.
- 13 Rabin J, Van Sluyters RC, Malach R. Emmetropisation: a vision dependent phenomenon. *Invest Ophthalmol Vis Sci* 1981; **20**: 561-4.
- 14 Von Noorden GK, Lewis RA. Ocular axial length in unilateral congenital cataract and blepharoptosis. *Invest Ophthalmol Vis Sci* 1987; **28**: 750-2.
- 15 Rasooly R, Benezra D. Congenital and traumatic cataract: the effect on ocular axial length. *Arch Ophthalmol* 1988; **106**: 1066-8.
- 16 Raviola E, Wiesel TN. An animal model of myopia. *New Eng J Med* 1985; **312**: 1609-15.
- 17 Recent developments in the study of growth factors: GRF and somatomedins symposium. Paris. 29-30 May, 1985. *Horm Res* 1986; **24**: (2-3): 81-200.
- 18 Gospodarowicz D, Neufeld G, Schweigerer L. Molecular and biological characterization of fibroblast growth factor, an angiogenic factor which also controls the proliferation and differentiation of mesoderm and neuroectoderm derived cells. A review. *Cell Differ* 1986; **19**: 1-17.
- 19 McVie JG, Muggia FM. European Organization for Research and Treatment of Cancer Workshop. Meeting report. *Cancer Res* 1987; **47**: 3032-6.
- 20 Clark SC, Kamen R. The human hematopoietic colony-stimulating factors. *Science* 1987; **236**: 1229-37.
- 21 Baird A, Esch F, Gospodarowicz D, Guillemin R. Retina derived endothelial cell growth factors: partial molecular characterization identity with acidic and basic fibroblast growth factor. *Biochemistry* 1985; **24**: 7855-9.
- 22 Gospodarowicz D, Massoglia S, Cheng J. Effect of retina derived acidic and basic fibroblast growth factor and lipoproteins on the proliferation of retina derived capillary endothelial cells. *Exp Eye Res* 1986; **43**: 459-76.
- 23 Wallman J, Turkel J, Trachtman J. Extreme myopia produced by modest change in early visual experience. *Science* 1978; **201**: 1249-51.
- 24 Yinon U, Rose L, Shapiro A. Myopia in the eye of developing chicks following monocular and binocular lid closure. *Vision Res* 1980; **20**: 137-41.
- 25 Wallman J, Rosenthal D, Adams JI, Trachtman JN, Romagnano L. Role of accommodation and developmental aspects of experimental myopia in chicks. *Doc Ophthalmol* 1981; **28**: 197-206.
- 26 Sherman SM, Norton TT, Casagrande VA. Myopia in the lid-sutured tree shrew (*Tupaia glis*). *Brain Res* 1977; **124**: 154-7.
- 27 McKanna JA, Casagrande VA. Reduced lens development in lid suture myopia. *Exp Eye Res* 1978; **26**: 715-23.
- 28 Wallman J, Gottlieb MD, Rajaram V, Fugate-Wentzek LA. Local retinal regions control local eye growth and myopia. *Science* 1987; **237**: 73-7.
- 29 Curtin BJ. Myopia: a review of its etiology, pathogenesis and treatment. *Surv Ophthalmol* 1970; **15**: 1-17.
- 30 Bedrossian RH. The effect of atropine on myopia. *Ann Ophthalmol* 1971; **3**: 891-7.
- 31 Gimbel HV. The control of myopia with atropine. *Can J Ophthalmol* 1973; **8**: 527-32.
- 32 Stuart-Black T, Chatfield C, Tustin G. Clinical assessment of the arrest of myopia. *Br J Ophthalmol* 1975; **59**: 529-38.
- 33 Brodstein RS, Brodstein DE, Olson RJ, Hunt SC, Williams RR. The treatment of myopia with atropine and bifocals: a long-term prospective study. *Ophthalmology* 1984; **91**: 1373-8.
- 34 Oakley KH, Young FA. Bifocal control of myopia. *Am J Optom Physiol Opt* 1975; **52**: 758-64.



Aetiology of myopia.

C I Phillips

Br J Ophthalmol 1990 74: 47-48

doi: 10.1136/bjo.74.1.47

Updated information and services can be found at:

<http://bjo.bmj.com/content/74/1/47.citation>

These include:

**Email alerting
service**

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Notes

To request permissions go to:

<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:

<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:

<http://group.bmj.com/subscribe/>