Recent Modalities In The Management Of Myopic Anisometropia In Children

An essay submitted
For Fulfilment of Master Degree in Ophthalmology
By

Khaled Kotb Abd Allah Mohamed
[M.B, B.Ch.]

Under supervision of

Prof. Dr. Taha Mohamed Abd El-Moneim Labib
Professor of ophthalmology
Faculty of medicine
Cairo University

Prof. Dr. Mahmoud Ahmed Kamal
Professor of ophthalmology
Faculty of medicine
Fayoum University

Dr. Ahmed Reda Awadein
Lecturer of ophthalmology
Faculty of medicine
Cairo University

Cairo University
2008

Acknowledgment

*First of all, I would like to express my deepest gratitude to "**Allah**" the most Merciful who is praised for all his favours and blessings.*

*I would like to thank **Prof. Dr. Taha Labib**, Prof. of ophthalmology, Cairo University, for his great help and support. It is a great honour to work under his supervision.*

*I would like also to express my sincere appreciation and thanks to **Prof. Dr. Mahmoud Kamal**, Prof. Of ophthalmology, Fayoum University, who helped me a lot to finish this work.*

*I would like to thank Lecturer **Dr. Ahmed Reda Awadein**, Lecturer of ophthalmology, Cairo University, for his help and advice.*

*Also I would like to thank my **mother and father** who stood by me through all this work, encouraged me and prayed for me. I also thank my **wife and children** for their support and prayers.*

Abstract

Anisomyopia of more than 2 diopters may result in amblyopia. The **prevalence of amblyopia of in myopes with 6.0 diopters of uncorrected anisometropia 100%.**

New techniques for **preschool vision screening** have become increasingly popular which allow early detection of children anisometropic amblyopia. The earlier detection and treatment of anisometropia may reduce or prevent amblyopia.

Traditional therapy for anisometropia includes refractive correction with **spectacles** or **contact lenses**, minimization of aniseikonia with contact lenses, and **amblyopia management** with occlusion therapy and/or pharmacologic and/or optical penalization of the sound eye.

Refractive surgery is a reasonable alternative to consider. **Photorefractive keratectomy** (PRK) and **laser in situ keratomileusis** (LASIK) have both been well received by adults with refractive errors. Refractive procedures that may have utility in children include PRK, LASIK, **laser epithelial keratomileusis** (LASEK), and possibly others like phakic IOLs, clear lens extraction and ICRs.

Key words: Myopia, anisometropia, amblyopia, traditional therapy, PRK, LASIK, LASEK, PIOL, clear lens extraction and ICRs.

Contents:

Page

List of figures:

Chapter one

Physiological Optics and refraction

Relevant anatomy

In order to understand the principles of **Myopia** and **Anisometropia** we are in need to understand the normal developmental aspect, the physiologic optics and the refractive status of the neonate’s eye.

Axial length:

Larsen noted that the **axial length of the neonate’s eye at birth is about 17 mm** and that it **increases by about 25%** by the time the child reaches adolescence ***(Larsen 1971)***. The size of a normal infant’s eye is about **three fourths** that of the adult. Geometric optics teaches us that the retinal image of the normal infant eye is about **three fourths** the size of the adult’s image. This is partially due to the fact that the size of the retinal image depends on an entity known as the **nodal distance**, which averages **11.7 mm in the newborn** and **16.7 mm in the adult** emmetropic schematic eye **(*Banks 1988*). As the distance between the nodal point and the retina increases, the image size increases.**

A smaller image means that much less fine details are recorded. The **small retinal image** may be one of the reasons why an **infant’s visual acuity is poorer than that of the adult**. In fact, experiments have shown that the neonate's visual appreciation for fine detail at birth is **one thirtieth,** or approximately 3%, of that in adults, yet the neonate appreciates large objects (e.g., nose, mouth, eyes of close faces) as does the adult **(*Banks 1988*).**

The visual acuity swiftly improves, and by the **age of 12 months**, the **infant's level of visual acuity is 25% (20/80) of optimal adult visual acuity.** This improvement in acuity seems to parallel eyeball growth. By the **age of 5 years**, the child usually has **20/20 vision** ***(Boothe 1985).***

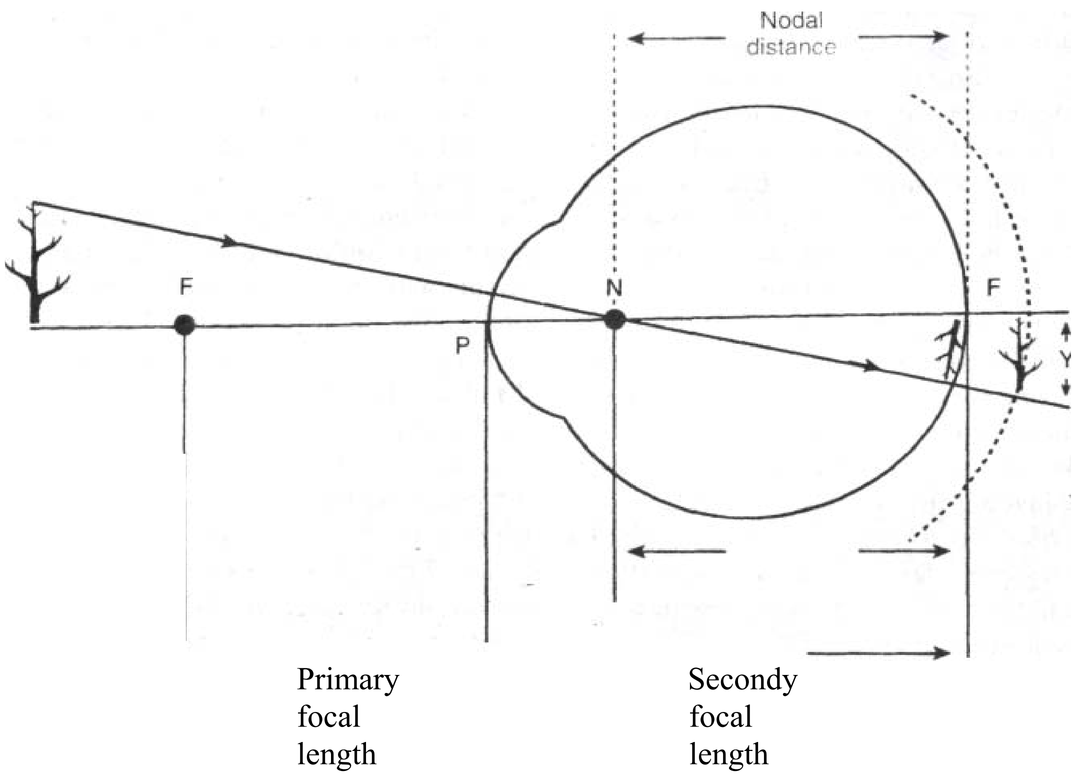

Figure 1: A digram of a reduced human eye. ***F***, Focal points; ***N***, nodal point; ***P***, principle point. The ***dotted line*** represent the retina of an enlarged eye (Adler's physiology of the eye).

As the eye grows, the **optical power of the crystalline lens and cornea must weaken in a tightly coordinated fashion** so that the image stays in sharp focus on the retina. If this tight coordination of growth fails, the infant may become nearsighted or farsighted ***(Frantz 1965).***

Because the **coordination** of eye length growth and the focusing power of the cornea and lens **may be imperfect** there is some **compensation** provided early in life, guaranteeing that almost every child can process a sharply focused retinal image of the world. **Accommodation is the safety valve** that can help provide a sharp image, even if all the ocular components are not perfectly matched. In the young child the range of accommodation is greater than **20 diopters**. This range, in addition to the farsightedness of almost all infants, means that most young eyes can focus almost any object by using part or all of this enormous focusing capacity. Because of the infant's **smaller pupil**, a second factor that helps the infant achieve a sharper retinal image is an **increased depth of focus** ***(Green 1980).***

Emmetropization:

The coordination of the power of the cornea, crystalline lens, and axial length to process a sharp retinal image of a distant object is known as **emmetropization** ***(Inagaki 1986).***

With age, the cornea, lens, and axial length undergo coordinated changes. Essentially, the **optical components** (cornea and lens) **must loose refractive power** as the **axial length increases** so that a sharp image remains focused on the retina ***(Inagaki 1986)***.

The cornea, which averages **48 diopters of power at birth** and has an increased elasticity, **loses about 4 diopters** by the time the child is **2**

years of age ***(Insler 1987).*** One may assume that the spurt in growth of the sagittal diameter of the globe during this period pulls the cornea into a flatter curvature. The fact that the **average corneal diameter is 8.5 mm at 34 weeks** of gestation, **9 mm at 36 weeks**, **9.5 mm at term**, and about **11 mm in the adult eye** supports this "pulling, flattening" hypothesis ***(Tucker 1992).***

The crystalline lens, which averages **45 diopters during infancy**, **loses about 20 diopters** of power **by age 6** ***(Wood 1996).*** To compensate for this loss of lens power, **the axial length increases by 5 to 6 mm** in the same time frame ***(Larsen 1971).*** As the cross-sectional area of the eye expands, there is an **increased pull on the lens zonules** and a subsequent **flattening of the lens** (the anterior lens surface is affected a bit more and the posterior lens surface a bit less), thus decreasing the overall lens power. There also may be a related **decrease in the refractive index** of the lens, which also contributes to the reduction in lens power ***(Hofstetter 1969).***

Because the **incidence of myopia starts to accelerate significantly around the age of 10** ***(Mutti 1997)***, one may question whether there could be a decoupling of the previously described coordinated drop in lens power and increase in axial length. An increased amount of near work at this age (e.g., schoolwork) is associated with a higher incidence of myopia ***(Zadnik 1998).***

It is also well known that **genetic predisposition** influences myopia incidence, as evidenced by the fact that **more Oriental children than**

Caucasian children are myopic ***(Zadnik 1998).*** Thus one might hypothesize that the **long periods of accommodation** that accompany schoolwork (ciliary body contraction) may **tend to stretch and weaken the linkage between the enlarging scleral shell and the ciliary body**. If this were to happen, the lens would flatten less during eye growth. Another way of looking at this phenomenon is to theorize that with the **linkage weakened**, the **restraining effect of the lens-zonule combination on eye growth is also weakened**, which results in an increase in axial length in the myopic student ***(Goss 1998).***

The optics of Myopia

Myopia is defined as the optical condition of the **non-accommodating eye** in which **parallel rays** of light entering the eye are brought to a **focus anterior to the retina.** It also can be described as the condition in which the **far point** of focus is **located at some finite distance in front of the cornea.** Thus, the uncorrected, non-accommodating myopic eye has some point at a finite distance beyond which objects are not seen clearly. At this far point, an object is in clear focus, but with increasing distances beyond it, the image becomes progressively more indistinct ***(Whitmore 1991).***

This far point is also defined as the **focal point** of the eye. The degree of myopia in diopters is found by determining the reciprocal of the far point or focal point of the eye measured in meters. Therefore, P = I/f (where P is the power of the refractive error in diopters and f is the distance of the far point or focal point of the eye in meters from the eye).

If the far point of an eye is at 33.3 cm, then the eye is1/0.333 m = 3.0 D myopic ***(Raviola 1985).***

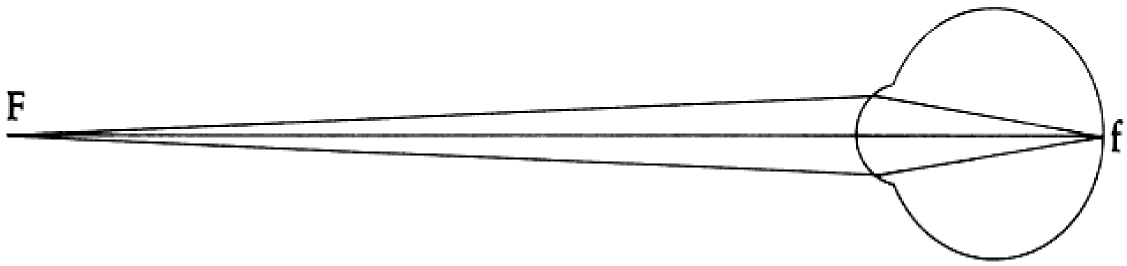

Figure 2: Light rays originating at the far point **(F)** of a -5-D eye focus at the retina. The far point and retinal focal point **(f)** are said to be conjugate (Duane clinical ophthalmology 2005).

<u>The prevalence of myopia:</u>

It varies with age, sex, race, ethnicity, occupation, environment, and other factors in various sampled populations ***(Mutti 2000).***

<u>Age of Myopia onset:</u>

A small percentage of children born myopic will not become emmetropic by 6-8 years. Additionally, children who were previously emmetropic or hyperopic may become myopic; the prevalence of myopia begins to increase at about the age of 6 years ***(Schaeffel 1995).***

Juvenile – onset myopia is defined as myopia with an onset between **7 and 16 years of age,** is due primarily to **growth in global axial length.** The earlier the onset of myopia, the greater is the progression.

Myopia starting after age 16 is less severe and less common. Refractive errors stabilize in about 75% of teens. In those who do not experience stabilization, progression continues into the 20-30s ***(Zadnik 1995).***

Adult- onset myopia begins at about **20 years of age**. Extensive near work is a risk factor ***(Zadnik 1995).***

Aetiology of Myopia:

Studies suggest that **mild to moderate myopia** may be **polygenic**. **Severe myopia** is probably **monogenic** in some cases, with different studies variously suggesting dominant, recessive, and rarely, sex-linked inheritance patterns. Monozygotic twin studies show a high concordance at lower degrees of myopia, with 74% of 28 twin pairs showing less than 0.5 D of difference ***(Fisher 1999)***.

Esophoria, against-the-rule astigmatism, premature birth, family history, and intensive near work are all reported **risk factors** ***(Fisher 1999)***.

It is conceivable that environment may have a substantial impact on the polygenic inheritance. **Krill** has observed that myopia produced by multiple genes is particularly susceptible to environmental influences.

Associations of Myopia:

Myopia has many associations with **systemic syndromes**, both inherited and sporadic. A large number of ocular conditions are also associated with myopia these include Aberfield syndrome ,Achard syndrome, Albinism, Alport syndrome, Congenital external ophthalmoplegia, Chromosome 18 partial deletion (long-arm) syndrome, Cornelia de Lange syndrome, Ehlers-Danlos syndrome, Forsius-Eriksson syndrome, Gänsslen syndrome, Gillum-Anderson syndrome, Gyrate atrophy, Haney-Falls syndrome, Hereditary ectodermal dysplasia syndrome, Homocystinuria syndrome, Hypomelanosis of Ito syndrome, Hypoparathyroidism, Kartagener syndrome, Kenny syndrome, Kniest's dise, Laurence-Moon-Bardet-Biedl syndrome, Marchesani syndrome, Marfan syndrome, Marshallsyndrome, Matsoukas syndrome, Meyer-Schwickerath and Weyers (oculodentodigital) syndrome, Myasthenia gravis, Noonan syndrome, Obesity-cerebral-ocular-skeletal anomalies syndrome, Oculodental syndrome, Pierre Robin syndrome, Pigmentary ocular dispersion syndrome, Riley-Day syndrome syndrome, Schwartz syndrome, Seiman syndrome, Stickler's syndrome, Syringomyelia, Trisomy 21 syndrome, Trisomy 22 syndrome, Turner syndrome, Tuomaala-Haapanen syndrome, van Bogaert-Hozay syndrome, Wagner's syndrome, Weill-Marchesani syndrome and Wrinkly skin syndrome (**O'hara 2005)**.

Myopia also has been associated with other **ocular syndromes** such as, Achromatopsia, Anterior lenticonus, Autosomal dominant cataract and microcornea, Bilateral blepharoptosis, ectopia lentis and high myopia syndrome, Choroideremia, Clefting syndromes, Coloboma, Congenital scleral ectasia, Congenital stationary night blindness, Ectopia lentis, Fabry's disease, Familial exudative vitreoretinopathy, Fundus flavimaculatus, Gyrate atrophy, Hereditary retinal detachment, Keratoconus, Microcornea, Microphakia, Microphthalmia, Myelinated nerve fibers, Nystagmus with or without amblyopia, Progressive bifocal chorioretinal atrophy, Retinitis pigmentosa, Retinopathy of prematurity, Vitreoretinal dystrophy and Wagner's disease (**O'hara 2005)**.

Nutrition has been implicated in the development of some refractive errors. Africa finds that children suffering malnutrition have an increased prevalence of high ametropia, astigmatism, and anisometropia (**O'hara 2005)**.

Types of Myopia:

Refractive and Axial Myopia: Myopia can be characterized as refractive or axial, although a continuum of the two types exists. **In refractive myopia**, the overall refractive power of the eye as determined by cornea and crystalline lens power, modified by anterior chamber depth, is excessive in relation to an eye of normal axial length (21.5 to 25.5 mm). The axial length is normal because it is the product of normal growth. **In axial myopia** there is an excessive elongation of the eye with respect to its refractive components. In these eyes, there is added expansion due to stretching of the scleral wall. It is of some clinical importance to appreciate that equal amounts of myopic progression are produced by smaller increases in axial length in refractive myopia compared with axial myopia ***(Whitmore 2005).***