The evolution of refraction in the fixing and the amblyopic eye

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Key words: Ocular refraction, amblyopia, fixing eye, ocular development, postnatal ocular growth, use-abuse theory

Abstract. The authors describe refractive changes in 61 children with unilateral amblyopia who were followed-up for 10 years. In each case the change was towards myopia. The various factors affecting postnatal development of the eye are discussed.

The refractive state of the eye alters progressively during infancy, adolescence and early adulthood partly due to true overall growth of the eye and partly due to differentiation of some of the refractive structures. There is a gradual lengthening of the antero-posterior axis from about 17 mm at birth to 23–24 mm when fully developed. The effects of eye growth are opposed by changes in refraction by the cornea and by the lens (Sorsby et al., 1961). These changes consist of progressive flattening of the cornea and continuing development of the lens. Corneal flattening decreases the curvature, causing a parallel decrease in convergence. Lens morphology is altered by the uninterrupted production of new lens fibres and the outer cortical layers become less curved than the inner layers, with a relatively greater optical density and consequently the total refraction by the lens is decreased (Duke-Elder, 1970).

If the only factor to affect the eye’s development after birth were the lengthening of the antero-posterior axis, development of myopia would be inevitable, but this does not occur because of forces opposing this myopia which are brought about by a decrease in the eye’s power of refraction. In most cases the result of these opposing forces is a state of emmetropia with underlying physiological hypermetropia (Shapiro et al., 1980).

The development of this delicate, complicated biological process can be influenced by various factors. With reference to this, Lepard (1975) investigated whether visual acuity and any initial refractive errors might influence the development of refraction by studying 55 children with a refractive error (with amblyopia) in one eye and with normal vision in the good, fixing eye. His conclusions are of great interest: the eyes with good vision showed a significant tendency to develop myopia whilst refraction in the amblyopic eye

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eyes not only did not alter appreciably but sometimes became more hypermetropic during the early years of development. This phenomenon has also been observed in amblyopic and normal eyes by Bielik et al. (1978).

These results are surprising because in the non-fixing eye they demonstrate a predominance of the forces reducing refraction over the myopic effects due to lengthening of the axis. Our study started from this stimulating thought and investigated the existence of the phenomenon. Within this scope we selected a number of amblyopic patients treated in the Orthoptic Department at Naples University (1st Faculty) who had been followed-up for at least 10 years by refraction in cyclopegia with atropine.

Methods and results

There were 61 children aged between 3 to 5 with amblyopic vision initially not greater than 3/10 in one eye, visual acuity of at least 8/10 in the other and no evidence of myopic refraction in either eye. Once or twice a year for 10 years these patients underwent refraction following cycloplegia with 0.5—1% atropine applied twice a day for 4 days. The initial and final results are shown in Table 1 and in the Figures.

Table 1. The number of amblyopic eyes per refraction are shown on the dark squares; those of the fixing eyes are shown on the striped squares.