

MYOPIA AND OPTOMETRY

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## INTRODUCTION

The scope of optometric care in clinical and educational settings is quite broad, but in private practice it is rarely possible for an optometrist to offer this full range of service. A majority offer contact lens services, but not everyone offers low vision services. And few offer the electrodiagnostic and biodiagnostic services that are now available in larger clinics. A private practitioner, of necessity, has limitations on the patients he can properly care for.

But no optometrist can exclude the myope from his professional care. Myopes are as routine to optometrists as children are to pediatricians. They are seen day after day, and receive professional care that is derived from each optometrist's understanding of ametropia, its etiology and its progression.

Professional opinions are likely to be different depending upon a practitioner's frame of reference. "Standard optometry," says Margach, "holds that vision is largely a composite of a group of human behaviors that, like the knee jerk, are genetically predetermined."<sup>26</sup> This is opposed by functional optometry which holds vision "as a learned human behavior...subject to significant modifications through environmental influences, both controlled and uncontrolled."<sup>26</sup>

If genetics is the only determiner of refractive error, then little can be done apart from compensation for that refractive error. But if ametropia is created by, or at least increased by detrimental, environmental influences, then it is logical to assume a position of prevention or control. It is this reasoning which has brought a large number of eye care practitioners into the arena of myopia control. A review of the literature regarding myopia, its etiology, and its control, is worthwhile.

## ETIOLOGY OF MYOPIA

In a 1955 review of the etiology of myopia, Snell discussed the following possibilities as forwarded by their proponents:

- excessive convergence (Foerster, Jackson, Harlan, Lancaster, Dvorak, Luedde).
- excessive accommodation (Cohn).
- heredity (Donders, Gifford, Sathaye, Sourasky).
- increased intraocular pressure on the head when bending forward (Levinsohn).
- congestion of the ocular coats leading to softening (Donders, Norris, Turner, Linder).
- too short an optic nerve (Hasner, Weiss).
- congenital deficiency of the sclera (Mauthner, Schnabel, Hernheiser).
- disorder of growth (Vogt, Stocker, Wood, Posey).
- extraocular muscle imbalance (Marlow).
- psychic and intellectual relations (Straub, Drualt-Tonfesco, Mills).
- endocrine dysfunction (Wiener, Haseltine, Bothman).
- avitaminoses (Knapp).
- constitutional diseases (Kasas, Donders, Morse, Sourasky, Rosenow, Nordgen, Smith).

Of these, he felt that "the most popular of all theories of myopia, even to the present day, has been Cohn's idea of school myopia."<sup>34</sup>

Francis Young agreed with this near work theory. In a review of the Pullman study of school children he felt that "only the amount of time spent in reading seemed to be related to the development of myopic refractive errors."<sup>44</sup> And his monkey and Eskimo studies<sup>42,46,48</sup> offered support for this near environment theory.

Curtin<sup>7</sup>, in 1970, outlined environmental induced myopia as prenatal, perinatal, or postnatal, including maternal illness, prematurity, nutrition, systemic disease, glaucoma, and ciliary muscle activity.

Then in 1976, Inkles concluded that there "appears to be substantial evidence supporting the following:

1. Excessive close work tends to increase the rate of myopic progression.
2. Nutritional deficiencies, especially protein deficiencies also tend to increase the rate of myopic progression."<sup>18</sup>

## PRESENT POSITIONS

Sorsby feels that "the traditional emphasis on environmental factors as productive of refractive errors finds no support in the detailed studies of today"<sup>35</sup> and that "emmetropia, correlation ametropia, and component ametropia are all genetically determined."<sup>36</sup> Contrast this with Young's statement that "two-thirds to three-quarters of refractive errors may be due to the types of near environmental conditions imposed..."<sup>45</sup> and it is obvious that opinions vary.

If Sorsby's 'refractive state' is the general set and Young's 'refractive errors' are the finished product, then Leary's reconciliation of the geneticist with the environmentalist seems appropriate. "If the environmental stress be considered as a function that has a constant trend toward myopia, it can modify or supplant that which genetics originally determined."<sup>24</sup> Apparently heredity starts the process which environmental factors, particularly near point stress and nutrition, guide and modify.

## NEAR WORK STUDIES

Young has been the researcher offering the most data regarding the effect of near environment upon refractive error. He points out that Eskimos in Barrow, Alaska have shown a marked shift in refractive error into myopia since the Federal Government made schooling for Eskimo children mandatory.<sup>48</sup> Monkeys in restrictive hoods were shown to develop significant amounts of myopia while their counterparts in the wild did not.<sup>42</sup> And Young<sup>43</sup> found that a cycloplegic could be used to decrease the myopic progression, just as Bedrossian<sup>1</sup> and Gostin<sup>13</sup> found decreased myopic progression in humans with cycloplegic therapy.

Kephart's survey of Colorado school children demonstrated "a definite trend toward a greater percentage of myopia with increasing school experience. Over the summer vacation period the percentage of myopia decreases indicating a recovery from the myopic trend resulting from school experience."<sup>19</sup> Hirsch

rejected Kephart's findings and concluded that "the myopic trend does not halt or reverse when the child is on vacation but rather continues at a similar or accelerated rate."<sup>15</sup> Kephart and Unger then studied school children in Indiana and found "the rural children are nearly emmetropic while the urban children are more myopic."<sup>21</sup> Furthermore, "a definite change in visual status occurs during the summer vacation period for school children; a lesser degree of myopia is exhibited in the fall than in the spring."<sup>21</sup>

Add to these findings the fact that "myopia is extremely rare, and almost non-existent in illiterate populations, but increasingly common in literate populations,"<sup>48</sup> and it becomes more difficult to deny the effect that the near environment can have on the refractive state.

#### MECHANISM

If near work does lead to myopic trends, and it appears that it does, then there has to be a mechanism by which the refractive error changes. The work of Young<sup>43</sup>, Bedrossian<sup>1</sup>, and Gostin<sup>13</sup> has already implicated the accommodative mechanism, but there is some difference of opinion as to how accommodation results in refractive changes. Sato, for instance, believes that "myopia is acquired through adaptive change in the refractive power of the crystalline lens and in the related systems..."<sup>33</sup> But there seems to be more evidence indicating that accommodation, through time, results in a change in the axial length of the eye.

Curtin<sup>7</sup> cited two opposing determinants of the size and shape of the eye, an expansion force from intraocular pressure and a resistance to expansion by the sclera. Though the short term effect of accommodation seems to be decreased intraocular pressure, the long term effect is just the opposite, an increase in the pressure.<sup>22</sup> Young<sup>48</sup> agrees that accommodation increases the intraocular pressure and cites the use of pressure transducers in the vitreous of monkey eyes to prove it. And this is consistent with Coleman's theory of accommodation which is based on

an analysis of the hydraulic forces in the eye.<sup>5</sup> Coleman's theory not only takes into account lens elasticity but also includes vitreous support as important during accommodation. Thus there would be an increase in the vitreous chamber pressure during, and as a causal factor of, accommodation.

Van Alphen believes that "the eye is born with a hypermetropic excess and it enlarges by growth and stretch. Growth is determined by genetic factors and stretch by the intraocular pressure."<sup>39</sup> Bell states that "physio-mechanical forces may sometimes be facilitated by extended periods of close work. The forces of ciliary contraction stretching the ocular coats as a result of sustained accommodation, and intermittent rises in vitreous pressure, also from sustained accommodation, are the most capable of altering scleral structure."<sup>2</sup> Therefore "stress actions on the sclera are capable of altering the refractive state of the eye by altering the sclera."<sup>2</sup>

Apparently the eye will follow a certain growth pattern that is genetically determined. This is the growth that the geneticists have been discussing for years. But the growth pattern can be altered by environmental factors, particularly those that would increase the intraocular pressure or decrease the resistance of the scleral coat to stretch. Therefore the environmentalists can cite nutrition, systemic disease, glaucoma, and ciliary muscle activity as etiological factors in myopic progression.

#### MYOPIA THERAPY

Not many consider genetic manipulations as part of their optometric services to mankind. Therefore if heredity was the only determinant of refractive errors there would be little in the way of prevention that could be hoped for. In 1965, Hirsch stated that "myopia has not yet been demonstrated to be preventable."<sup>16</sup> But heredity is not the sole determinant of the refractive<sup>state</sup>, and thirteen years after the statement by Hirsch, Margach<sup>26</sup> wrote about stabilizing, reversing, and preventing myopia. There

are those in the profession who believe that something can be done about the myopic trend.

Inkles listed the many therapies that have been proposed: "corrective lenses, eye exercises, drugs, contact lenses, visual hygiene, special schools without near work or athletics, operations on the cornea and sclera, lens extraction, diet, prisms, massage and compression, paracentesis, iridectomy, operations on the extraocular muscles, subconjunctival injections, and vitamins."<sup>18</sup> Some of these have been proposed for the treatment of pathological myopia, some are rather radical procedures, and only a few are feasible or desirable for routine use.

It is best to consider treatment regimens in light of the etiology and mechanism of progression of that which is to be treated. Therefore if scleral stretching results in increased myopia, and this stretching is a result of improper nutrition, then proper nutrition would be an obvious means of therapy. "If the sclera is the principle supporting tissue of the globe and its mode of development the principal factor in the shaping of the eye, then the availability of an adequate supply of amino acid building blocks (increased protein in the diet) and the presence of certain vitamins...would appear to be essential in the management of the myopic eye."<sup>6</sup>

Bell<sup>2</sup> discusses the role of vitamin C in collagen formation and development, as well as its intraocular pressure reducing qualities. Inkles points out that "the side effects of better nutrition in a pre-teenager are positive, rather than negative. Thus from the outset, nutritional therapy has certain advantages over the more tedious therapies..."<sup>18</sup>

Nutritional therapy might increase the resistance of the sclera to stretch, but because it doesn't affect the system which initially caused an excess stress, it isn't the only choice of therapy. "And the proposed mechanism of accommodation increasing the intraocular pressure causing scleral stretching and axial elongation need not be true to justify therapy aimed at decreasing

the accommodative effort. Young<sup>43</sup> and others<sup>1,13,37</sup> have implicated accommodation as the etiological factor apart from its actual mechanism, showing that cycloplegics decrease the myopic trend.

Accommodative effort associated with near work is reduced by cycloplegics, but this is obviously not a practical means of therapy. In 1975, Rehm<sup>31</sup> discussed the use of the myopter, an instrument which decreased both accommodative and convergence demands, but unfortunately the bulk of this instrument limits its usefulness. Therefore undercorrection or bifocals are still the simplest and most desirable means of decreasing the accommodative effort during prolonged near work.

#### BIFOCAL CONTROL

A survey of one thousand optometrists by Feinberg in 1959 indicated that "3 out of 10 children with myopia problems are provided with bifocals."<sup>10</sup> In the same year Mandell's study led him to conclude that "the bifocals used on myopic patients in this practice have not eliminated or reduced the progression of myopia beyond what might be expected to happen on a chance basis."<sup>25</sup> Oakley and Young criticized Mandell's study, pointing out that the bifocal wearers were younger than the control group and were progressing in myopia at faster rates from the start. Their own investigation led them to conclude that "bifocals seem to be a relatively effective means of controlling the progression of myopia although probably not as effective as atropine."<sup>29</sup> Oakley and Young therefore are members of the fairly large number who believe in the usefulness of bifocals for children.<sup>3,4,8,11,27,29,30,32,38,40,41,48</sup> Roberts and Banford referred to that number as "several thousand" as of 1967.<sup>32</sup>

If a practitioner is to use bifocals as a preventative measure, he must decide which patients will benefit. In addition, he must choose the prescription which is the most appropriate and effective.

Young feels that there are no reliable predictors of which



children will benefit from preventitive therapy and recommends "the institution of such therapy in all children who are myopic or who appear to be becoming myopic."<sup>48</sup> Birnbaum proposed that against the rule astigmatism may be a forerunner of myopia and that "clinicians consider the judicious application of plus lenses for nearpoint vision tasks in individuals who exhibit against-the-rule astigmia which is low in degree and can be presumed to be recent in origin."<sup>4</sup> Roberts and Banford concluded that "Our various statistical analyses provide strong evidence that children exhibiting esophoria at far and near, a high ACA ratio, and an indicated add in the near point net findings will progress more rapidly than their contemporaries showing more normal findings, if they are provided with single vision lenses...these are the very children showing the slowest rates of change when provided with bifocals."<sup>32</sup> They further stated that indiscriminately using bifocals on all juvenile myopes was as unwise as seldom or never using this technique.

There is presently no universal rule regarding the power of the prescribed near addition. Tait<sup>38</sup> advocated full distance correction with an arbitrary +1.00D or +1.50D addition. Oakley and Young<sup>29</sup>, in their investigation, undercorrected distance vision by 0.50D and used +0.75 to +1.00 additions. But Roberts and Banford<sup>32</sup> had found no advantage to undercorrecting distance vision. They found near prescriptions as indicated by near point findings as preferable to more or less plus, and the most effective bifocal additions tended to be +0.75 to +1.00D.

To date, the study of Roberts and Banford offers the most useable guidelines for identification of patients who will benefit from bifocal lenses. They also offer perhaps the best advice as to amount of added power to prescribe. Unfortunately, absolute guidelines have yet to be drawn.

#### CONCLUSION

Myopia is dealt with in optometric practices every day. It is not a very serious disorder, except in its more pathological

forms, and therefore its prevention seems less than crucial. The structural component of myopia which is genetically determined is something that a person is forced to live with. But the functional component, as well as any structural component created by function, is amenable to certain control.

With the understanding that accommodative stress plays a significant role in myopic progression, a practitioner can at least offer some simple advice. Proper reading distances, proper lighting, good posture, and occasional 'looking up' to more distant objects are all simple stress reducers which are easily understood by concerned parents.

Some situations, however, call for a more aggressive treatment plan. Bifocal lenses have been shown to decrease myopic progression and should be considered for children with obvious myopic trends, concentrated near habits, and clinically obvious needs for plus at near. This treatment plan may require more tact in case presentation, but should not be avoided simply because parents assume bifocals are for grandparents. Low powered plus additions should be prescribed when it is in the patient's best interest.

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