A 3-Year Study on the Effect of RGP Contact Lenses on Myopic Children

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ABSTRACT

Aim and Background: Recent studies in the West have shown that rigid gas-permeable (RGP) contact lenses can control the progress of myopia in children. These studies were done on Caucasian children, whose myopias are less rapidly progressive than those which we see in Singaporean children. This three-year study was started in 1993, with the following objectives:

1. **To verify whether RGP contact lenses can control the progress of myopia in Singaporean children.**
2. **If so, to investigate the mechanism by which the lenses control myopia; whether by corneal flattening or by reducing the growth of the axial length.**
3. **If so, to assess if the effects are permanent, by discontinuing lens wear.**

Materials and Methods: The study was carried out at the Eye Clinic of the School Health Service. Enough school children were referred to the clinic from the various schools to achieve about 100 children wearing contact lenses. Past studies showed that the drop-out rate would be 50%, as there is no cosmetic motivation in 10 year-old children to wear contact lenses. The successful wearers were those who had parental encouragement and support.

Results: The results show that there was a suppression of the progress of myopia in children wearing the lenses as compared to their counterparts wearing spectacles. However, only in ten eyes was there arrest of the myopia. For the lenses to be effective, they needed to be worn regularly for about eight hours a day. Reasons for the drop-outs included lack of motivation, lens intolerance and simply being too busy with the school curriculum.

Discontinuance of lens wear for more than 2 months had minimal effect on the refraction, indicating that the controlling effect was not due purely to corneal change.

Conclusion: It is recommended that more studies be done to confirm the findings of this study. Children with rapidly progressive myopia can wear rigid gas-permeable contact lenses to reduce the progression.

Keywords: rigid gas-permeable contact lenses, myopia, autorefraction, axial length, corneal flattening

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INTRODUCTION

For a long time there has been a clinical impression among contact lens practitioners that the progress of myopia in children is reduced when the child starts to wear rigid contact lenses. However, published results were conflicting[1-14].

Past studies

Past studies were mostly done with the old hard PMMA (Polymethylmethacrylate) contact lenses. The only study published so far on the use of a rigid gas-permeable lens was the Houston Study[15,16]. In 1985, Grosvenor et al fitted 100 myopic children with RGP lenses, matched with a control group of 20 single vision spectacle wearers.

Fifty-six remained in the study at the end of 3 years. Myopia increased by 0.16 D per year compared with 0.51 D per year in the controls. Over the 3-year period, mean increase in myopia was 1 D more in spectacle wearers.

Twenty-three subjects were then asked to stop using the lenses for 2 – 5 months. Mean myopia increase was 0.27 D, corresponding to a mean corneal steepening of 0.25 D.

Also of special interest is the study with PMMA lenses published by Janet Stone in 1976. Her study on 84 subjects showed myopia increase of 0.10 D per year compared to spectacle wearers' increase of 0.35 D per year. Corneal change was less than the change in refraction (myopia correction was not solely due to corneal flattening)[3].

Another good study was published by T Stuart Black-Kelly et al in 1975[2]. This was a study done in Bath, England, where there were five groups of subjects:

	Results
Group 1 : Control group - spectacles.	myopia increase 0.50 D per year
Group 2 : Atropine 1% tds for 1 week, Bifocals, & Phenylephrine 5% drops at night.	50% myopia arrested
Group 3 : Contact lenses only.	38% arrested
Group 4 : Contact lenses, group 2 failures.	65% myopia arrested
Group 5 : Atropine daily.	95% myopia arrested

Need for this study

The prevalence of myopia is increasing rapidly in our schools. Not only is the prevalence increasing but the degree of myopia has also increased. There is a fear that this trend will lead to an increase in the incidence of blinding complications of myopia, such as chorioretinal degeneration and retinal detachment. The pandemic nature in which myopia has spread suggests factors other than genetic at work. Local studies of Singaporeans showed a relationship between close work and myopia[17-19].

The School Health Service carries out annual visual checks on school children, and spectacles have been prescribed for school children over the years. The fact that myopia is on the rise indicates that although the wearing of spectacles clears the vision, it does nothing to control the progress of myopia. Some other alternative to spectacles is required.

Although some studies have shown that the use of rigid contact lenses can control the progress of myopia in children, these studies were done mostly in the West, where myopia is of a lesser degree and less progressive. The effect of these lenses on the Asian eye may not be the same. There is therefore a need for more of such studies to be carried out on our school children in Singapore, as they have one of the highest prevalences of myopia in the world.

Loopholes in such studies

There are many loopholes in such studies, which have made ophthalmologists skeptical about the results. Possible loopholes are :

1. Age of subjects
   It has been shown that myopia stabilizes somewhere between 18 and 23 years of age. The subjects for this kind of study should therefore be younger, otherwise when arrest or control of myopia occurs, it is questionable whether it could have been due to age. It has also been shown that the most rapid progression of myopia occurred between 8 to 13 years of age[20-22]. After this age, the rate gradually decreases until about age 20.
2. Bias of subjects
   The subjects should not be chosen by the observer. The children were randomly selected from the various schools in Singapore. They were then randomly selected for contact lens wear. From past studies, it was learnt that the drop-out rate would be 50%. To achieve 50 regular C L wearers, we therefore required 100 C L wearers. Many who were randomly picked for contact lens wear refused, and many who wanted to wear contact lenses were told they could not.
3. Overcorrection
   There have been criticisms of past studies that the contact lenses prescribed were overcorrected. We paid special attention to this by doing a cycloplegic refraction, and by not overcorrecting for astigmatism.
4. Accuracy of refraction
   To maintain objective refractive readings, the refractions were done under cycloplegia. Cycloplegia also eliminated the pseudomyopias.
5. Repeatability of tests done
   We found that the tests done were quite repeatable (intra- and interobserver). Cycloplegic autorefraction was found to be a repeatable objective method of refraction. The reliability of keratometry has been shown to be in the order of +0.25 D[23]. Accuracy of A-Scan ultrasound measurements with a hand-held probe has been found to be 0.2 mm[24]. We limited the number of people performing tests to four. All measurements were done at least 3 times, and the average reading was taken. All measurements were done on a Saturday morning and with the same equipment.
6. Matching cohorts
   The study and control cohorts should be matched in terms of age, sex, initial refraction and astigmatism. As mentioned above, there was a preponderance of higher myopes in the contact lens cohort. Otherwise the 2 groups were reasonably matched in terms of age, sex, and astigmatic error.

Change in corneal curvature

There is little doubt that rigid contact lenses can alter the shape of the cornea. Morrison in 1956, showed that myopia can be stabilized by fitting a contact lens flatter than the flattest meridian (orthokeratology)[1]. Over a two-year period, 1021 myopes aged 7 – 19 years were fitted with PMMA lenses and showed no progress of myopia. The fitting was 1.62 to 2.50 D flatter than the flattest corneal meridian. Several years later, he showed that the progress of myopia was also arrested when the fitting was "on K". In 1977, Kerns compared 26 conventional wearers with 36 orthokeratologic wearers[9]. The subjects had 1 D less myopia. Polse in 1983, compared 40 conventional wearers with 40 subjects. The subjects had 1 D myopia reduction while the controls had 0.50 reduction. There has recently been new interest in orthokeratology (accelerated orthokeratology) as an alternative to excimer laser surgery[11,12].

The question now is whether rigid gas-permeable contact lenses can control the progress of myopia without flattening the cornea (ie. without orthokeratology).

From the above studies, the following important points are to be noted :

i. For corneal change as seen in orthokeratology to occur, the lenses need to be fitted 1 to 2.5 D flatter than the flattest K reading[12]. In our study, the lenses were fitted "on K".

ii. Orthokeratology with the conventional design rigid lenses take 1 to $1^1/_2$ years to complete.

iii. Accelerated orthokeratology requires special lenses (with steeper secondary back peripheral radius)[11]. The lenses we used were the usual rigid gas-permeable lenses.

iv. Axial length reduction due to corneal change is negligible (about 1 D if there is 6 D corneal change)[12]. Maximum corneal change in orthokeratology is only about 3 dioptres.

v. Complete return to baseline levels occur 77 days after discontinuing contact lens wear. This is why our subjects, who agreed to discontinue wearing, were asked to do so for more than 77 days. (Tredici, however, showed that complete return to the original corneal curvature occurred in 3 to 8 weeks with PMMA lenses)[10].

vi. Corneas of eyes that have a higher degree of myopia are more difficult to change because they tend to be more rigid[12].

Objectives

The objectives of this study were therefore :

1. To verify whether RGP contact lenses can suppress the progress of myopia in Singaporean children.
2. If so, to investigate the mechanism by which the lenses control myopia; whether by corneal flattening or by controlling the growth of the axial length.
3. If so, to assess if the effects are permanent, by discontinuing lens wear.

To achieve the above objectives, we needed to do the following:

a. Compare the increases in myopia between a cohort of children wearing RGP lenses with a cohort of similar children wearing spectacles. This can be shown by a graph comparing the rates of increase in myopia between the 2 cohorts, and by comparing the mean increases in myopia per year of the 2 cohorts.

b. Compare the amounts of corneal flattening between the 2 cohorts.

c. Compare the increases in axial length between the 2 cohorts.

d. Study the effect of the discontinuance of lens wear – whether the refraction remains the same after discontinuance of C L wear.

e. Study the effect of lens wear on the astigmatism, and on the anterior chamber depth.

f. Assess the importance of the hours of lens wear, and whether there is minimum wearing time required for the lenses to be effective.

Definition of terms

Myopia: "A refractive error which has a spherical equivalent of -1 Dioptre or more." Any astigmatic value, if present, is included as a spherical equivalent refraction.

Refraction: "This is performed by the autorefractometer 45 minutes after the commencement of cycloplegic eyedrops." This is because the duration for adequate cycloplegia is about 45 minutes.

Cycloplegia: "Cycloplegia is induced by the administration of 1% Cyclopentolate eyedrops every 5 minutes (a total of 3 doses).

MATERIALS AND METHODS

As early as 26 February 1991, the first author approached Dr Uma Rajan, Director of the School Health Service, about conducting this study because there was an increasing prevalence of myopia in our school children. The following equipment were made available for the study:

Autorefractokeratometer (Nidek, ARK 900 model);
Ultrasound A-Scan, with hand-held solid probe (Sonomed, 1500 model);
Slit-lamp Microscope with Goldmann's Applanation tonometer (Neitz, SL-H1-Model).

Gas-permeable vs PMMA contact lenses

It is well-known that PMMA hard contact lenses are not gas permeable and can cause corneal hypoxia in the form of "Sattler's Veil" (corneal oedema), "Spectacle Blur" and "Overwearing Syndrome". Such corneal changes alter the refraction of the eye and will give errors in the refraction test, causing increased myopic finding. These changes are temporary and variable, and a true finding can be obtained if the lenses are removed for a few days before the tests are done. The authors believe that this is contributory to the fact that past studies done with PMMA lenses were contradictory. We persuaded the contact lens manufacturer in Japan, Menicon Co Ltd, to supply 150 pairs of rigid gas-permeable contact lenses (Menicon Ex), and later, Visitech Pte Ltd in Singapore, to supply another 150 pairs of RGP lenses free for the study (Fluoroperm 60). The lenses were fitted "on K", and most of them had diameters of 9.2 mm, optic zone widths of 7.8 mm and centre thickness of 0.20 mm. The fitting was done by the first and second authors (K C Y and J C).

Soft vs rigid lenses

There are 3 reasons why soft lenses were not used:

1. Soft lenses have a higher incidence of ocular complications.
2. Soft lenses do not correct astigmatism well.
3. In past studies, small increases in myopia have been noted with soft lenses.

Subjects

Singapore is divided into six zones by the School Health Service for its health screening services. The subjects for the study were randomly selected and referred to the Eye Clinic of the School Health Service on a Saturday morning.

Criteria for inclusion

The following criteria were set for the inclusion of the subjects:

1. Chinese school children aged 10 years to 12 years. Ten years of age was chosen because children younger than 10 years would have difficulty with insertion and removal, and hygiene. We excluded all other races in order to exclude racial factors.
2. Corrected visual acuity of 6/6 or better for each eye.
3. Myopia with no more than 3.00 D of astigmatism.
4. No significant binocular vision problem.
5. No underlying eye disorder.
6. No previous contact lens wear.

Measurements

The measurements carried out included cycloplegic autorefraction, keratometry, axial length and anterior chamber depth. They were carried out by the same four nurses or technicians and with the same equipment to reduce interobserver inconsistencies. All measurements were made at least 3 times, and the average taken. All measurements were done on a Saturday morning, and with the same set of equipment.

Measuring corneal change

Stone, in her study published in 1976[3], concluded that about 50% of the control of myopia in her contact lens subjects was due to corneal flattening. The other 50% was due to axial length shortening. There was, however, no measurements made of the axial length.

This finding seemed to be in keeping with the 2:1 ratio claimed by orthokeratologists, that the reduction in myopia is about twice the dioptric amount of corneal flattening as measured by the keratometer[7,8].

Grosvenor et al's study published in 1990 showed again that less than 50% of the control of myopia was due to corneal flattening (average of 0.37 D). Complete keratometry data were not available for the spectacle wearers, but it was assumed that there was little or no change in keratometer findings in the spectacle wearers based on the results of other studies[3,25].

Erickson and Thorn[26] studying four orthokeratology studies, found that some reduction in myopia was unaccounted by the keratometer readings, and that this might be due to corneal flattening occurring inside the portion of the corneal surface not measured by the keratometer.

Grosvenor et al applied this conclusion to their study and suggested that it was likely that a significant amount of apical corneal flattening might occur, not measured by the keratometer. It was also suggested that corneal topography would be able to demonstrate this.

There was no corneal topography machine available at the start of our study. It was debated on whether we should send our subjects to the Singapore National Eye Centre for the measurement or not; this would have put a greater strain on the children, in terms of time and money.

The other reasons why we did not do corneal topography were:

i. We planned to persuade the contact lens wearers to discontinue using their lenses for more than 77 days[13] to allow for the cornea to regress. A refraction was then done, which would reflect apical change.
ii. We were not fitting flatter than the flattest meridian (as is done in orthokeratology).

RESULTS AND DISCUSSION

Analysis

a) Both eyes
Some past studies analysed the results of only one eye (the right eye) of the subjects. We decided to include both eyes as they were sometimes different in their refractions and in their responses to contact lens wear. This was indeed found to be true when the statistical analysis was done. The results were statistically more significant for the left eye than for the right in the axial length and corneal flattening findings.

b. Spherical equivalent
We decided to take the spherical equivalents as the dioptric readings in our calculations.

c. Average keratometer reading
The average keratometer reading was used in the calculations involving corneal curvatures. As in past studies, the dioptric reading and not the mm reading was used.

d. Change in corneal curvature
It was decided to use the refractive astigmatic findings for assessment of the shift of corneal curvature from with-the-rule to against-the-rule or vice versa. This was considered to be more accurate as the keratometer did not measure within the 3 mm chord diameter.

Motivation for contact lenses

Past studies showed a drop-out rate of about 50% in young children wearing contact lenses. This is not surprising, as there is no cosmetic motivation at this age. The successful wearers were those who had parental encouragement and support. Generally speaking, these were the children who had been changing glasses every six months or so due to a rapid progression of myopia of 1 or 2 dioptres a year. The contact lens wearers with lower degrees failed to adapt as well to their contact lenses due to a lack of motivation (see profile of drop-outs below). We were surprised to find that most of the children could tolerate RGP lenses, and could manage with the insertion and removal. Only in a few cases were insertion and removal of lenses done by the mothers. Children of mothers who were highly myopic and/or who wore lenses themselves were more likely to accept them.

Profile of subjects

Those children, whose degrees were increasing rapidly, and their parents were more motivated to use contact lenses. The successful C L wearers were more highly myopic than the spectacle wearers: the mean initial degree of myopia was 1.31 D greater for the C L wearers. The initial astigmatism was fairly similar for the 2 cohorts. Sex distribution was also fairly even: for C L wearers, it was 18 males and 27 females; and for the spectacle wearers, there were 16 males and 29 females.

Contact lens wearers

We had 105 children wearing contact lenses. By the end of the study, 49 had dropped out. Of those who were still wearing , 10 were irregular wearers, wearing only intermittently and not every day. One defaulted and could not be contacted. One was lost to follow-up because she went abroad. They were excluded from the study group. We were left with 45 regular wearers.

Reasons for drop-out

Twenty of the drop-outs gave discomfort as the reason. Others said they had "no-time", especially in the mornings when they were rushing to go to school. The problem of time became more acute when the children were in Primary 6, when they had to prepare for their Primary School Leaving Examination (PSLE). Some said that it was too "troublesome". Other reasons were lens dislodgement, difficulty with insertion or removal, puffy lids and simply "not keen". It is interesting to note that there were two cases who dropped out, and when they found that their degrees were increasing again, they decided to get back on the study.

Ocular complications

No one dropped out because of ocular complications. There were a few cases of allergic conjunctivitis and one of superficial punctate keratitis. Although a hotline for emergencies was made available, no one utilised it.

Wearing time

Of the regular wearers, most of them could wear at least 7 hours every day. Only 6 failed to achieve this. It was felt that 7 hours a day was a reasonable wearing time to achieve, although the few who failed to achieve this also had fairly good results. It was generally felt that the higher myopes were more motivated to wear, but there were wide individual variations in the results, and we could not correlate the effectiveness of C L wear with the length of wearing time. As the children became more adapted to the contact lenses, they were able to wear them for longer periods of time. Some increased from 3 hours a day to 16 hours a day.

Some children required maternal assistance in insertion and removal of the contact lens. One dropped out because whenever he developed "dust problem" in school, his mother was not there to remove the lens. Breakages were not too common, and replacements were not a cause for dropping-out.

Most preferred to wear their lenses to school. Some did not wear whenever they had physical education (PE). Some wore their lenses only at home and a few did not wear them during the weekends.

Myopia progression

The results show that the effect of the use of contact lenses is seen within the first year of wear (Fig 1). The mean increase in myopia per year is reduced to 0.42 D as compared to the mean increase in spectacle wearers of 0.78 D (Table I). There was therefore a suppression of the progression of myopia by 0.36 D every year (0.78 – 0.42 D). These results were found to be highly statistically significant ($p < 0.0005$). Eighty percent of the C L wearers had less increases than the mean increase of the spectacle wearers. Although the graph shows a difference in the annual increases, there were a few wide individual variations in progression within both groups of subjects. Even though the mean increase in myopia for C L wearers was 1.32 D after 3 years, one eye decreased in myopia by 0.81 D and another increased by 4.17 D. Similarly for the spectacle wearers, although the mean increase was 2.32 D after 3 years, one eye increased by 0.69 D and another by 5.46 D.

The increase in myopia is seen at every dioptre to be higher with the use of spectacles. Our results also show that, contrary to popular belief, high myopia (above 6.00 D) does continue to increase, and that the increase in myopia in the spectacle wearers is seen to be slightly higher with the higher myopes.

Axial length

As the child grows, it is expected that the axial length will also grow. Fig 2 shows that contact lens wear controlled the axial length increase. The mean increase in axial length per year for C L wearers was 0.22 mm, while for the spectacle wearers it was 0.31 mm (Table II). The reduction in axial length growth was therefore 0.31 minus 0.22 mm, ie. 0.09 mm. This is equivalent to 0.23 D reduction. (Studies with the Schematic Eye have shown that as the axial length of 1 mm changes, and if uncompensated for, will cause a change of 2.5 D in the refraction). The difference between the two cohorts is a statistically significant finding ($p = 0.008$). It is interesting that the results of the left eye were statistically more significant than those of the right eye.

The reduction in axial length therefore accounted for 0.23 D of the 0.36 D reduction in myopia per year. The remaining amount of 0.13 D (0.36 – 0.23 D) is therefore attributable to corneal changes.

Corneal flattening

Generally speaking, it has been shown by Sorsby that the larger the globe, the flatter will be the cornea[27]. This was substantiated in our study. As the axial length grew, there was corneal flattening in the spectacle wearers. The mean corneal flattening for spectacle

Table I – Mean annual increase in myopia

For spectacle wearers	=	0.78 D
For contact lens wearers	=	0.42 D
80% of the C L wearers had less increases than the mean increase of the spectacle wearers.		
Suppression of the progression of myopia	=	0.36 D

Table II – Mean increase in axial length

For spectacle wearers	=	0.31 mm
For contact lens wearers	=	0.22 mm
Suppression of A L growth	=	0.09 mm
Schematic eye calculations:		
1 mm A L change	=	2.50 D
∴ Suppression	=	0.23 D
Suppression of myopia (0.36 D) minus Suppression of A L (0.23 D)	=	0.13 D
Corneal flattening measured by the keratometer	=	0.08 D
Corneal flattening calculated from the refraction	=	0.14 D

wearers was 0.07 D (Table III). Calculations are based on the average of the steepest and flattest corneal meridians. For the C L wearers, there was slightly more corneal flattening (Fig 3), the mean being 0.15 D. The difference was therefore 0.08 D, being the amount of corneal flattening due to contact lenses. There was a subtle shift to against-the-rule astigmatism. This is not unexpected as the contact lenses were fitted in alignment with the flattest meridian.

The mean corneal change worked out to be 0.29 D against-the-rule, which gives a corneal flattening equivalent of 0.14 D:

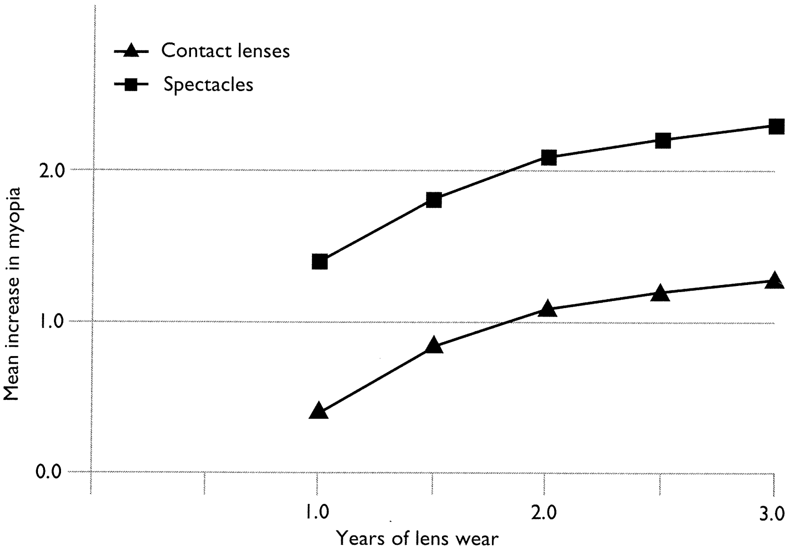

Fig 1 – Mean progression of myopia.

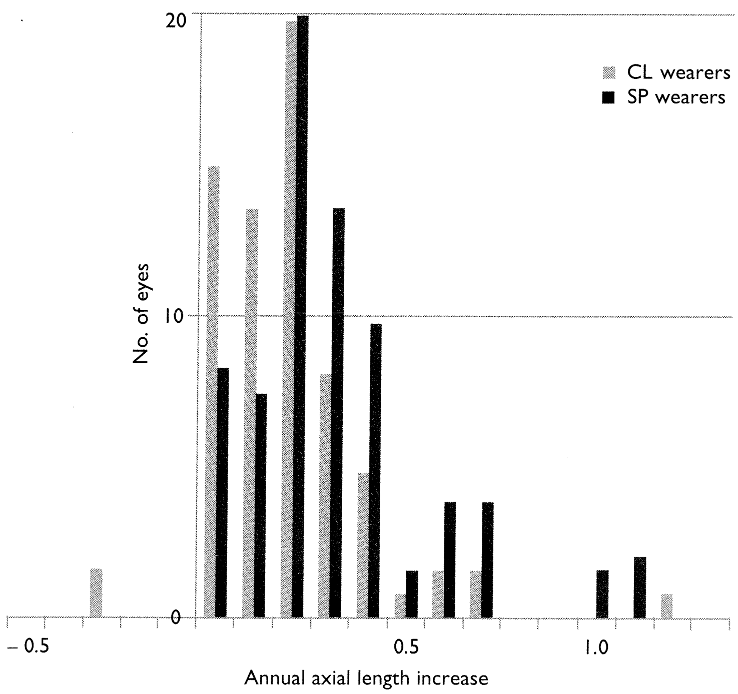

Fig 2 – Axial length increase

Table III – Mean corneal flattening

For spectacle wearers	=	0.07 D
For contact lens wearers	=	0.15 D
Suppression of myopia due to corneal flattening	=	0.08 D

Mean change in corneal curvature

Spectacle wearers	: 0.36 D with-the-rule
Contact lens wearers	: 0.07 D with-the-rule
Change due to C L wear	: 0.29 D against-the-rule

This latter result was worked out from the refraction findings which reflect apical corneal change (vector analysis). It would seem that the keratometer has under-estimated the amount of corneal flattening because it does not measure the apical cornea.

The difference between the two groups was found to be statistically significant ($p = 0.002$). As with the axial length data, it is interesting that the results of the left eye were statistically more significant than those of the right eye.

The difference in corneal flattening between the 2 groups was 0.08 D, whereas the difference in myopia decrease was 0.36 D. The proportion is much less than the 2:1 ratio reported in the western studies. It is likely that this is due to the fact that the corneas of eyes which have a higher degree of myopia are more rigid, and therefore less malleable[12].

Anterior chamber depth

There was a deepening of the anterior chamber by 0.03 mm (mean per year) in the spectacle wearers, while there was hardly any change (mean) in the C L wearers. As accuracy of the A-Scan measurement with a hand-held probe is only 0.2 mm[24], it is not appropriate to attach much significance to this result. It was also statistically shown that the results were not significant.

Discontinuance of C L wear

We asked some of the C L wearers to stop wearing C L, to confirm that the effect of stabilisation was not due merely to a corneal change. If corneal only, then the change will not be permanent, and regression will occur. It has been shown that complete return to baseline levels will occur 77 days after discontinuing C L wear. Therefore those who agreed to stop wearing were asked to do so for more than 77 days. Unfortunately, most of the C L wearers refused to stop wearing. Objections came from the parents who said that after persuading their children to wear C L, they did not want to ask them to stop wearing them. We could persuade only 6 to do so.

It was Erickson and Thorn[26], studying 4 orthokeratology-studies, who found that some reduction in myopia was unaccounted for by the keratometer findings, and suggested that this might be due to apical corneal flattening occurring inside the portion of the corneal surface measured by the keratometer. If this was true, then it would be more accurate to examine the refraction before and after discontinuing C L wear. There was little change in the refraction after discontinuance, indicating that the

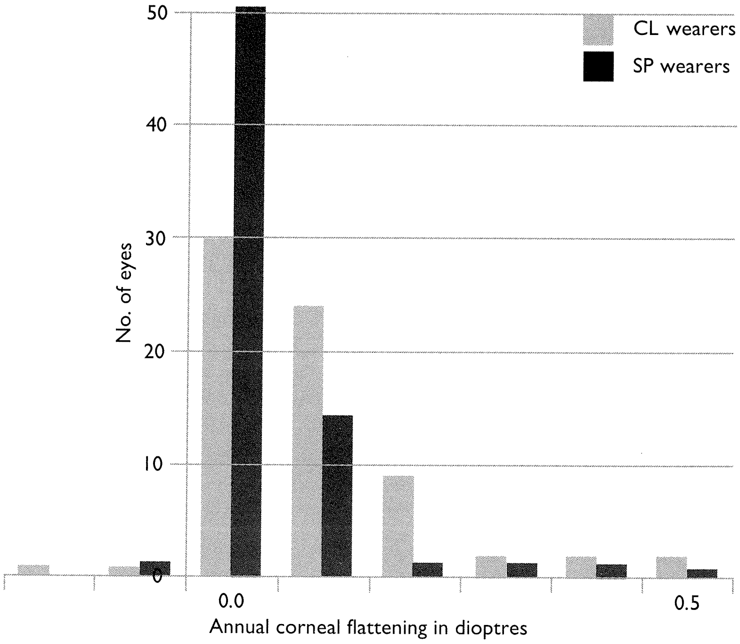

Fig 3 – Corneal flattening

effect of C L is not merely corneal. The mean increase in myopia after discontinuance was 0.11 D. The mean corneal steepening was 0.05 D, which was due to a regression towards the direction of with-the-rule astigmatism. There was also a mean increase in axial length of 0.07 mm, and anterior chamber depth of 0.08 mm.

Profile of drop-outs

There were 49 drop-outs. The profile of the drop-outs corresponds to the profile of C L wearers, although there were more drop-outs among the lower myopes. This was because the contact lens wearers with lower degrees failed to adapt as well to their contact lenses, due to a lack of motivation.

Outliers

As stated above, there was wide inter-subject variation within the two groups. This may be due to the nature of myopia itself, and to intra- and inter-observer variations in the measurements. The use of RGP contact lenses, instead of PMMA, and the use of cyloplegic auto refraction have contributed to more reliable results for this study than for past studies.

Statistical analysis spotted the presence of a few "outliers" in the data. Rather than discarding the outliers, the data were subjected to the Kruskal-Wallis ANOVA procedure (which is non-parametric). The results were consistent with the t-test results.

CONCLUSIONS

This three-year study has shown that RGP contact lenses can suppress the progress of myopia during its most rapid phase of development from 10 to 13 years of age. The mean increase in myopia per year for the RGP lens wearers was reduced to 0.42 D as compared to a mean increase of 0.78 D in the spectacle wearers (Table II). Eighty percent of the children wearing RGP contact lenses had a mean increase of less than 0.78 D. However, there is wide inter-subject variation and it is not possible to predict which child will do well. It can be said that the child whose myopia is rapidly progressive will be more likely to be a successful C L wearer because the parents will be more motivated to encourage and help the child. The results would have been better if there was better compliance with C L wear.

The results also show a controlling effect on the growth of the axial length (Table II). It must be remembered that children at this age are still growing, and it is to be expected that there will be axial length growth, as the rest of the body grows. The difference in axial length growth, ie. the suppression, was 0.09 mm. This translates to 0.23 D decrease in myopia (per year). As the total amount of myopia suppression was 0.36 D (Table I), the remaining suppression of 0.13 D was most likely due to corneal change. This was confirmed by the keratometer reading (Table III), which gave a mean corneal flattening difference of 0.08 D. This corneal change was seen to be due to a shift in the corneal shape towards against-the-rule astigmatism, which is to be expected when the contact lenses were fitted in alignment with the flattest meridian. Calculations from the refractive findings showed a mean corneal flattening equivalent of 0.14 D. When the C L wear was discontinued, the cornea regressed to its initial shape.

Past studies were conflicting because of the wide inter-subject variations, lack of equipment to do reliable measurements, and because PMMA hard contact lenses were used. As more studies with RGP rigid lenses are done, it is hoped that a clearer picture will emerge, although results will still be variable because of the wide inter-subject variation which exists. With the development of newer methods of measurement to reduce intra- and inter-observer variation, it is hoped that this inter-subject variation will narrow.

In the meantime, how contact lenses can suppress the progress of myopia is open to conjecture. Animal studies have shown that the reduction in quality of the retinal image (visual form deprivation) can produce myopia[28-30]. This suggests that the spectacle lens may aggravate myopia. The higher the degree, the thicker the lens, and the worse the peripheral distortion of the image. The spectacle lens also does not correct astigmatism as well as the RGP contact lens. For the high myope with astigmatism, the RGP contact lens offers unquestioned optical advantages. Otsuka[4,6] showed the importance of the full correction of corneal astigmatism in suppressing myopia. There is little doubt in our minds that the RGP contact lens is a superior way of correcting myopia in offering the least visual form deprivation to the eye. However with the contact lenses which are presently available, only about 50% of children can adapt to them. It is conceivable that with the development of better materials for contact lenses, offering higher DK values and improved comfort, more children will be able to adapt to contact lenses. New techniques of fitting will also improve on the comfort of lens wear.

Recommendations

1. It is recommended that more studies be done to reduce inconsistencies due to the wide inter-subject variations.
2. It is recommended that children with rapidly advancing myopia may be fitted with RGP contact lenses. It is this group of patients who need treatment, and who are more likely to succeed in contact lens wear, as they and their parents are more motivated to use them.

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