An Ethnic Comparison of Anterior Segment Characteristics: A Preliminary Report

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Introduction

With the introduction of more sophisticated keratometers it has been possible to construct model corneas upon which "off the peg" type contact lenses may be designed. These are typically aspherical, gas permeable and perhaps ultimately disposable, but essentially contoured to the "average" cornea.

Traditionally however one prescribed individually designed, PMMA lenses which may be retrospectively modified as required and indeed clinical experience frequently suggests variations from the norm can and do occur. Further we practice in a multi-racial society in an era of international travel which must prompt one to question if a lens design on say a Caucasian model cornea is equally compatible to a cornea of another patient from a different racial group? The purpose of this paper is to overview some differences in the corneal topography of various ethnic groups in addition to presenting preliminary results of a larger on-going study.

Racial Classifications

Racial classification is complex, enigmatic and often contradictory. Differences between people come from many sources but are broadly divided into those that are hereditary or genetic and those due to environment. Furthermore, these two factors interact with each other in that the manifestation of the genetic factor depends on the environment.

Both J. Z. Young (1971) and C. S. Coon (1965) write of three major "poles" of differences among the world's people:

1) The Negroids are the principal inhabitants of Africa and generally are dark skinned and spiral haired. Facial features show common everted lips, a broad nose and dark irides.

2) The Caucasoids are the major inhabitants of Europe and Northern America. In general they have the fairest skin and the greatest frequencies of blond hair and light eyes and are characterised by a thin nose and lips.

3) The Mongoloids mainly live in Asia. The principal morphological traits of the mongoloids include coarse, straight black hair, little beard and body hair, yellowish skin, flattish faces with prominent cheek bones. Their noses are either low bridged or aquiline.

Their eyes are generally brown with slanted eyelids. Epicanthic eyefold is of higher percentage than the other racial populations.

A fourth, smaller population grouping of genes may be called Australoid, characteristic not only of Australian aborigines but of other people in parts of the East Indies. Their genetic build up shows a dark skin but other characteristics of body form and of hair resemble those produced by Caucasian genes.

Structural or morphological variations may of course be considered in terms of regional groupings of genes coupled with presumed environmental interaction. In fact, the distinction of genes usually changes gradually with distance. Therefore, in other words, the components of men's biological variability change gradually with geographical distance, as for instance, the situation of skin colours, head shape and blood groups. This graduation in distribution makes it impossible to divide men into sharp distinct races and in describing sub-races one may have to rely on a common central tendency from which exceptions can and do occur (Coon, 1965).

Central Keratometry

Data on the corneal contour is of course most readily available from conventional keratometry. The K readings from 100 white Caucasians and 100 mongoloid corneas prior to contact lens fitting were selected from our records and compared. To facilitate analysis all subjects were myopes under four dioptres and aged between 18 and 35. From Table I it can be seen that the mongoloid corneas were steeper than the Caucasians, the difference being significant at the 1 per cent level (t-test).

If these results are compared to the published data on emmetropic negroids (Babalola and Szajnzicht, 1960) it can be shown that the latter eyes are probably larger and show a significantly flatter mean K value than either of the other two races (p<0.005) and is probably associated with the postulated correlation of corneal curvature and axial length (Sorsby, 1957).

Our Mongoloid group were entirely Chinese and it is of interest to consider if they are truly representative of the Mongoloid race. If the corneal radii of this control group are compared to published data as illustrated in Table II the mean K readings of the Chinese corneas appear no different to Eskimos (Alsbirk, 1977) but significantly flatter than the flatter K readings of Japanese eyes (Amano and Tanaka, 1968). Variations in the age distribution of subjects in the three groups cannot of course be ruled out as a contributing factor although it is suggested this is unlikely to be a significant factor. Alsbirk (1977) was unable to demonstrate any significant age variation in the mean K readings of Eskimo corneas and it is probable that the Japanese subjects of Amano *et al* presenting for contact lens fittings were pre-presbyopic myopes.

Anecdotal evidence suggests that patients examined by practitioners in Northern Ireland showed flatter and more toric corneas than other white Caucasians. To investigate this claim the K readings of 100 patients seen in a practice in Colraine, N. Ireland (Laverty, 1984) were carefully matched and compared to our control group as shown in Table III. The results were the opposite to what might have been anticipated in that the Ulster corneas were not flatter but significantly steeper, p<0.001 compared to our control group of white, mainly English corneas. It is of course possible that if a Celtic group say from the West Coast of Ireland had been evaluated the results could have been different and this avenue of investigation is being pursued.

The frequency distribution for our three control groups is shown in Figs. I and II.

Peripheral Corneal Flattening

The impetus for the present investigation came from the clinical observation that hard corneal lenses such as the Menicon O₂, presumably designed from an oriental model eye, provided adequate edge clearance in Chinese but not in Caucasian corneas even allowing for the permeable nature of the material. This suggested that Mongoloid and Caucasian corneas may flatten to a different extent and this was reported in a pilot study (Loran, Lam and Watson, 1983). Two groups, Chinese and white Caucasian were matched for K readings, refractive error and age and the horizontal shape factor was measured between 12 noon and 3.00 pm with a Humphreys Auto-keratometer on fourteen corneas in each group. Each cornea was measured centrally and 12.5 °nasally and temporally resulting in 504 measurements and as illustrated in Table IV the shape factor of $\pm 0.12 \pm 0.08$ in the Orientals and $\pm 0.20 \pm 0.038$ in the Caucasians. This corresponds to flattening indices of 0.88 and 0.80 (Bennett, 1968) suggesting that if our small samples are truly representative then compared to their European counterparts, the Chinese corneas flattened significantly less (5 per cent level, Chi-square test).



Corneal Sensitivity and Thickness

It has been shown that although no significant differences occur in the corneal touch threshold in subjects with Heterochromia (Millodot, 1976), blue eyed people have significantly more sensitive corneas than brown eyed people (Millodot, 1975). Negroids and Mongoloids have almost 100 per cent dark hides whereas Caucasoids will vary from the dark eyes of Mediterraneans and Indians, to the mixed iris colours of Western Europeans and the blue eyes of the Nordics. The corneal epithelium is a continuation of the epidermal layer of the skin and one might therefore speculate that patients exposed to bright sunlight would manifest thicker skin with more pigmented melanin and also thicker corneas with darker irises. Douthwaite and Kaye (1980) have shown that corneal sensitivity is inversely related to thickness. It has also been shown (Alsbirk, 1978) at a latitude of 79"North that the central corneal thickness of male Greenland Eskimos were on average 0.024mm thinner than male Danes living temporally in Greenland. Furthermore the corneal thickness in the Eskimos reduced with age suggesting that environmental factors such as Arctic conditions may be significant. In general one might anticipate that darker races might have thicker and less sensitive corneas correlated with eye colour. It is intended to investigate this hypothesis further.

Retrospective Study

In order to compare the relative contact lens wearing success of different groups a retrospective study was undertaken of UMIST patients fitted with PMMA corneal and standard thickness (C.T.-0.12mm) 38 per cent Hema daily wear lenses. Two groups of Chinese and Caucasoids, each of 32 patients were matched for range of age, refractive error and K readings. All patients were aged 18-35, were myopes under 4.0D with K readings between 7.60 and 8.00 in the flatter meridian showing less than 1.0 D of corneal astigmatism. The criteria of Sarver and Harris (1971) was used for the comparison in which the percentage of patients achieving successful wear was considered. The parameters, after 4 to 6 months wear, included satisfactory wearing time (8 hours plus per day), subjective assessment of comfort, a contact lens acuity comparable with spectacles, and contact lens induced changes within acceptable limits.

The results showed no significant overall difference between the Mongoloid and Caucasoid soft lens wearers or between subgroups. However a significant difference (p < 0.001, Chi squared) did occur with the relative success in PMMA corneal lens wearers. The Indian (N=10) and white Caucasians (N=15) adapted equally well at 87 per cent success which is better than the Mediterranean (N=3) at 75 per cent or Mongoloids (N=16) at 59.4 per cent as illustrated in Fig. III. It may be that the Chinese eyes were fitted with lenses with excessive edge lift, designed on a non-mongoloid model eye. A larger retrospective study, including hard gas permeable lenses, hyper-thin, and also high water content hydrogels, is necessary however, before one can attempt a meaningful racial prognosis for a specific material or contact lens design.



FIG (111) RETROSPECTIVE STUDY OF PHMA CORNEAL CONTACT LENS HEARING SUCCESS

Striaie

The presence of deep stromal striaie at approximately 6 per cent corneal swelling is now generally accepted as a manifestation of hydrogel lens induced corneal oedema (Sarver, 1971). In addition (Kamiya, 1980), has reported horizontal striaie at 4 per cent corneal swelling although to the authors' knowledge this has not been reported elsewhere in the literature and prompts the question: "Are horizontal striaie confined to mongoloid corneas?" At present this question remains unanswered.

Summary

The evidence from the literature, in addition to our preliminary soundings, suggests that significant ocular variations may occur between differing racial groups. These are probably due to biological, genetic, environmental and miscellaneous factors and confirm the need for further investigation. However, well defined sub-groupings of the three primary races is especially difficult due to racial admixtures, and inter-breeding coupled with cultural, religious and linguistic departures within smaller sub-groups. In a larger on-going study by us summarised in Tables V, VI, VII the samples of population will be restricted to specific geographical areas on the assumption that each is truly representative. It is hoped to present the results and check possible implications on contact lens design and prognosis at a later date.

Table I. Racial comparison of central K readings

Race	Investigator	N	Flatter K	Steeper K	Diff	Mean
Caucasian	Loran & Lam (84)	100	7.88	7.75	0.13	7.81
			±0.29	±0.30	±0.12	± 0.09
Mongoloid	Loran & Lam (84)	100	7.79	7.63	0.16	7.71
			±0.19	±0.22	±0.05	20.06
Negroid	Babalola &	33	-	100 C	-	7.98
	Szajnzicht (60)					+0.03

Table II. Mongoloid comparison of central K readings

Race	Investigator	N	Flatter K	Steeper K	Diff	Mean
Chinese	Loran & Lam (84)	100	7.79	7.63	0.16	7.71
			±0.19	±0.22	± 0.05	± 0.06
Japanese	Amano & Tanaka (68)	180	7.54 ±0.22	-	-	-
Eskimo	Alshirk (77)	511	-	100	\sim	7.76

Table VI.

Subject acceptance profile for the main investigation 1) Male — it has been found that menstruation

affects corneal thickness and sensitivity.

2) Age between 18 and 28, since age affects sensitivity and corneal contour.

3) No prior contact lens experience or have not

worn contact lenses on a regular basis.

4) Free from all ocular and systemic pathology.

5) Subject receives no medication.

6) Spherical component of spectacle prescription

between piano to 4.00DS.

7) Corneal astigmatism under — 1.00 D.

8) Flattest corneal meridian between 7.50 and 8.10mm.

Table VII.

Protocol for the main investigation

							Characteristic Ocular Parameter Visible Iris & Pupil Diameters	Instrument/Method mm graticule in American Optical Co C.L.C. Ophthalmometer
							Corneal Contour	Wesley Jessen
								Photo electric keratoscope (PEK 2000)
							Central & Peripheral Corneal	Zeiss Electronic, Digital
Table 1	II. Caucasian co	omn	arison o	f central	K read	dings	Thickness	Pachometer
		- P					Corneal sensitivity & fragility (with heat sealed nylon tip)	Cochet & Bonnett aesthesiometer
1.11	101112111220	\$200	1221011122	220000000	1232	122000	Tear chemistry	(a) wetting value
Race	Investigator	N	Flatter K	Steeper K	Diff	Mean		(b) viscosity
English	Loran & Lam (84)	100	7.88	7.75	0.13	7.81		(c) sequential staining
	- 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10		±0.29	±0.30	± 0.12	±0.09	Pigmentation (skin, sclera, iris	Graded 0-4
N Irish	Loran, Lam &	100	7.73	7.59	0.14	7.68	& choroid	(Munsell Colour Chart)
	Laverty (84)		±0.13	± 0.10	±0.03	±0.17		

Table IV. s

Shape Factor

Index of

0.80

0.88

Flattening

Peripheral cor	neal flattening	of matched	i groups
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0.20

+0.038

0.12

 ± 0.080

N

14

14

Race

White

Caucasoid

Chinese

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aesthesiometry.

Table V.

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Racial	CLASSI	tication	tor the	main	investigation
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Race or Sub-Race Mongoloid Chinese	N 50
Caucasoid	150
White	50
Mediterranean	50
Indian	50
Negroid	50

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