STUDIES IN THE AETIOLOGY OF PTERYGIUM

Part 1—Pinguecula and Pterygium in Caucasians in Singapore

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SUMMARY: The disease of pterygium is described as seen in Caucasians over a period of three years in Singapore.

The complexity of opinions on aetiology is discussed and the possibility that ultra-violet solar radiation might be the cause is propounded.

Introduction

When corneal epithelium near the corneo-scleral junction suffers damage, epithelial cells from the conjunctiva can slide across the limbus so that an epithelial bridge joining conjunctiva and cornea may become a permanent feature of the eye. This condition is known as " Pseudo-pterygium " and it is said that a diagnostic feature is that one can pass a probe under the bridge.

If, however, chronic pathology in the superficial corneal layers spreads gradually from the limbus towards the centre of the cornea, the resulting migration of conjunctival epithelium, sub-conjunctival connective tissue and new vessels leads to a wing-shaped, fleshy lesion whose apex moves gradually over the cornea. This is the disease of Pterygium (πτερυξ—a wing) suffered by millions living in peri-equatorial regions. It is a cause of much discomfort and disablement, and, in neglected cases, blindness (Fig. 1).

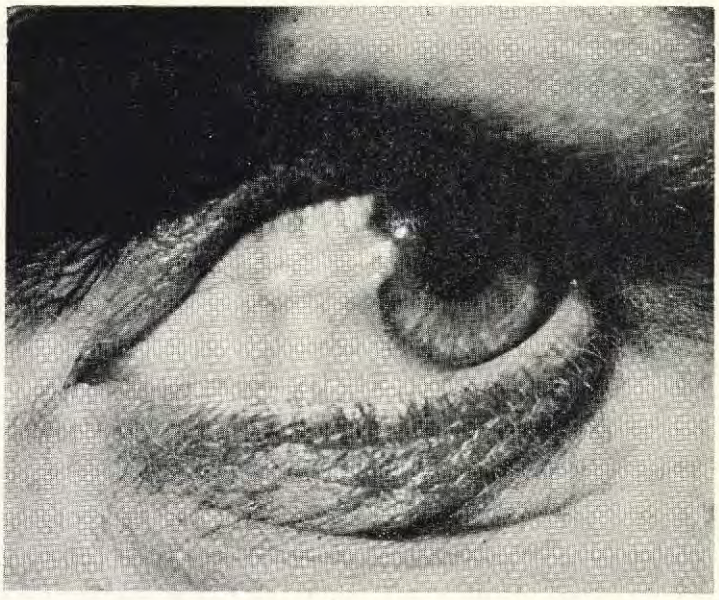

Fig 1. Pterygium in a 40 year old Englishwoman, who had spent three tours in the Tropics. The condition was bilateral.

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During a three year tour in Singapore many hundreds of cases of pterygium have been seen, mostly among Gurkhas, Malays and Chinese but also, in significant numbers, among Australians and, to a lesser extent, in Europeans. Interest in this fascinating and enigmatic condition has grown with increasing experience.

Pterygium occurs only in those resident for three years or more in the zone between 40° North and 40° South of the Equator. Only the interpalpebral areas of conjunctiva and cornea are involved and the condition occurs on the nasal side far more often than on the temporal side. When temporally-situated pterygium occurs it almost always follows a pre-existing nasally-situated pterygium. The apex of the lesion may move right to the centre of the cornea, but never beyond. In its progress it tends to cause tension flattening of the horizontal meridian of the cornea and a consequent astigmatism, which can be relieved by surgical excision (Bedrossian, 1960); but the tendency to recurrence after excision is so great and regrowth so rapid that it is necessary to supplement surgery by anti-mitotic doses of β-irradiation. Even this measure often fails to prevent recurrence. None of the many different operations which have been described for the removal of pterygium is uniformly successful: personal experience suggests that recurrence follows any procedure which allows conjunctival epithelium to slide, post-operatively onto the cornea. In the light of these facts there has, understandibly, been a good deal of interest in the subject of prevention of pterygium. The aeteology, however, remains speculative, notwithstanding considerable research, and the literature is growing apace.

Aetiology

Conclusions on the aetiology of pterygium are notable for their diversity. Thus, recent papers attempt to implicate such factors as drying of the tear film (Elliot, 1967); diet (Parthasarthy and Gupta, 1967); working in sawmills (Detels and Dhir, 1967); infrared radiation, chemical irritants and dust (Saif et al, 1967). Perennial arguments about the relative importance of wind, dust and sunlight and about the significance of pinguecula as a pre-pterygial lesion, continue unabated and apparently unresolved.

In his comprehensive review of the literature up to 1964, Duke-Elder (1965) mentions as suggested aetiological factors (and mostly without prejudice) heat, dry atmosphere, high winds, dust, dessication of epithelia, reduction in lacrimal secretions, fumes from oil wells, heredity, ultraviolet radiation, extension of pinguecula, neoplastic change, corneal ulcer, episcleritis, trachoma and other conjunctival infections, allergy, trophic changes, malnutrition, choline deficiency, raised blood cholesterol, a "neurotrophic condition" of the conjunctiva, circulatory disturbances and the mechanical effect of the extraocular muscles on the eyelids.

Opinions are apt to vary with the geographic location: workers in the Middle East are likely to be impressed by the significance of chronic exposure to dust whereas those, whose patients enjoy a maritime ecology, will tend to dismiss this hypothesis. Ophthalmologists who practice exclusively in the United Kingdom need have no opinions at all. The observation by Norman-Hansen (1911) that pterygium is common in Eskimos, seems to preclude dust as an essential aetiological factor, but it has not been possible to check this reference.

In the light of this spectrum of opinion on the cause of pterygium, it is tempting to postulate a multiple and variable aetiology. But Occam's Razor, having served us well in the past, should not lightly be discarded, and it may be more profitable to consider what factor or factors are common to all pterygium groups.

Discussion

Cameron (1965) has amply demonstrated the peri-equatorial distribution and it is a matter of common observation that even very chronic irritative influences do not normally produce pterygium in people permanently resident in temperate areas. It does not necessarily follow that pterygium is caused by exogenous geographical factors. One might, for instance, postulate an ethnic constitutional tendency to pterygium. But such a hypothesis must give way before the increasing number of observations of cases of pterygium occurring in expatriates from non-pterygium areas, after some years of residence in zones with a high incidence of ptygerium. Another interesting circumstance, in this context, is the incidence of pterygium among Australians, especially in Queensland. Since these are, for the most part, ethnically identified with Western Europe, it would seem that endogenous racial factors are probably irrelevant. As a general rule Europeans in the tropics succeed, rather better than do the mass of the local population, in protecting themselves from the environment. Nevertheless, in three years of ophthalmic practice in Singapore, many European patients have been seen who are suffering from chronic conjunctivopathy with large pingueculas featuring hyaline degeneration, neovascularisation and progressive extension towards and across the limbus. In some cases, by regular bio-microscopic examination, it has been possible to note the onset of the corneal pathology (punctate epithelial staining and the appearance of small islets of opacity just below the epithelium) and to watch the evolution of the fully-developed pterygium. This can occur very rapidly and in spite of energetic conventional treatment by protection and local steroids.

Whether or not tropical pinguecula is a necessary preliminary to pterygium, there is no doubt that, in South-East Asia, pinguecula can, and regularly does, progress to pterygium. Picó (1965) referring to the findings in the climatically analogous Puerto Rico, draws the same conclusion.

All of these European patients have been exposed to the tropics for periods of three to twelve years and those with the longest exposure have the most marked changes. This does not, of course, necessarily imply a linear causal relationship. Those who have lived longest in the tropics are, ipso facto, the oldest, and we may possibly be seeing no more than the effects of immediate solar irritation on an age-sensitised tissue.

Clinically, tropical pingueculas differ so strikingly from the harmless, asymptomatic, degenerative lesions seen in most aging Caucasians as to justify the regular adoption of the adjective. Their chief feature is an acute inflammatory element, and day to day clinical experience suggests that the invasive phase with its oedema, hyperaemia, new-vessel growth and subjective discomfort is essentially an inflammatory process spreading to link up with the corneal epithelial and sub-epithelial damage which is the precursor of manifest pterygium. Observations on established pterygia are of limited value because, ironically, the manifest lesion, from which the name derives, far from being the essential lesion, actually forms a screen to conceal the underlying basic pathology from the enquiring eye.

The writer's interest in the possibility that ultraviolet solar radiation might be the cause of this inflammation was aroused by two independent circumstances. The first was the remarkable similarity, qualitatively if not quantitatively, between the clinical features of the early invasive stage of pterygium and those of the kerato-conjunctivitis resulting from accidental exposure to a large dose of ultraviolet light (U-VL) from an

artificial source such as a " Sun-ray " lamp or an electric welding arc. The most striking feature of both is the punctate corneal epithelial damage: in the case of the U-VL burn this localised cellular destruction is obviouslly the result of the radiation acting directly on cell nucleo-protein. The acute inflammatory reaction induced by U-VL in the conjunctiva is also paralleled in the pre-pterygial stage.

The second circumstance was the gradual realisation that attendance rates of patients with pterygium and tropical pinguecula varied strikingly with the state of the weather. During, and for a few weeks after, periods of cool, cloudy weather the number of such attendances dropped sharply. This realisation led to the observation that there was a close correlation between the cloudiness of the weather and the quiescence of pterygia and pingueculas. Even more impressive was the corollary: when sunlight intensity was high, most of the cases under surveillance showed an increase in the bulk of the pterygium, from increased vascularisation and hyperaemia, and there was an increase in the incidence of extending lesions. Granted, this may be " post hoc sed non propter hoc " but we regularly base clinical decisions on less suggestive evidence than this.

It is tempting to postulate that high pterygial incidence occurs in the equatorial belt because, there, sunlight falls most perpendicularly and is least attenuated by the atmosphere. Visible light covers a spectrum from about 780 nanometres (red) down to about 380 nm (violet). Solar radiation extends down to about 100 nm (soft X-rays) but, fortunately, an ozone belt in the upper atmosphere cuts out all U-VL below about 290 nm. The wave-band between 320 and 380 nm is called U-V.A and has few important biological effects, but U-VL of wavelength between 280 nm and 320 nm (U-V. B) can and does damage deoxyribonucleic acid (DNA) and has shown to be a cause of skin carcinoma.

Atmospheric attenuation of these radiations is clearly of the greatest importance. Obviously, attenuation at any point on the earth's surface will be greatest when the sun is near the horizon. It follows that the period around noon, in tropical areas, is the most dangerous and that perhaps we ought to have paid more attention to the admonitions of Sir Noel Coward!

Cameron's pterygium map shows that although all the areas of highest incidence are peri-equatorial, there are some regions near the equator with a lower incidence than some further away. It is therefore necessary to account for these exceptions of which one notable example is Ceylon. Speaking at the 3rd Pan-Asian Congress of Ophthalmology in Singapore in 1968, Sivasubramanian suggested that the observed incidence of less than 1 per cent (of about 90,000 patients) might be explained by the two annual monsoons and the ample cloud cover secondary to the particular topography of the island.

A comparison of pterygium incidence with figures for annual average solar radiation is illuminating. Budyko (1963) has prepared a world map showing isorads of average radiation, in which figures of 120 to 200 kilolangleys occur in the 40° North to 40° South belt. The correlation with pterygium incidence is shown in Table I.

Admittedly, these figures are far from complete and considerably more detail is required, especially of incidence of pterygium. Unfortunately, real statistics of pterygium incidence are almost unobtainable: figures derived from ophthalmic clinics do not, of course, give any useful information on incidence. Through the courtesy of the Com-

Table I

Correlation of pterygium with figures for annual average solar radiation

Area	Pterygium incidence per cent	Average annual solar radiation (Kilolangleys)
Correlation good		
NE African litoral, Canal Zone	10+	200
NE Australia	10+	180
Caribbean	10+	180
Madieras	10+	180
Central America	10+	160—180
Hawaii, Samoa	10+	160—180
Cocos Islands	5—10	140—160
E Australia	5—10	140—160
Borneo, New Guinea	5—10	140—160
Indonesia, Malaysia	5—10	120—140
Equatorial Africa	5—10	100—140
South Africa	2—5	140
S and SW Australia	2—5	140
Correlation poor		
Arabian Peninsula	5—10	220
India, Burma	5—10	160—180
Ceylon	Less than 2	160

mander-in-Chief, Far East and the High Commissioner of the Western Pacific, the writer has initiated enquiries into the feasibility of obtaining figures for some of the Pacific Island populations. Such data is of additional interest, as pterygium appears to be particularly common among tropical islanders.

Enquiries have shown that currently available data on solar radiation is also somewhat unsatisfactory. Some of the published figures are not derived from actual measurements but are estimated from cloudiness data. There is, however, a large volume of solar radiation figures, as yet unpublished, held by the World Meteorological Organisation, Geneva, so the basis of a usefully detailed correlation exists, if pterygium figures can be obtained.

The more deeply one reads into the literature of pterygium the more obvious it becomes that current ideas on the subject are based on statistically dubious data. A number of small studies, such as those of Hilgers (1959 & 1960) on pterygium on the island of Aruba offer figures of real value (it is of interest, incidentally, to note that Hilgers found that the incidence differed with race) but a great deal more work of this kind will have to be done before speculation gives way to demonstrable fact. A number of intriguing puzzles also remain: why, for instance does pterygium occur in only a proportion of the members of a susceptible society? why does pterygium advance at different rates in different individuals? why does it always start on the nasal rather than on the temporal side of the cornea? why do pterygia never occur on the sub-tarsal limbus? why do excised pterygia recur in spite of protection from ultraviolet light? why do highly active pterygia recur most readily and most rapidly after excision? I hope, in the course of the next two parts of this series to suggest plausible answers to some of these questions.

(*See References on Page* 130)