THE ETIOLOGY OF PRIMARY CATARACT.

BY

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DESPITE the fact that primary cataract has a strong personal interest for so many of us, its causes have been, and still are, veiled in a mist of uncertainty which all our efforts have failed to pierce and which even now shows little signs of lifting. Nevertheless, it may prove profitable to review our knowledge of the subject and to consider it in the light of discoveries made in other branches of medicine. So long as we remain in ignorance of the causes of the disease we shall be unable to prevent its occurrence or to bring it to a standstill once it has commenced to develop, and the treatment is likely to remain, as hitherto, mainly surgical.

It is not proposed to consider here forms of cataract caused by purely local conditions, such as those varieties which follow trauma, detached retina, intraocular tumours, retino-choroiditis, and inflammatory exudations on the lens capsule, or such as are due to developmental defects in the lens vesicle, but only those progressive and non-progressive forms which may be considered to be primary in nature.

Amid the general obscurity certain known facts stand out clearly. These are:

1. *A cataract is the result of a degeneration of the fibres or cells of the lens.*

This degeneration may be due to a cause which is active for a limited period only. In this case the cataract is likely to be non-progressive—for example, punctate cataract, lamellar cataract, etc. In the case of a non-progressive cataract the opacity resulting from the degeneration becomes buried in the substance of the lens by the subsequent growth of healthy fibres around it. The cause may, on the other hand, be one the action of which is continued; a progressive type of cataract—such as senile or presenile—is then produced. It is likely that, if a large portion of the lens fibres have degenerated, the degenerative process may continue, even though the primary causes have ceased to be active.

2. *Primary cataract is nearly always bilateral.*

This indicates that the cause of the disease must be sought for in some constitutional and general change or defect. The cataract may grow more rapidly and may be more advanced in one eye than in the other, but it is exceedingly rare to find the occurrence of uncomplicated primary cataract limited to one eye. When the cataract is further advanced in one eye than the other it will often be found that the more affected eye is the subject of an uncorrected error of refraction of long standing. In some cases it will be found that a correcting lens has been worn in a faulty position. An eye which is the subject of an uncorrected error of refraction and strain appears to be specially liable to the ocular complications of diabetes, nephritis, syphilis, and focal sepsis; it is natural, therefore, to expect that such an eye may be exceptionally susceptible to cataract formation should a constitutional cause of the disease be present. Asthenopia, due to refraction error, is occasionally associated with a bubble-like opacity situated in the anterior cortex very close to the capsule. When examined with an electric ophthalmoscope, in the aperture of which a *plus* 12 D lens has been placed, the opacity is found closely to resemble a bubble of gas seen at the bottom or on the sides of a tumbler containing soda-water. These opacities may, on rare occasions, disappear after the error has been corrected.

3. *Certain conditions are generally admitted to predispose to the development of cataract.*

Senility, diabetes, pellagra, the ingestion of certain poisons, and rickets are the most prominent of such conditions; but cholera, gastro-intestinal disturbances, focal infections, and debilitating general conditions are considered by many to be factors in the causation of cataract.

4. *An hereditary predisposition to the disease exists.*

The lens cells of some persons, therefore, suffer from an inherited susceptibility to certain noxious influences, or the organs and tissues of their bodies inherit a defect which allows disturbances in their function to occur with unusual facility; such disturbances injuriously affect the nutrition of the lens fibres.

5. *Convulsions of the type found in tetany have frequently been followed by the development of cataract.*

The observations of Noël Paton and Findlay suggest that tetany is due to a defective action of the parathyroid glands; these ordinarily detoxicate a guanidine compound derived from muscular metabolism; tetany occurs if this process is interfered with. Fischer and Triebenstein claim to have found evidences of tetany and latent tetany in 88.2 per cent. of cases of senile and presenile cataract, whereas such evidences were only found in 8.3 per cent. of control cases free from cataract.

6. *Cataract has been observed to follow the removal of the thyroid, either for experimental purposes or for surgical reasons.* Thyroidectomy is not, however, always followed by cataract, and, assuming the operation to be complete, some additional factor must be present to cause the disease in such cases. In this connexion it must be remembered that it may be difficult to avoid injury to or removal of the parathyroids in the execution of a thyroidectomy. The writer has seen cases of cataract associated with hypothyroidism, the history and course of which strongly suggested that the ocular condition was dependent upon deficient endocrine function.

7. *Excessive glare may be a contributing cause of cataract.*

A peculiar form of slowly progressive cataract is found amongst bottle-makers and furnace workers. Its frequent occurrence among such workers suggests that the rays which emanate from a furnace may, in some cases, be capable of inducing a degeneration of the lens fibres; the fact that they do not invariably do so suggests that additional factors, possibly of a constitutional nature, may be present in those workers who become affected by the disease. Exposure to excessive heat and glare may also be one of the reasons why cataract occurs with such frequency amongst natives of India. The disease, however, does not appear to be unusually common amongst well-nourished Europeans of middle age who are resident in the country, so that such exposure is probably no more than a minor cause of cataract. It is of interest to note in connexion with this subject that Elliot states that he has met with a proportion of cataract amongst retired Anglo-Indians, which strongly suggests that residence in the East influences the liability to the disease. It has been stated that the opacities of commencing cataract are most commonly found in the lower part of the lens, and it has been suggested that this is due to the fact that the bulk of light rays come from above and, falling upon the lower portion of the lens, affect it injuriously. The writer is not at all convinced by his experience in India that, in that country at all events, the lower portion of the lens is much more frequently attacked by early cataract than other areas. Elliot has pointed out, however, that a great part of the light entering the eye in the tropics is reflected chiefly from the ground, and that the eyes are often protected by a solar topee or turban from the light which comes from above. In the tropics, therefore, one would expect to find that injurious rays affect the upper part of the lens at least as commonly as the lower.

8. *Cataract occurs more commonly in India than in most other countries.*

After making due allowance for the fact that the proportion of competent surgeons to the size of the population is small, the vast numbers of cases of cataract dealt with by individual surgeons in India leads one to the irresistible conclusion that the disease is extraordinarily common in that country. The great number of persons, blind from cataract, met with on the roads and streets is confirmatory evidence. All classes of the native population appear to be affected, but the disease seems to be more prevalent among the poorly fed lower classes than among the well-to-do. Cataract also seems to be most common in the hotter, drier, and more arid districts.

The differences between the Indian and the European, which bear on the subject, may be divided into three groups: (a) constitutional; (b) dietetic; (c) general surroundings.

(a) *Constitutional.*—The average Indian matures at an earlier age than the average European and, as a rule, he pays the penalty for this by an earlier occurrence of the retrogressive tissue changes due to senility; these changes are shown in the lens by a comparatively early appearance of presbyopia and by the fact that the accommodative power of a

middle-aged Indian is rarely equal to that of a European of the same age. Gastro-intestinal troubles afflict most residents in the tropics, whether Indian or European, but the European is usually in a better position to deal with these than the Indian is. Helminthiasis is extraordinarily common amongst Indians: at least 70 per cent. of the general population in the south of India suffer from hookworm disease.

The prevalence of pyorrhoea, in a very advanced degree, amongst better-class Indians is a most striking feature in the south of India, and probably in other parts of the country too. The disease is very common among the lower classes also, but these do not appear to be so generally affected as those who are more wealthy. The soft nature of the diet, the habit of betel chewing, and a fondness for sweets seem important factors in the causation of the condition.

A large number of Indians suffer from diabetes. The disease appears specially to affect those of the well-to-do and upper classes, and it is interesting to note that it sometimes has an undoubted connexion with pyorrhoea. The writer frequently found that the urine of a patient suffering from glycosuria rapidly became free from sugar when his pyorrhoeic teeth had been extracted and he had been rendered free from oral sepsis. Patients have often told him that they had formerly suffered from glycosuria, but that they were then free from the disease. Such patients were found on examination to be edentulous, the pyorrhoea from which they used to suffer having undergone a natural cure. A large proportion of Indian patients operated upon for cataract in private practice suffered from glycosuria.

(b) *Dietetic*.—The diet of Indians varies greatly in different parts of the peninsula, and is also influenced by circumstances of caste and religion. Despite these differences, the fact that the bulk of the diet is composed of a dry grain is a feature common to all. A lack of fresh vegetables exists in the diet of most Indians, especially those of the lower classes. During many months of the year fresh vegetables are only obtained with difficulty in the more arid parts of the country—even by the well-to-do. The dietary of Indians is consequently poor in essential food factors, and this deficiency is accentuated by the probable paucity of such substances in the vegetables, etc., grown in the hot season. McCarrison has found that the milk of cows fed upon dry fodder lacks essential factors which the milk of cows fed upon fresh green stuffs contains; long-continued hot, dry weather is thus likely to exert some influence upon the occurrence of diet deficiencies. His observations also show that the endocrine glands are injuriously affected by a deficiency of vitamins in the food, and that the harmful effect is likely to be enhanced if the diet is badly balanced and contains an excess of carbohydrates. This lack of essential food factors is frequently shown in India by the occurrence of beri-beri, scorbutic conditions, and keratomalacia.

(c) *General Surroundings*.—Exposure to heat and glare and a life passed in bad hygienic surroundings are the characteristics of the general conditions under which most Indians live. As stated above, exposure to glare may have some influence upon the causation of the lens degeneration from which they so often suffer, but other additional factors are likely to be required to produce cataract. Bad hygienic surroundings may sometimes cause constitutional conditions which favour the occurrence of cataract, but their influence in this connexion is probably slight. The tropical sun is a powerful ally of the sanitary officer in the rural districts, and, owing to its influence, many villagers escape punishment for their hygienic errors.

It has been suggested that the sclerosis of the lens fibres, which normally occurs with advancing age, is the cause of cataract. Magnus considered that the resistance to the flow of nutritive fluid, offered by the sclerosis of the nucleus, was an important factor, and Becker supposed that an unequal and irregular sclerosis produced a stress and strain upon the cortical fibres which led to the formation of clefts and spaces between them. When considering the consequences of sclerosis it must be remembered, however, that although opacities are present in the lenses of very many people who are advanced in years, yet the proportion of old people affected by progressive cataract is not very high. Obviously, since sclerosis of the lens almost invariably occurs with the advance of age, and progressive cataract does not do so, this hardening of the lens cannot be considered to be the chief cause of senile cataract. Sclerosis of the lens cannot account for those cases of presenile cataract which occur at an age when the hardening of the nucleus is negligible. In discussing the causes of primary cataract it is important to consider all

forms of the disease together, and to avoid concentrating the attention upon one particular variety.

The lens epithelium, owing to its ectodermic origin, might be expected to react injuriously to influences towards which allied ectodermic structures display a special susceptibility. Some evidence exists that this occasionally occurs in the case of conditions associated with a deficiency of thyroid secretion; but, when one remembers that the lens is a purely passive structure, and that the nutritive requirements of its fibres are very limited, one would expect its response to noxious influences to be small and tardy. The difficulty of tracing the cause of a cataract in any particular instance is considerably enhanced by this fact.

A consideration of the conditions which are generally admitted to predispose to cataract shows that most, if not all, are such as are likely to be accompanied by marked disturbances of the endocrine organs. Senility is, perhaps, the condition which is most often associated with cataract. Failure of the generative glands to function fully is a leading feature of senility, and, owing to the delicate balance that exists between the activities of the internal secretory organs, such failure must require a compensatory effort on the part of the other endocrine glands. Satisfactory compensation occurs in most cases, but its establishment may sometimes be rendered difficult, or may be prevented by the existence of other factors, such as infections, food deficiencies, and hereditary influences.

Diabetes is generally recognized to be associated with a disturbance of the endocrine organs, and it is possible that such a disturbance may be a more powerful factor in the production of a diabetic cataract than the presence of a minute quantity of sugar in the aqueous humour. This latter may, however, be a contributing cause of the lens degeneration. Pellagra is a disease considered by many to be due to a food deficiency. Considerable disturbance of endocrine function occurs in it, and symptoms of hypoparathyroidism, such as "Chvostek's sign" (mechanical irritability of the facial nerve) and brittleness of the nails, are common.

Gastro-intestinal disturbances, infections, and the food deficiencies and conditions of malnutrition so common in India, are also causes of defective endocrine function, and may in this way affect injuriously the nutrition of the lens and render its fibres liable to degeneration.

It has been suggested by Peters that the cataract which follows tetany may be due to an irregularity in the supply of lymph, caused by a cramp of the ciliary muscle during the fits; tetany, however, is a manifestation of defective endocrine function—in this instance of the parathyroid—and it is possible that the cataract may be caused by a defect in the quality of the lymph rather than by a defect in its quantity. In any case the number of cataracts, the cause of which can be ascribed to convulsions, is by no means great and only represents a very small proportion of the primary cataracts met with; it is quite possible, however, that minor degrees of parathyroid deficiency, insufficient to cause convulsions, may be comparatively common, and that such may have an important influence in causing the disease.

It will thus be seen that a fair amount of evidence exists which suggests that a defective function of the endocrine organs may be one of the essential causes of primary cataract. From clinical observation, and from the known effect of thyroid and parathyroid deficiencies upon tissues allied to the lens, it might be expected that disturbances in the function of these glands would most likely prove determining factors; such disturbances, however, need not necessarily occur primarily in these glands, but may be dependent upon a failure in the function of other endocrine organs.

Whilst it must be admitted that it is not possible to state with certainty the cause of primary cataract, the following conclusions appear to be legitimate:

1. The cause of primary cataract is probably a constitutional one.
2. Most of the morbid conditions which are associated with the development of primary cataract injuriously affect the action of the endocrine glands.
3. Primary cataracts sometimes follow thyroid and parathyroid deficiencies, and are almost certainly then caused by a disturbance of endocrine function.
4. Exposure to injurious heat and light rays and the existence of an uncorrected error of refraction are likely to determine the formation of a cataract in the eye of a person who is predisposed to a degenerative change in his lens fibres by a constitutional defect.