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## FLUORINE AND FLUOROSIS

FLUORINE is one of the trace elements that are normally present in our body, and in small quantities it is believed to exert a beneficial influence. It is so widely distributed in nature that a small intake of the element is unavoidable. It is present in drinking water and many of our foodstuffs, and was at one time frequently used as a preservative, although its use as such is now prohibited in most countries. Certain insecticides and fumigants contain fluorine, and industries, such as mining and the conversion of phosphate rock into superphosphate, a common fertilizer, and the manufacture of glass, enamel and aluminium, expose workers to appreciable dangers of excessive fluorine intake. Prolonged ingestion of abnormal quantities produces a chronic toxic state, the earliest visible sign of which is hypoplasia of the teeth often described as 'mottled enamel', 'chronic dental fluorosis', etc. Its commonest source is drinking water, and the level above which effects are produced is about one part per million, equivalent to 1/120 grain of fluorine to a pint of water. It was first noticed in cattle grazing near a superphosphate factory in Italy, and it has since been recognized in farm animals in many places. The affected animals show lameness, thickening of bones and cachexia, and analysis of their urine and bones shows an increased amount of fluorine. The bone marrow is considerably reduced.

The first account of mottled enamel in human beings was given in 1902 by Eager of the United States Public Health Service who noticed its frequency among Italian emigrants from Naples. Black and McKay (1916) found it occurring in various parts of the U.S.A. and described it more fully in 1916. Since then, cases have been reported from every continent, but although popular belief associated the condition with drinking water, it was not till 1932 that fluorine contained in it was established experimentally by Smith and her associates, as the ætiological factor. Its recognition in India is more recent. In 1936 the health authorities noted a peculiar disease in the Nellore district in Madras Presidency, which was characterized by stiffness and pain in the spinal region and in various joints. A preliminary survey revealed the presence of fluorine in the drinking water of the district and a heavy incidence of mottled enamel in the teeth of school children, and subsequent investigation showed that both these conditions were present in several other districts as well.

The average fluorine content of water in the endemic areas is well over the threshold level,

it being derived from the fluoride-containing strata of earth. The depth of the wells does not appear to have any connection with fluorine concentration, but sometimes it has happened that the substitution of deep well water for that of shallow wells for sanitary reasons led to the occurrence of mottled teeth. It may be stopped by changing to a water supply containing fluorine less than one part per million. Even before the discovery of the causative agent it was not uncommon for people to abandon otherwise satisfactory water supplies, feeling that the water was responsible for the defective enamel formation. In Madras, sometimes whole villages moved from one site to another in search of better water.

Fluorine is a normal constituent of our teeth and bones, and in chronic poisoning these structures suffer most. Mottled enamel is one of the first signs and is seen in people who, during the period of calcification of the enamel, have resided in an area with high a fluorine content in the drinking water. The process is naturally slow in appearing and in progressing. The outer surface of the front teeth is usually most affected, showing opaque paper-white patches or horizontal bands of varying widths. Sometimes the whole surface loses its normal glossy translucency and assumes a dull chalky white appearance. Later, the whiteness is replaced by brown or yellow, occasionally black, markings. As the condition progresses, pits appear. Histologically there appears to be a lack of cementing substance between the enamel rods. The discoloration is described as due to deposit of a pigment in the interstices between the rods. The teeth are of normal shape. The severity of the lesions increases with the concentration of fluorine in the water and the length of time of its ingestion. Normally there is no effect on general health, and in very mild cases there may be nothing more than some white spots. The mottled teeth contain more fluorine than carious teeth, and American work has suggested that they are less prone to caries, and work in England seems to bear this out. This has led to the suggestion that non-toxic amounts of sodium fluoride may be added to drinking water for the prevention of dental decay.

Endemic dental fluorosis occurs in many parts of the world, but cases with skeletal changes seem to be comparatively rare. They were first observed by Flemming Moller and Gudjonsson (1932) in cryolite workers near Copenhagen, who had been exposed to fluorine for long periods. Cryolite, a double fluoride of sodium and aluminium, containing as much as 54 per cent of fluorine, is used in the manufacture of aluminium. Besides showing some anæmia and dyspeptic symptoms, many of these workers had restricted mobility of the spine, and in severe cases almost complete rigidity. Radiography showed a progressive sclerosis of the bones, especially of the vertebræ, pelvis and ribs, with calcification of the costal cartilages. In

typical radiograms the osseous pattern is completely effaced, the bones appear marble-white and structureless and their contours are irregular. The attachments of muscles become thickened and ossified, and there is considerable ligamentous ossification, especially about the intervertebral and costo-vertebral articulations. In a study of some advanced cases in Madras, Shortt and his colleagues (1937) found similar changes in the bones, the clinical picture resembling spondylosis deformans, but the articular cartilages were not affected. They also observed that the bone changes appear in adults usually preceded by symptoms, such as general tingling sensation in the limbs and body, followed by pain and stiffness, especially in the lumbar spine. The stiffness increases until the entire spine behaves like a continuous column of bone. The ribs become fixed and the breathing entirely abdominal. The final stages of the condition are generally evident in people past forty; there is definite cachexia with complete rigidity of the spine and joints, the patient becomes bedridden, and dies of some intercurrent disease. Such severe cases are restricted to villages with a high fluorine content in water (about 6 parts per million). Similar lesions have also been reported from South Africa.

It is not known whether the bones begin to be affected at the same time as the teeth. Kemp, Murray and Wilson (1942) made a preliminary enquiry in some English villages to find out whether the fluorine in the drinking waters, while sufficient to produce dental fluorosis, caused any skeletal changes during the growing period which might lead to incapacity in later life as seen in other countries. They found early signs of spondylosis deformans in some children and young adults, but the correlation was by no means definite. The authors believe that fluorine may favour the development of such defects, but probably there are other factors as well, such as defective nutrition. This is borne out by the work of Pandit and his colleagues (1940) who found that the incidence and severity of the disease had a definite relation to the economic and nutritional status of communities, and that the two important factors concerned in the production of severe chronic fluorine intoxication were the high fluorine content of water supplies and deficiency of vitamin C in the diet. A diet rich in calcium, phosphorus and vitamin D has been reported to have a beneficial influence on the condition. There is no doubt that economic conditions are the factor responsible for the rarity of advanced bone changes in countries such as the U.S.A. and England.

Elsewhere in this issue we publish two articles in which Pillai, Rajagopalan and De record the remarkable protection afforded by whole milk powder (klim) against fluorine poisoning in experimental rats. They also found that a supplement of bone powder in their diets gave considerable relief to the symptoms of intoxication such as stiffness of limbs, difficulty in free

movement, etc. These results, they think, may be due to their calcium and phosphorus contents. A reduction of the concentration of fluorine with improvement of the diets gradually produced a beneficial effect on the mottling of the teeth as well. Fluorosis can be such a crippling disease that it is worth testing these observations in human beings.

R. N. C.

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## Special Article

### SOME TROPICAL MEDICAL PROBLEMS IN SURGICAL CASES\*

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In the surgery of tropical medicine, two stages are passed through. The recently arrived surgeon in India tends to operate without consideration of such diseases as amœbiasis which mimic surgical conditions of European practice; also he tends to overlook the effects of a hot climate. After initial mistakes, there is a tendency to diagnose tropical diseases when they are not present, and therefore to hesitate to operate on such surgical condition as acute appendicitis. The co-operation of physicians and surgeons is needed in all hospitals, not only for acute cases. A regular round by a physician of the surgical wards is a good routine in the tropics.

Unfortunately, there is not, as far as I know, a recent good book on the surgery of tropical diseases.

*Climatic effects.*—The effects of heat need equal emphasis both in the surgical and medical wards. Hyperpyrexia, dehydration, hæmo-concentration and circulatory failure are frequent

\*Being a paper read at the Surgical Convention in Calcutta on 6th September, 1943.