

ENDEMIC FLUOROSIS IN THE NELLORE DISTRICT OF SOUTH INDIA

By H. E. SHORTT, M.D.

LIEUTENANT-COLONEL, I.M.S.

C. G. PANDIT, M.B., B.S., Ph.D., D.P.H., D.T.M.

and

RAO SAHIB T. N. S. RAGHAVACHARI, B.A.

(From the King Institute of Preventive Medicine, Guindy)

ABOUT the month of April 1936 the district health officer, Nellore, Dr. Lakshminarayana, had his attention drawn by the health inspectors of Podili and Darsi ranges of the Nellore district to a disease characterized by a definite train of symptoms and which was very prevalent in the district. The most obvious symptoms of this disease were stiffness and pain in the spinal region and in various joints. Cattle were stated to be similarly affected. In August 1936, the district health officer drew the attention of the Director of Public Health, Madras, to the existence of this disease and suggested that an investigation unit should be despatched from the King Institute, Guindy, to study the disease on the spot. In September the district health officer received an account from Dr. Holsted, of the American Baptist Mission, of the same disease, as observed by him in the village of Bommireddipalli.

As is usual in all parts of India, when a disease is not of known origin, this disease was attributed by the local inhabitants to the drinking water—in this case, as will later be apparent, with good reason. All these reports on the disease were considered to be sufficiently circumstantial to warrant the despatch of an investigation unit from the King Institute, but it was considered advisable, in the first case, to bring a few of the affected cases into hospital for a more thorough investigation than could be conducted in the field.

At this stage of the investigation one of us (C. G. P.) in the ordinary course of reading came across two short reviews describing a condition found in cryolite workers in Denmark due to chronic fluorine poisoning (Roholm, 1936). The symptoms described closely resembled those present among the patients in the district which was the subject of our investigation. The clue thus obtained as to the probable cause of the so-called 'mystery disease' in the Nellore district pointed the more obviously to fluorine in drinking water since this district contains well-known mica mines, a mineral often found associated with deposits containing fluorine compounds.

A small investigation unit under Mr. Raghavachari was despatched immediately from the King Institute to carry out a preliminary survey of the drinking water sources in the district, as regards fluorine content. This investigation at

once revealed the presence of fluorine, in some cases in large amounts, in the drinking water of the district and a heavy incidence of mottled enamel, the common early sign of fluorine poisoning, in the teeth of school children, thus confirming the conclusions already arrived at, on theoretical grounds, as to the probable cause of the disease. The widespread nature of the condition now revealed made it evident that the whole question of the prevalence and prevention of chronic fluorine poisoning, in at least the Nellore district and probably in other surrounding, or even distant, areas, had become a matter of urgent public health importance demanding a thorough investigation. Consequently, a second unit consisting of the Director, King Institute, and Mr. Raghavachari visited the area and was joined by the district health officer. The ground previously covered, as well as much new ground, was visited and arrangements were made for the obtaining of water samples from a very wide area covering the major portion of the Nellore district. As it was necessary that more detailed examination of affected cases should be made under hospital conditions allowing of full clinical, biochemical, and radiological investigations, a certain number of sufferers from the disease was transported to the General Hospital, Madras, in consultation with the Superintendent, Lieut.-Colonel G. R. McRobert, I.M.S. The investigation of these cases will form the subject of another report. As the preparation of this report and a full investigation of the water problem will take some time, a short summary is given below of the salient points in the investigation which have emerged up to date.

Chief clinical symptoms in persons affected by the disease

Early effects.—These are exhibited in the children and take the form of a chocolate-coloured mottling or banding of the teeth. This effect, however, may be replaced by a dull but pure chalky-white appearance in the same situations. No other effects are noticeable in children. These early manifestations of the disease are present in over 50 per cent of school children in the several villages so far examined. In spite of the high incidence of this condition, none of the accounts of the disease received from the district made any mention of it. Had this symptom been noticed and reported, it is likely that the cause of the disease might sooner have come to light, as this is the symptom of fluorine poisoning most commonly reported in the literature.

Later effects.—Adults of thirty years and upwards, of both sexes, complain of pain in the spinal column, especially in the cervical and lumbo-sacral regions, and some stiffness and pain in the joints of both upper and lower extremities; there is usually anorexia. These symptoms are not yet sufficiently severe to prevent

the doing of light manual labour and the sufferers are still fairly well nourished.

Final condition.—The final stages in the condition are generally evident in people past forty and may be summarized shortly as follows :—

(a) Complete rigidity of the spine including the cervical region so that the affected person to turn his head must turn the whole body.

(b) Rigidity of the joints of both upper and lower limbs with inability to assume the squatting position.

(c) Fixation of the thoracic walls so that breathing becomes entirely diaphragmatic, while the chest is often barrel-shaped in an antero-posterior view but flattened in front.

(d) Symptoms of pressure on the spine may be present without actual spinal deformity.

(e) The patient is eventually completely bed-ridden and usually dies of some inter-current infection.

Physiography of the district

The district of Nellore lies to the north of Madras and comprises the area lying between the coast and the Velikonda hills. The width varies between 20 and 60 miles and the north-south extension is about 180 miles. The western border of the district includes outlying parts of the Velikonda hills but no part of the area is any considerable height above mean sea level. The coastal area is composed of low-lying sedimentary deposits including laterite. Apart from the coastal area the rest of the district forms a gentle slope upwards towards the Velikonda hills with detached hills or small ranges rising out of the plain. The district is traversed by several rivers in a general west-east direction, but these are not true perennial streams and have no surface flow for 10 months in the year. The only river of considerable size is the Penner river which enters the sea at Nellore, the headquarters town of the district. Throughout the length of the coast line, and parallel with it, runs the Buckingham canal.

Geology of the district

The district dealt with in this report, *i.e.*, the more northern part of the Nellore district, may be said to be composed of three zones parallel to the coast. The coastal or eastern zone consists of marine and fluviatile alluvia, the central zone of sedimentary rocks, and the western zone of crystalline gneissic rocks. The central zone contains rocks of two ages, schistose and granitoid gneisses. Most of the affected districts so far examined fall within the area of granitoid gneisses.

Over sixty specimens of rocks, taken from well-diggings, river and tank beds and mines and mine areas, were examined by us for the

presence of fluorides and in nineteen specimens fluorides were found to be present. These specimens are at present being examined by the Geological Survey of India with a view to their identification as minerals.

Water supplies of the district

The chief sources of drinking water throughout the district are shallow wells. Water is often found at a depth of about twelve to fifteen feet from the surface and the wells are dug to about ten feet below this level. Occasionally, the water may lie at a distance of 30 feet below the surface. The mounds of earth dug out of the wells are a characteristic feature of the generally flat landscape.

As a general rule, no effort is made to conserve the water supplies and the majority of the wells take the form of step wells.

It has already been stated that most of the waters examined in the affected districts showed a considerable proportion of fluorine and the further observation emerged from the examinations that, as a general rule, the degree to which the population of a village was affected by the disease was in direct proportion to the fluorine content of the water supply. In one case two wells, separated by not more than 150 yards, contained very different amounts of fluorine, which was found to be correlated with corresponding marked differences in the degree of involvement of the two villages using them as regards the incidence of symptoms of chronic fluorine poisoning. Our preliminary field tests for fluorine have shown amounts varying from 0 to 10 parts per million.

The villagers themselves, correctly attributing the disease to drinking water, had in many cases migrated from site to site in the search for better water, and their empirical choice of one well as against another was usually found to be justified by a lower fluorine content. As the fluorine gives no evidence of its presence in taste or smell this correct selection of the best available wells was difficult to account for until we found that high fluorine content often went with high total solids.

Extent of the problem

Although the investigation of the problem has not at present been carried beyond the Nellore district and its immediate surroundings, we have certain indications which point to the fact that probably a larger area is affected and, possibly, now that the subject has been raised, the condition may be found in other parts of India. In any case, now that the cause of so widespread a condition of disability has been discovered the public-health department of the Government of Madras will, we have no doubt, take the necessary measures to bring relief to the people of the district.

Solutions to the problem

The recognition of chronic fluorine poisoning in Nellore district is of such recent occurrence that its prevention on a large scale can, as yet, be considered only on theoretical grounds.

The filtration of fluorine out of the water, while perfectly feasible as a laboratory measure, would probably be too costly for practical application in the field.

A second line of prevention might be the provision of water supplies from a greater depth in the hope that these might be free from fluorine. This would depend mainly on the geological factors concerned but is a line of research worthy of trial as it would be a simple solution. We have already arranged with the district authorities in Nellore for some experimental bores in the affected area.

Summary

1. This account records the discovery of an area in Madras Presidency showing a high incidence of chronic fluorine poisoning.

2. This condition has been given the title of 'endemic fluorosis' because, so far as we know, in no previous description has the disease been so directly attributable to naturally-existing surface, or near-surface, water supplies, so severe in its manifestations in later life, as distinct from its effects on the teeth of children, and on so large a scale.

3. The clinical symptoms of the condition, and the geology and physiography of the district are briefly dealt with.

Acknowledgments

We have to acknowledge the important part played in this preliminary investigation by Dr. T. Lakshminarayana, district health officer, Nellore, for bringing to our notice the existence of the 'mystery disease' and for very great help in carrying out the field investigations. To Mr. K. Venkatramanan, m.sc., of the King Institute, we are indebted for very numerous chemical and other tests involved in determining the presence of fluorine in both water and minerals.

Dr. K. V. Gopalakrishnan, civil assistant surgeon, Ongole, was of great help to us in arranging the moving of patients, some of them bed-ridden, under difficult conditions of transport, and Dr. Holsted, of the American Baptist Mission, helped us greatly in the examination of children at various villages.

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THE EFFECTS OF THE INJECTIONS OF MILK PREPARATIONS IN LEPROSY*

By SARASI LAL SARKAR

and

BENI MADHAB BHATTACHARYA

Raj Kumari Leper Asylum, Deoghar

AT the request of one of us (S. L. S.) Bengal Immunity Company and Bengal Chemical and Pharmaceutical Works, Limited, sent a quantity of their milk preparations and vaccines (combined strepto- and staphylococcal) for trial in the Raj Kumari Leper Asylum, Deoghar.

In leprosy cases complicated with the presence of ulcer and eczema, injections of vaccines and milk preparations were given a trial.

In some of the ulcerative cases, injections of vaccines appeared to be beneficial and to promote the healing process. Regarding the injections of leprosy nodules ground up with sand, sterilized and standardized, Dr. Muir has remarked in his book on leprosy: 'Much benefit up to a certain point is often derived from these injections..... There is no reason to believe that there is any specific action in any of these remedies; rather it would appear that protein shock is caused and that this has a remedial effect on leprosy. Not dissimilar is the effect of various fevers (such as malaria, kala-azar, typhoid, smallpox, etc.) in "B" cases (modern "C" cases) during the course of which diseases marked improvement in leprosy conditions may occur'.

The same thing may be said of the injections of staphylo- and streptococcal vaccines. Some benefit is derived in the beginning, but this is only temporary. Some of the ulcers are healed up, but are very liable to break out again. In such cases we found the injections of milk preparations useful. Better results are obtained if these injections are combined with the course of vaccines. When the vaccines produce no further improvement, the healing process will be stimulated again as the milk injections are started. Some hospital patients insisted upon getting injections of milk preparations to prevent the relapse of the ulcers, after they have been healed up by vaccine injections. What has been said about ulcers, holds good about the cases in which eczema is present as an associated condition.

Comment.—The ulcerated conditions in leprosy are to a certain extent due to trophic disturbance. The ulcers are apt to heal up and break out according as the nerve trunks which carry their trophic fibres have any disturbance, such as neural pressure arising from an inflammatory condition in the nerve itself or in its neighbourhood. Injections of milk preparations appear to relieve congestions and thereby the neural pressure. As will be seen from the case notes given below, some of the ulcer cases and

* Rearranged by the Editor.