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INCIDENCE OF SIMPLE GOITER IN AREAS OF ENDEMIC FLUOROSIS IN NALGONDA DISTRICT, ANDHRA PRADESH, INDIA

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For many years, considerable interest has centered upon the metabolic interrelationship of two halogens, fluorine and iodine, and their effect on the thyroid gland. Several studies have been reported concerning the influence of fluorine compounds on the size of the thyroid gland. The reports are conflicting (1-9). It was therefore considered desirable to examine in detail the possible relationship between simple goiter and fluorosis as found in an endemic fluorosis belt in India.

Investigation

The villages of Kamaguda, Yedvelli and Yellareddyguda in Nalgonda District, Andhra Pradesh were selected for the investigation. These villages lie close to each other and are known areas of endemic fluorosis, as indicated in a detailed account published earlier (10). The climate is hot and the temperature in the shade reaches 115° F (46.1°C) in summer. The inhabitants are manual laborers working on tobacco plantations.

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TABLE 1

Thyroid Enlargement Related to Halogen and Mineral Content of Water Supply

Village (Population)	Water Quality								Age (Years)					Incidence of Visible Goiter				
	Fluorine		Iodine															
	(ppm)	Mean	µg/l	Mean	F⁻/I⁻ Ratio	Total Hardness (mg $CaCO_3$/100 ml)	Total Calcium (mg/100 ml)	Total Magnesium (mg/100 ml)	Group 1 (0-13)	Group 2 (14-17) M	Group 2 (14-17) F	Group 2 (14-17) Total	Group 3 (18 and over)	Group 1	Group 2 M	Group 2 F	Group 2 Total (%)	Group 3
Kamaguda (95)	9.6	10.7	18.4	14.4	1.3	19.95	7.99	Negligible	53	4	6	10	32	-	1	3	4(40)	-
	11.8		10.4			8.21	2.40	0.54										
Yedvelli (813)	5.5	6.1	37.4	44.0	7.5	14.68	4.08	1.09	435	82	113	195	183	-	4	20	24(12)	-
	5.8		39.2			22.61	3.07	3.63										
	6.0		41.4			6.07	2.43	Negligible										
	6.2		42.5			6.97	2.79	Negligible										
	6.6		50.1			13.38	2.72	1.60										
	6.8		53.7			23.27	4.72	0.36										
Yellareddy-guda (1100)	2.5	5.4	222.6	175.3	32.4	5.97	2.39	Negligible	573	135	94	229	298	-	4	17	21(9)	
	3.8		198.2			28.60	5.85	3.40										
	4.2		118.4			11.24	4.50	Negligible										
	5.5		248.5			7.17	2.87	Negligible										
	6.0		174.8			2.67	1.07	Negligible										
	6.5		160.4			5.89	2.36	Negligible										
	7.5		104.2			2.75	1.10	Negligible										

The populations of Kamaguda, Yedvelli and Yellareddyguda are 95, 813 and 1100, respectively. The three communities have two, thirteen and eighty-four wells, respectively. Fifteen samples of drinking water consumed by the inhabitants were analyzed for their content of fluorine, iodine, total hardness, total calcium and total magnesium contents - two from Kamaguda, six from Yedvelli and seven from Yellareddyguda (Table 1). Determination of fluorine was made by the thorium nitrate titration method and of iodine by Harvey's method (12). Total hardness of water was calculated from the figures of total calcium and magnesium and expressed in mg of $CaCO_3$/100 ml water.

A survey of the diet was carried out by careful questioning of representative samples of the population in the three villages. Investigations by Pasricha (13) have shown that the oral questionnaire technique, when carried out with proper care, can yield as reliable an estimate of food intake in poor Indian communities as the more conventional, weighing methods.

The nutritional state of the people in the district studied is poor. The diet is deficient in animal proteins, fats, calcium and vitamins A and C (Table 2). The villages are situated far from the sea. Thus no marine foods such as fish and shell fish are being consumed. An average of about 11 g of sea-salt is being consumed daily. The salt is derived from two sources, and a mixture containing roughly equal parts of each is available in the local market. The iodine content of the salt derived from the two sources is 9. 6 and 6. 0 µg/g, respectively.

TABLE 2

Composition of Daily Diet Consumed in the Three Villages

Protein (g)			Calcium (g)		0.48
Animal	5.2		Phosphorus (g)		1.78
Vegetable	73.1	78.3	Iron (mg)		39.1
Fats (g)			Vitamins		
Animal	8.9		Carotene (i. u.)	1048	
Vegetable	19.9	28.8	Vitamin A (i. u.)	176	
Carbohydrates (g)	494.9		Vitamin B_1(mg)	2	
Total Calories	2618		Vitamin C (mg)	23	

The fluorine and iodine content of the solid part of the diet was not examined because the solid food consumed by the local inhabitants is obtained from various neighboring villages.

Observations

Incidence of goiter: This report is not concerned with goiters accompanied by thyrotoxicosis, but with those which are customarily described as simple or endemic. We tried to determine whether or not there is a geographical distribution of goiter. The thyroid gland of every inhabitant of the three villages under review, altogether 2008 cases, was examined. The clinical method of grading and recording the size and possible changes in the thyroid gland, as outlined in a M. R. C. Memorandum was employed. The types of gland were grouped as follows: (a) invisible at rest; (b) visible to the trained observer, but soft, smooth and symmetrical; (c) conspicuously enlarged (clearly visible ++, but showing no palpable asymmetry, firmness or nodular change); (d) showing a degree of firmness, asymmetry or nodularity which can be regarded as definitely pathological. Throughout the whole survey special attention was paid to the patient's age at the time of appearance and disappearance of the thyroid enlargement.

Visible thyroid glands of type (b) were encountered only in the ages 14-17 (Table 1). These cases were examined every 6 months until they were 17 years of age. The visible glands became less noticeable or invisible after puberty and were, therefore, regarded as within the limits of normal. Thyroid enlargement belonging to types (c) and (d) were not encountered in any of the age groups.

No cases of cretinism or of deaf-mutism were seen in the villages under review.

Discussion

An adequate amount of iodine is essential for thyroid function. A number of estimates of minimal and optimal requirements for iodine in man are available. With quantities between 100 and 1000 µg/day the thyroid gland seems to function efficiently (14). Low iodine intake is an established cause of goiter. Among many factors which have from time to time been suggested as favoring the development of goiter or increasing the need for iodine, the following may be mentioned: polluted water, excess calcium, hardness of water, excess fluorine, arsenic, cobalt, bromine and consumption of goiterogenic substances. Heredity and environmental factors also influence the requirements for iodine.

As long ago as 1854, Maumené suggested that fluorine might be the cause of endemic goiter. This possibility was put forward again by Marine (2) and by Wilson (7). Wilson reported a high degree of dental fluorosis in goiterous areas of the Punjab, India, although no mention is made about the iodine intake. In Somerset, England, Wilson also found a parallelism between the incidence of goiter and dental fluorosis. Ornek reported cases of dental fluorosis and endemic goiter occurring together in Isparta, Turkey. On the other hand, Roholm (3) states that, in human cryolite intoxication no change was observed in the size of the thyroid gland. With the exception

of Maumené's insufficiently described case, no clinical observations are known from spontaneous or experimental intoxication to indicate any effect on this gland. The hypothesis of struma-producing effect of fluorine cannot be generally applicable. In two autopsies of cryolite workers, Roholm reported thyroid glands which were normal both macroscopically and microscopically. In Iceland, where fluorosis is present but where goiter is not endemic, the consumption of seafood is very high (6). Murray et al. (15), in a report to the Medical Research Council, were unable to show any correlation between the two variables but, as they point out, the range of fluorine levels which they encountered was not wide.

In the present investigation no instance of marked and permanent enlargement belonging to types (c) and (d) was found. Intake of 11 g sea-salt/day containing an average of 7.8 µg iodine/g will supply 85.8 µg iodine/day. The high level of iodine both in salt and in water presumably insures a large enough intake of iodine to outweigh any possible effect of excess fluorine. A profitable study of the relation of fluorine to endemic goiter could be made in areas such as Isparta in Turkey and the Punjab in India where fluorosis and high goiter incidence have been reported to coexist.

With regard to the slight and temporary enlargement of the thyroid encountered in the age group 14-17 (type b), detailed scrutiny of the data in Table 2 reveals that with a fall in mean fluorine content of the water from 10.7 mg/l in Kamaguda to 5.4 mg/l in Yellareddyguda, there was a corresponding progressive fall in the incidence of pubertal goiters from 40% in Kamaguda to 9% in Yellareddyguda. However, associated with the fall in fluorine content there was also a rise in mean iodine of the water. The figures can be interpreted to indicate that, so far as type b goiters are concerned, (1) fluorine may be actually goiterogenic, and (2) high concentrations of iodine may have a goiter-preventing effect. Investigations in other areas, where the variations in fluorine content are not associated with variations in iodine content of the type encountered here, may throw light on this particular problem.

Summary

The results of analyses of the mineral content of drinking water from three Indian villages with endemic fluorosis surveyed for the incidence of thyroid enlargement are reported.

With the possible exception of temporary thyroid enlargement encountered in pubertal subjects (type b), no relation was found between the incidence of endemic goiter and the fluorine in the water supply.

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