

19. Lepine: Blutzucker (Bergmann), S. 156, 1913.
 20. Embden, G. and E. Lehnartz: Zeitschr. f. Physiol. Chem. 134:243, 1924.
 21. Embden, G. and C. Haymann: Zeitschr. f. Physiol. Chem. 137, 1924.
 22. Abraham, A. and P. Kahn: 141:161, 1924.
 23. Lantz, H. and M. E. Mayer: Zeitschr. f. Physiol. Chem. 141:181, 1924.
 24. Shimizu: N.J.A.C. 12, No. 5-6, 1948.
-

ELECTROCARDIOGRAPHIC STUDIES OF THE INHABITANTS IN HIGH FLUORIDE DISTRICTS

by

T. Takamori, S. Miyanaga, H. Kawahara, I. Okushi, M. Hirao and H. Wakatsuki
Tokushima, Japan

(Reproduced from the Tokushima Journal of Experimental Medicine 3:50-53, 1956)

In the Aso volcano districts of Kumamoto Prefecture, Japan, a dental disease occurs which is known locally as "Yonaba", meaning "teeth affected by volcano ash". Undoubtedly, this condition is identical with mottled teeth, irrespective of the cause.

Since the reports of Smith, Lantz and Smith (1) and Churchill (2), we know that mottled enamel is usually caused by drinking water which contains fluoride in excess of 1 ppm.

No systematic studies on how fluoride affects the cardiovascular system had appeared previous to Okushi's report (3) from our department in 1954.

The authors examined the inhabitants of a high fluoride area where a high incidence of mottled enamel was encountered. In 1953, electrocardiographic and X-ray examinations in Shionoe, Kagawa Prefecture, and in Odani, Okayama Prefecture, revealed many instances of myocardial damage, cardiac hypertrophy and dilatation. In 1954 Okushi (4) published experimental data concerned with the effect of sodium fluoride upon the heart muscle of rabbits. This communication presents EKG observations on subjects residing in the Mt. Aso fluoride area.

Method and Procedure

In 1954 electrocardiograms were taken on 102 inhabitants (90 children and 12 adults) of the Aso volcano district and 59 children in Beppu city. The examina-

From the Department of Internal Medicine, School of Medicine, Tokushima University, Japan.

tions were carried out with standard limb and chest leads by means of the Sanborn electrocardiograph.

Fluoride content of drinking water was determined by the aluminum hematoxylin method (5). Kawahara's (6, 7) classification of mottled enamel of the inhabitants was adopted.

Results

A) Electrocardiograms of Residents of the Aso Volcano District:

1) Narikawa Village (Fluoride content of drinking water 0.6 to 4.4 ppm):

Among 12 adults the following results were obtained:

One case with a high degree of myocardial damage, with coronary insufficiency and mitral p wave; one case of multiple ventricular premature contractions with prolonged Q-T interval (Fig. 1); one case of nodal premature contractions, with nodal escape and coronary insufficiency (Fig. 2); one case of auricular fibrillation with multifocal ventricular premature contractions and coronary insufficiency (Fig. 3); one case of coronary insufficiency with prolonged Q-T interval; five cases with prolonged Q-T interval. In only two of the 12 cases with mottled teeth was a normal electrocardiogram obtained.

Among 22 children, one case showed evidence of right ventricular strain with a high degree of coronary insufficiency (Fig. 4); two showed ventricular strain; five prolonged Q-T interval. In 14 cases, the ECG was within normal limits.

2) Kuronagare Village (Fluoride content 1.6 to 1.9 ppm):

Of 8 children, one case showed right ventricular strain with coronary insufficiency and p pulmonale pattern; one patient had a right bundle branch block; one case, right ventricular strain. Five cases were within normal limits.

3) Imamachi Village (Fluoride content of drinking water 5.9 to 6.2 ppm):

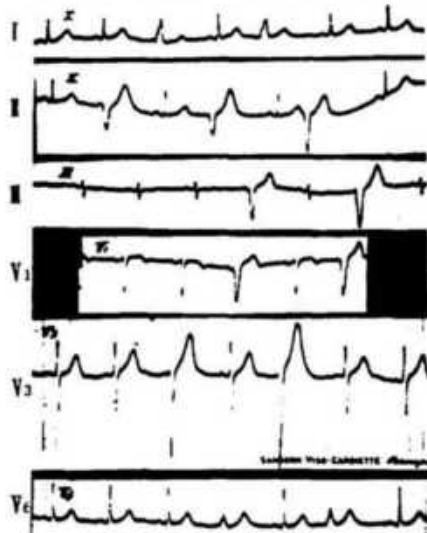
Of five children, two cases showed a high degree of ventricular strain with coronary insufficiency; one a prolonged Q-T. Two cases were within normal limits.

4) Onoda Village (Fluoride content 0.5 to 0.7 ppm):

Of three children, one case showed left ventricular extrasystoles with right ventricular strain and p pulmonale pattern, one case right ventricular strain with sinus tachycardia. In one case the EKG was within normal limits.

Samples of EKG ChangesFig. 1

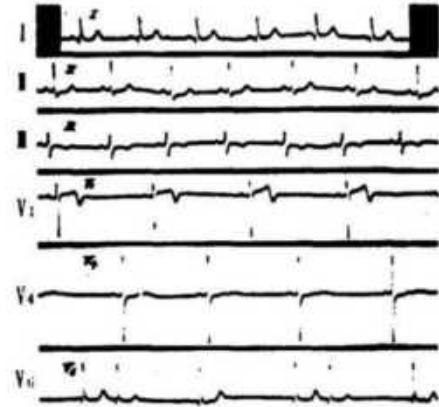
♂ 79 Yrs., Narikawa (F⁻ in Water 0.6 to 4.4 ppm), Mottling Enamel P₅ B₃.



Multiple ventricular premature contractions with prolonged Q-T interval.

Fig. 2

♂ 30 Yrs; Narikawa, Mottling P₃ B₃.



Depressed ST₂, ST₃. Nodal premature contraction with nodal escape and coronary insufficiency.

Fig. 3

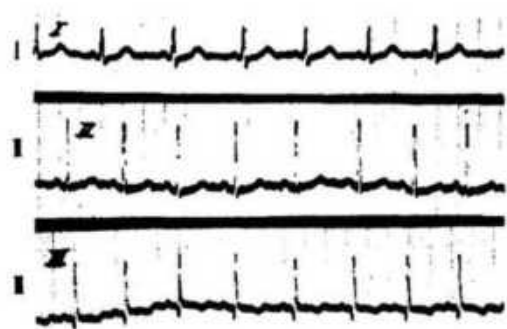
♂ 62 Yrs.; Narikawa



Marked myocardial damage; auricular fibrillation, multifocal ventricular premature contraction; coronary insufficiency.

Fig. 4

♀ 16 Yrs; Narikawa, Mottling P₂B₃



Right ventricular strain; coronary insufficiency.

5) Nakadori Village (Fluoride content 0.6 to 0.7 ppm):

Of 4 children, one showed prolonged Q-T interval. The other three electrocardiograms were within normal limits.

6) Other villages of the Aso volcano district, Yunoura, Dabaru, Hosen, Tamachi, Yamada, Ogura, Kurokawa and Miyaji (Fluoride content 0.0 ppm):

Of 45 children, three showed a high degree of myocardial damage; five, slight myocardial damage. The remaining 37 were within normal limits.

In the inhabitants of Aso volcano district, of 56 subjects with mottled teeth, 30 showed myocardial damage but, of 46 without dental fluorosis, only six had myocardial damage.

B) Electrocardiograms in Beppu city with practically no fluoride in drinking water (0.0 to 0.1 ppm):

Of 59 children, two showed evidence of slight right ventricular strain; one exhibited a prolonged Q-T interval. The remaining 56 were within normal limits.

Discussion

The relation between the electrocardiographic findings and the fluoride content of drinking water in the respective villages is shown in Table 1.

Our studies indicate a higher incidence of myocardial damage in the high-fluoride districts, namely 10 among 12 in Narikawa village (0.6 to 4.4 ppm), and 0 among 11 adults in fluoride-free Yunoura village ($\alpha > 0.01$). It is also noteworthy that a significantly higher incidence of myocardial damage in school children occurred in high fluoride districts, namely 8 among 22 children in Narikawa village, than in nonfluoride districts such as Yunoura village ($\alpha > 0.05$).

A higher incidence of myocardial damage was also noted in inhabitants of the Aso volcano districts than in those of Beppu city (0.0 to 0.1 ppm). Of 102 inhabitants of the Aso volcano district, 36 cases had myocardial damage; whereas of the 59 school children examined in Beppu city, only three were thus affected.

The relation between myocardial damage and mottled enamel in the 102 inhabitants of the Aso volcano district is shown in Table 2.

Our results further indicate that the majority of residents with myocardial damage also have mottled teeth ($\alpha > 0.01$). Conversely, among those without mottled teeth, the negative EKG findings outnumber those with myocardial damage ($\alpha > 0.05$).

TABLE 1

The Relation between the Electrocardiographic Readings and the Fluoride Content of the Drinking Water

	Village	No. of cases	E. C. G.			Fluoride in ppm	
			within normal limits	Degree of myocardial damage			
				I	II		III
Adults	Narikawa	12	2	5	1	4	0.6 to 4.4 0.0
	Narikawa	22	14	5	2	1	
	Yunoura	11	11				
	Dabaru	2	2				
	Hosen	1	1				
	Tamachi	1		1			
	Onoda	3	1		1	1	
Children	Kuronagare	8	5		1	2	1.6 to 1.9
	Imamachi	5	2	1		2	5.9 to 6.2
	Yamada	16	12	3		1	0.0
	Ogura	2	1			1	0.0
	Nakadori	4	3	1			0.6 to 0.7
	Kurokawa	6	4	1		1	
	Miyaji	6	5	1			
	Beppu City	59	56	2	1		0.0 to 0.1

TABLE 2

The Relation between Myocardial Damage and Mottled Teeth

Myocardial damage \ Mottled teeth	Mottled teeth		Total
	(+)	(-)	
(+)	30	6	36
(-)	26	40	66
Total	56	46	102

Conclusion

1) In the Aso-volcano district, a higher incidence of myocardial damage based on electrocardiographic studies was found in inhabitants of high fluoride communities than in "nonfluoride" villages.

2) In subjects with mottled teeth, greater myocardial damage was encountered electrocardiographically than in persons without mottling in the Aso-volcano district.

3) The authors conclude that the myocardial damage observed in the inhabitants of the Aso-volcanic district is predominantly due to the excessive fluoride content of the drinking water.

Bibliography

1. Smith, M.C., Lantz, M.E. and Smith, H.V.: J. A. D. A. 22, 1953.
2. Churchill, H.V.: Indust. Engin. Chem, 23:996, 1931.
3. Okushi, I.: Shikoku Acta Medica, 5:55, 1954.
4. Okushi, I.: Shikoku Acta Medica 5:52, 1954.
5. Okuno, H.: J. Chem. Soc. Japan, 63:23, 1943.
6. Kawahara, H.: A Monthly Record of Dental Science, 52:7, 1952.
7. Takamori, T.: The Tokushima Journal of Experimental Medicine, 2:25, 1955.

Corrections:

Volume 4, pages 5-15:

In the article by Drs. Buck and Reusmann "A New Semiautomatic Method for Fluoride Determination in Plant and Air Samples", the names of two co-authors, Dr. Kfeld and Mr. Pallasch, who collaborated in the development of the apparatus illustrated, were inadvertently omitted. Herewith, we wish to acknowledge their co-authorship.

Drs. M. Buck and G. Reusmann

Volume 4, page 105:

The editorial cited the article by G. A. Posen, J. R. Marier et al. as documentation for four deaths in Ottawa, Canada. The reference should have been "New Facts on Fluoridation" Saturday Review, March 1, 1969, page 54.

In the following sentence the word "probably" should be substituted for "considered" so that it reads: "Fluoridated water for hemodialysis was probably the cause of death."