

## DENTAL AND EARLY-STAGE SKELETAL FLUOROSIS IN CHILDREN INDUCED BY FLUORIDE IN BRICK-TEA

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**SUMMARY:** Fluorosis from brick-tea was discovered during the last decade in western and northern parts of China. Dental fluorosis has a high prevalence among children in these brick-tea endemic areas, but skeletal fluorosis does not normally become apparent until adulthood. In July 2002 we examined 132 primary school children, age 8 to 13 years, in a low-fluoride-water area of Naqu County, Tibet, and found that 111 of the children (84.1%) had dental fluorosis from drinking traditional brick-tea. Among these 111 children, 96 (86.5%) were found by radiological examination to have developmental skeletal abnormalities in the wrist. We view these findings as warning signs of early-stage skeletal fluorosis indicating that dental fluorosis in children should be considered more than a matter of cosmetic concern.

Keywords: Brick-tea; Children; Dental fluorosis; Early-stage skeletal fluorosis

### INTRODUCTION

Dental fluorosis is an obvious external sign of excessive early childhood consumption of fluoride, including drinking high-fluoride brick-tea.<sup>1</sup> Whereas water-borne fluoride has long been recognized as an important source of both dental and skeletal fluorosis, little is known about the pre-clinical or early-stage aspect of brick-tea skeletal fluorosis. The present report addresses this question.

### MATERIALS AND METHODS

During July 2002, 132 primary school children, 8 to 13 years of age, living in the Naqu County, Tibet, with a known regular consumption of traditional brick tea, were given dental and physical examinations. The children with dental fluorosis received additional radiological examination of the wrist of their right hand. Brick-tea consumed by these children beginning immediately after nursing at about age 2 or 3 is a rich source of fluoride intake for them.<sup>2</sup> Besides the dental, physical, and radiological wrist examinations, occasional urinary fluoride analyses were also made. The radiological examinations included the distal end of the radius, the carpal bones, and the proximal ends of the metacarpal bones.

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## RESULTS

None of the children showed any overt clinical symptoms or signs of skeletal fluorosis by physical examination. The mean urinary fluoride concentration (with SD) was  $2.31 \pm 0.91$  ppm. Among the 132 children examined, the number with dental fluorosis was 111 (84.1% prevalence), and the dental fluorosis index was 3.67. Of the 111 children with dental fluorosis, 96 (86.5%) exhibited radiological signs of abnormal wrist skeletal development. Radiographic changes in the right wrist bones of the children compared to controls not drinking brick-tea are illustrated in the Figure.



**Figure.** Panels A and B reveal abnormal radiological signs in the wrist of the right hand of habitual brick-tea drinking children. On the right of each of these panels is an unlettered radiograph of a normal control of the same gender and age. Panel A is the dorsal radiograph of the right wrist of an affected ten-year-old boy. There are multiple transverse trabeculae in the distal metaphysis of the radius (black arrow). The carpal bones show varying degrees of sclerosis. In front of the white arrow is an almost circular area of strong radiographic density paralleling the contour of the short lobe. Panel B shows the right wrist of an affected eight-year-old girl. The black arrow points to multiple transverse trabeculae in the distal metaphysis of the radius. The white arrow indicates a sharply defined line of increased density. The metacarpal bones display increased density.

In the brick-tea drinking children, the distal metaphysis of the radius presented multiple, transversely arranged radiodense lines, and there was moderate sclerosis of the epiphysis-metaphysis. The carpal bones had attained the normal contour for the age but exhibited various degrees of density, ranging from visibly thickened, dense trabeculae to thick, sharply defined bands parallel to the contour, and to diffusely increased density. The proximal ends of the metacarpal bones showed minor, sometimes a pronounced, degree of increased density.

## DISCUSSION

The results of urinary fluoride examinations showed that the children are currently—and probably for some time have been—exposed to excessive fluoride intake, most likely from traditional high-fluoride brick-tea.<sup>1,2</sup>

The wrist, with adjoining bones, offers an ideal target location for radiographic examination in cases of suspected skeletal fluorosis.<sup>3</sup> The field includes the distal end of a long bone with an epiphyseal plate (radius), multiple short (carpal) bones, and the proximal end of long (metacarpal) bones without any epiphyseal plate. Thus, all types of bones are represented in the wrist, except flat bones.

The radiographs conclusively demonstrate the presence of early-stage skeletal fluorosis, and they offer impressive information on the mode of action by fluoride on cartilage and bone maturation. Fluoride arrests the maturation of cartilage cells in the growth plate and in the ossification centers of short bones. At the arrest of longitudinal bone growth, bone is laid down transversely on the most distal row of cartilage cells, the so-called distal terminal plate. When growth is resumed, the plate is pushed into the metaphysis and now appears as a transverse bar in the metaphysis. The processes may repeat and multiple transverse lines result. The radiographic appearance of transverse lines thus indicates an intermittent growth/activity of the epiphyseal plate—a ‘stop-and-go’ activity.<sup>3,4</sup>

In the short bones, ossification starts in the center and spreads uniformly toward the periphery—the inner border of the short bone therefore parallels the external contour. When the ossification process is exposed to fluoride, the resorptive phase in the normal turnover of bone is decreased and excessive mineralization of the matrix results. The almost circular, strongly radiodense structure in panel A of the Figure (10-year-old boy) and panel B (8-year-old girl) thus represents the area undergoing ossification during a certain recent period of time.<sup>4,5</sup> The second (unlettered) panels in the Figure show normal wrists of controls of the same sex and age.

Even though physical examination did not reveal overt clinical symptoms or signs of skeletal fluorosis in the children, the radiographs clearly showed developmental skeletal abnormalities that represent an early stage of skeletal fluorosis. Therefore, dental fluorosis in children should be viewed as more than a matter of cosmetic concern, since it can also be a sign of early-stage skeletal fluorosis that might lead to full-scale debilitating skeletal fluorosis in adulthood.<sup>1</sup>

### ACKNOWLEDGEMENT

We thank to Professor Yunzhao Wang, Former Director of the Radiological Pathology Research Laboratory, Beijing Medical University Ji Shui Tan Hospital, for his examination, review, and approval of the radiological diagnosis of skeletal fluorosis and critical review of the manuscript.

### REFERENCES

- 1 Cao J, Bai X, Zhao Y, Liu J, Zhou D, Fang S et al. Fluorosis induced by drinking brick tea. *Fluoride* 1996;29(3):139-43.
- 2 Cao J, Zhao Y, Liu J. Brick tea consumption as the cause of dental fluorosis among children from Mongol, Kazak and Yugu Populations in China. *Food Chem Toxicol* 1997;35(8):827-33.
- 3 Wang Y, Yin Y, Gilula LA, Wilson AJ. Endemic fluorosis of the skeleton: radiographic features in 127 patients. *AJR Am J Roentgenol* 1994;162(1):93-8.
- 4 Ogden JA. Growth slowdown and arrest lines. *J Pediatr Orthop* 1984;4:409-15.
- 5 Frager DH, Subbarao K. The 'bone within a bone'. *JAMA* 1983 Jan 7;249(1):77-9.