A Comparison of Later Stage Dental Maturation in a Small Group of Children from Chernobyl and British children.

H. M. LIVERSIDGE AND C. E. A. ROGERS
Department of Paediatric Dentistry, St Bartholomew's and The Royal London School of Medicine and Dentistry, Queen Mary, University of London, Turner Street, Whitechapel, London, E1 2AD

ABSTRACT The aim of this study was to investigate the dental radiographic development of a small group of children born in Chernobyl, Ukraine, around the time of the nuclear disaster with an age matched group of British children. The design was a cross sectional non random retrospective study consisting of five boys and five girls from Chernobyl (age range 10.03 to 12.37) and 20 age and sex matched British children of white Caucasian origin. Developing permanent mandibular teeth were assessed from rotational tomograms using criteria described by Demirjian, Goldstein and Tanner (1973). Third molar formation was also assessed. Dental age was calculated and compared to real age using a t-test. The difference in dental age (DA) and real age (RA) was not significant when the two groups were compared. Dental age in both groups of children was advanced compared to the standards. These results suggests that the Chernobyl disaster has not affected root formation of late forming permanent teeth of these children.

INTRODUCTION

Irradiation is known to alter or destroy cells that are actively proliferation or differentiating at the time of exposure (Coggle, 1983; Hall, 1994). Developing teeth were shown to be radiosensitive to x-rays soon after their discovery, but the effect of atomic or nuclear irradiation on developing teeth has not been reported. This study investigated permanent tooth formation in a small group of children aged around 12 years from Chernobyl who were born just before or soon after the nuclear disaster.

MATERIALS AND METHOD

The sample studied consisted of radiographs of five girls and five boys from Chernobyl (aged 10.03 to 12.37 years) and a control group from London, UK. The ten unrelated children, all resident in Chernobyl since birth had their radiographs taken on 10 June 1998 as part of a thorough dental examination (including rotational pantomographs) in a general dental practice. This group was compared with an age (±0.2 years) and sex matched group of healthy white Caucasian children from London (n = 20). The control group was selected from the primary care daybook in the Department

TABLE 1. Real age, dental age, and the difference in years of the Chernobyl Children.

Number	Sex	Date of Birth	Real Age	Dental Age	Diference
1	male	31 May, 1988	10.3	12.30	2.27
2	female	8 September, 1987	10.75	12.60	1.85
3	male	11 October, 1986	11.66	13.60	1.94
4	female	5 September, 1986	11.76	13.00	1.24
5	male	5 May, 1986	12.10	15.50	3.40
6	female	3 May, 1986	12.10	14.70	2.60
7	male	26 May, 1986	12.12	12.30	0.18
8	female	13 April, 1986	12.16	14.70	2.54
9	male	13 April, 1986	12.16	16.00	3.84
10	female	24 January, 1986	12.38	11.90	-0.48

of Paediatric Dentistry at St. Bartholomew's and the Royal London Dental Hospital. Radiographs of these children were taken as part of their dental treatment at the hospital. Real age of each child on the day of the x-ray was calculated using date of birth (Eveleth and Tanner 1990). Dental age was evaluated from the method described by Demirjian Goldstein, and Tanner (1973), and Demirjian and Goldstein (1976), whereby the radiological appearances of the seven permanent teeth on the left side of the mandible are examined. Each tooth is rated into one of eight developmental stages, converted into a score, the total of which in turn is converted to the dental age. Dental age was calculated for each child and compared to the real age, with the mean difference for boys and girls for each group compared using a t-test. The age of the children means that a number of teeth have finished development. This method of assessing dental maturation in ten to twelve year olds is largely root growth of canines, premolars, and the second molars. Thus, in this study, only the later stage of dental maturation is investigated. This method also does not allow comparison of data of individual teeth, unless raw data are presented in other ways. Another drawback of this method is that root stages are few and widely spaced in time thus small differences between groups are less easily noted. The formation stage of the lower left third molar was also assessed separately; with an additional stage zero indicating the presence of a crypt but no cusp tips. Further analysis of the raw data allowed a comparison of the number of individuals from each group in each individual stage. The proportion and range of formation stages for the second and third permanent molars (M_2 and M_3) was also calculated. The second author examined all the radiographs after training and calibration; intra-examiner accuracy was 96% after triplicate scoring of each radiograph with discrepancies never more than one stage.

RESULTS

Results of dental age, real age and the difference for the Chernobyl children are shown in Table 1. The difference between DA and RA plotted against real age is illustrated in Figure 1 showing both groups of children; The horizontal reference line represents zero difference between dental and real age, and each dot represents one child. The vertical reference line is the date of the nuclear disaster. Children older than 12.12 years were born prior to 26 April, 1986.

A comparison of the mean difference between dental and real age of the two groups (Table 2) was not significant for either boys or girls. The bar charts showing the distribution of growth stages of M_2 and M_3 show that the Chernobyl group appearS less variable than the control group (Figs. 2 and 3).

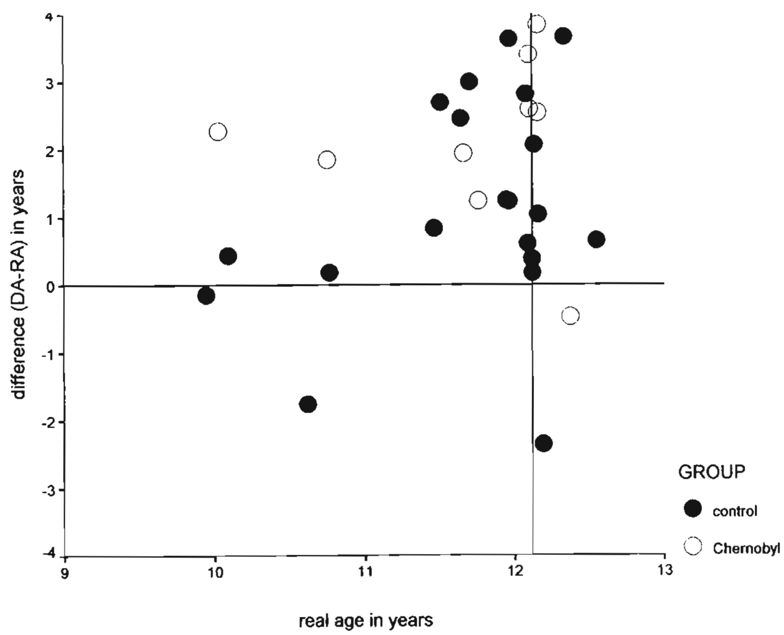

Fig 1. Scatter plot of the difference between Dental Age and Real Age against Real Age in years.

DISCUSSION

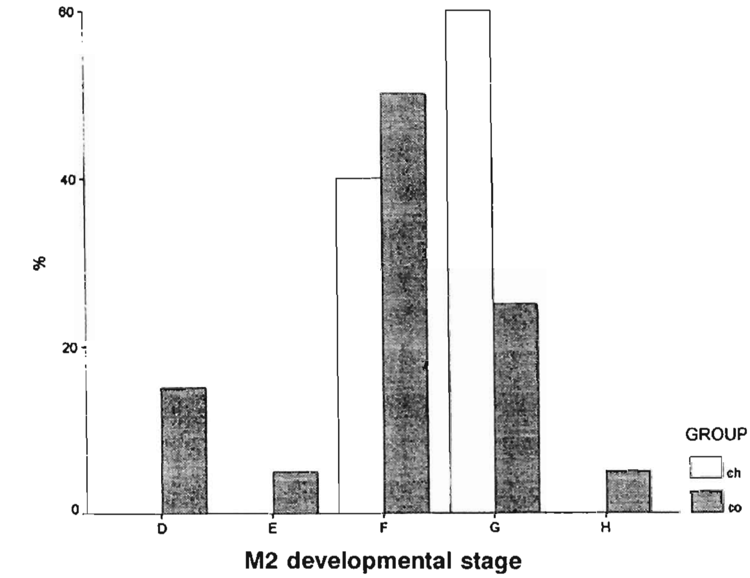

Fig 2. Bar chart of stages of dental development of M_2 (second permanent molar). Of the Groups ch is Chernobyl; co is Control.

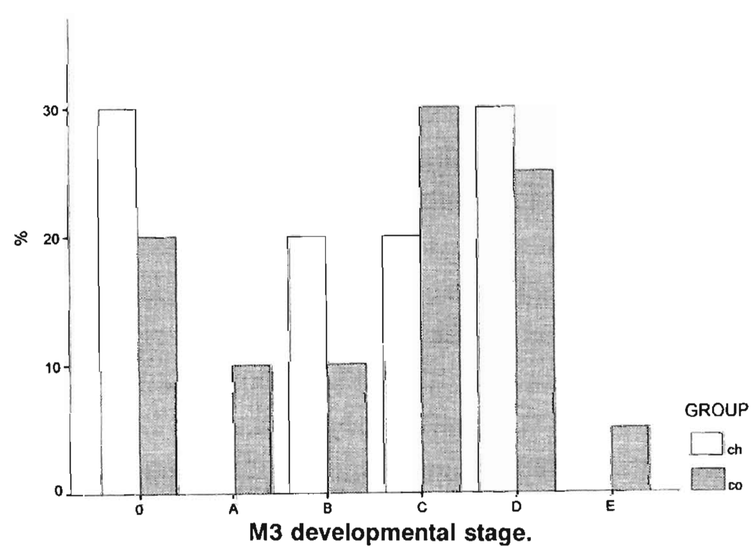

Fig. 3. Bar chart of stages of dental development of M_3 (third permanent molar). Of the Groups ch is Chernobyl; co is Control.

The effects of radiation on general health have been monitored since the Second World War by the Atomic Bomb Casualty Commission (now known as Radiation Effects Research Foundation) and continuing evaluation of current knowledge on the effects of ionizing irradiation is reported to several national bodies including United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). Age at irradiation is an important factor in risk determination and developmental effects of irradiation on the fetus are related to the stage at which exposure occurs (BEIR, 1980). Irradiation in utero or early childhood can retard growth and development of the brain (UNSCEAR, 1986; Brent, 1996; Streffer, 1997) and induce malignancy; a marked increase in thyroid cancer has been reported in Belarus since the Chernobyl accident (WHO, 1995). The effect of irradiation on somatic growth reviewed by Nakamura and Akiyama (1995) and maturation is uncertain (UNSCEAR, 1977).

Children exposed in utero to the atomic bombs in Japan were not significantly different to other Japanese children in maturation of the wrist bones (Russell et al., 1973). Growth status including bone age was retarded among children exposed to fallout radiation in the Marshall Islands (Sutow et al, 1965).

However, the number of very young children in this study was small. No radiation-related effect on height has been observed in children living in Russia, Belarus or Ukraine at the time of the Chernobyl accident (IAEA, 1991). The effects of the accident are under evaluation by the World Health Organization in its International Programme on the Health Effects

TABLE 2. Mean difference between real age and dental age in years .

	N	mean	sd	p-value
males				
Chernobyl	5	2.33	1.43	
control	10	1.11	1.06	0.08
females				
Chernobyl	5	1.55	1.26	
control	10	1.17	2.10	0.72

sd is standard deviation

of the Chernobyl Accident (WHO, 1995). In addition, a programme of oral health care in Belarus is underway (Wright et al., 1993, Operation Belarus website).

The effect of radiation on developing teeth has been known for almost a century, however, teeth have only recently been included in the UNSCEAR reports. Both ameloblasts and odontoblasts are affected and the extent of damage is dependent on the dosage and stage of histo-differentiation (Dahllöf et al., 1994). Most clinical data assessing growth are based on small and heterogeneous groups of patients treated in different ways at varying ages and the effects of irradiation are complicated by direct radiation damage, malnutrition, other treatment modalities, the presence of residual tumours and endocrine late radiation effects (UNSCEAR, 1993). This fact applies to developing teeth also (see reports of groups of children (Jaffe et al., 1984; Maguire et al., 1987; Sonis et al., 1990; Holtgrave et al., 1995; Nasman et al., 1997). The clinical manifestation of irradiation on the developing dentition (reviewed by Goho, 1993; Maguire and Welbury, 1996) usually consists of several types of injury reflecting the number of teeth developing at any time during childhood. Dahllöf et al. (1988) have classified injury ranging from microdontia, altered or arrested root growth, delayed eruption to failure of a toothbud to develop.

This very small group of children from Chernobyl was not significantly different in their dental maturation compared to the control group. An important factor that needs to be considered in this study is the sample of children from Chernobyl. The children were all on a visit organised by a charity for a month long holiday in Hertfordshire, UK, from their home environment in Belarus. The selection criteria for these children is unknown but one imagines that health status and social skills played a part. When dental age of each child from Chernobyl is plotted on the standard percentile curves, seven of the ten children are at or above the 90th percentile. Both groups of children, as a whole, were advanced compared to the standards; a finding in common with other reports (see Liversidge et al., 1999).

An interesting finding was the distribution in formation stage of the molars suggesting that the group from Chernobyl is relatively more homogeneous. Two of the ten children from Chernobyl in this study were born one year after the accident. The remainder were born around the time of the disaster. Tooth germs of the permanent incisors, canines, as well as the first molars, have formed by 30 weeks in utero. However, the only permanent tooth where dentino- and amelogenesis occurs prior to birth is the first molar (Tonge, 1969). Clinical examination of the ten children showed no macroscopic enamel defects on first permanent molars. One child had a white enamel opacity in the incisal third of the upper central incisors and upper left lateral incisor. However, as no other teeth were affected, the opacity can be assumed to be unassociated with any systemic disruption. None of the children from Chernobyl in this sample presented with missing or abnormal teeth.

The conclusion from this study is that the Chernobyl disaster has not affected later dental maturation in this small group of children.

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