Delayed dental age in boys with constitutionally delayed puberty

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SUMMARY It was the purpose of this study to evaluate dental age in boys with delayed puberty and to compare them with a group of normal, healthy boys. The study group consisted of eight boys with constitutional delay of growth and puberty (CDGP), older than 14 years, and with a testis volume smaller than 4 ml. The control group comprised 38 normal, healthy boys, aged between 12.4 and 14.3 years. Dental age was assessed using the Demirjian method and, on the basis of this evaluation, a dental delay score (i.e. dental age minus chronological age) was calculated in the CDGP and the control group.

It was found that Demirjian's dental age assessment is a valid method for scoring dental age in Belgian boys between 12 and 14 years of age, and that CDGP boys showed a significant delay in dental development compared with normal boys ($P = 0.0085$).

This study revealed a significant retardation in dental maturation of boys with CDGP.

Introduction

Constitutional delay of growth and puberty (CDGP) is the most common cause of pubertal delay (Kletter and Kelch, 1993). Delayed puberty is defined as the lack of development of secondary sex characteristics by 14 years of age or failure to complete sexual maturation within 4.5–5 years after its onset (Styne, 1991).

The age of onset of puberty varies greatly among normal adolescents, with 95 per cent of boys entering puberty between 9.2 and 13.8 years of age (Tanner, 1978).

Prader (1975) defined constitutional delay of growth and puberty as: 'constitutional delay of growth occurring in otherwise healthy adolescents with stature reduced for chronological age, but generally appropriate for bone age and stage of pubertal development, both of which are usually delayed.'

CDGP is not a disease, but a condition in which puberty and its associated growth spurt occur at an age that is near or beyond the extreme of the normal range. These boys appear remarkably healthy, but are shorter than their age-matched peers throughout childhood. Reassurance that puberty will occur on its own may be all that is needed. Many boys, however, will be distressed over their short stature and immature appearance. If they are older than 14 years of age, a low-dose testosterone treatment can be offered so they appear more mature with no restriction of adult height (Wilson *et al.*, 1988; Uruena *et al.*, 1992).

Constitutional delay of growth and puberty is more common in boys than in girls and tends to have a familial pattern (Stanhope and Preece, 1988).

The development of the dentition is an integral part of craniofacial growth, even though it is only marginally related to other maturational processes. Several authors have concluded that the correlation between dental maturity

and physical development is low (Steel, 1965; Anderson *et al.*, 1975; Hägg and Taranger, 1982; Demirjian *et al.*, 1985). In precocious puberty several examiners have investigated dental development: Roberts *et al.* (1985) and Seckel (1950) found that dental ages were retarded relative to their chronological age in children with idiopathic precocious puberty. Garn *et al.* (1965) stated that children most advanced somatically or sexually are, in general, most advanced dentally and vice versa. Dental maturation has been shown to be mildly, but consistently delayed in patients with delayed development (Garn *et al.*, 1965; Keller *et al.*, 1970; Pirinen, 1995), but to a lesser degree than skeletal maturation. The results of these earlier studies are difficult to interpret because of a lack of parallel controls. In the present study, dental maturation was evaluated in boys with delayed puberty, and a control group was used for validation of the Demirjian's method on Belgian boys between 12 and 14 years of age.

While delayed puberty refers more specifically to a general retardation in growth, the aim of this study was to determine whether there is a concurrent retardation of dental development.

Subjects and methods

Within an intake period of 2 years, eight Caucasian boys aged between 14.1 and 16.2 years with delayed puberty were identified as requiring testosterone treatment at the Department of Pediatrics of the University Hospital of Leuven. They were all diagnosed as having delayed puberty (Rosenfield, 1990). The inclusion criteria for enrolment in the study were: chronological age >14 years, testicular volume <4 ml, statural height below the third percentile for chronological age and delayed bone age. The scores for bone age ranged between 9.7 and 14.5 years using the Tanner–Whitehouse II method (Tanner *et al.*, 1983).

Thirty-eight normal, healthy Caucasian boys aged between 12.4 and 14.3 years, who were examined at the High School Medical Center, served as a control group. The only selection criteria were normal pubertal development and the willingness to participate in the study.

None of these boys had or were having orthodontic treatment.

Informed consent papers were signed by the parents of the participating boys and the study was approved by the Institutional Review Board of the Catholic University of Leuven.

Panoramic radiographs were used to assess patients' dental ages by using the method of Demirjian *et al.* (1973), and Demirjian and Goldstein (1976). The Demirjian dental development computer program (Silver Platter Multimedia Database, Silver Platter Information Inc., Norwood, MA, USA) was used to train and evaluate the examiner, in order to score the different stages of development correctly and consistently. The individual radiological appearances of the seven permanent teeth on the left side of the mandible were evaluated according to developmental criteria, with each tooth being categorized into one of eight stages. These individual stages on a radiograph can easily be inserted into the clinical evaluation programme, which converts them into a maturation and a dental age score. This evaluation programme is one of the sections which is included in the Dental Development Program. After examination of all radiographs, some were excluded, either because the boys had a maximum dental age score (full maturation of all seven teeth), or because there was extraction or agenesis of at least one tooth in the lower jaw (wisdom teeth not included), or because the radiograph was unclear due to movement during exposure. After this exclusion the control group comprised 38 subjects and the CDGP group comprised eight boys.

In order to assess the reliability of the Demirjian's dental age assessment in Belgian boys and of the examiner, the scores of 10 boys were measured twice, with an interval of 1 month, by the same examiner and by a second independent examiner as a pilot study. No significant differences between the intra- and inter-observer measurements were found (Wilcoxon-test).

Dental delay score, defined as dental age minus chronological age, was used for evaluation. The Wilcoxon-test was used for statistical analysis of the data.

Table 1 Chronological and dental ages and dental delay scores in CDGP and normal boys.

	CDGP (*n* = 8)		Controls (*n* = 38)	
	Mean ± SD	Range	Mean ± SD	Range
Chronological age (years, months)	15.1 ± 0.8	14.1–16.2	13.4 ± 0.7	12.4–15.2
Dental age (years, months)	13.7 ± 1.2	11.2–15.0	13.3 ± 1.0	11.1–14.6
Dental delay score	–1.3 ± 1.2	–2.9–0.5	0.0 ± 1.1	–2.0–1.5

Results

No significant ($P > 0.05$) inter- or intra-observer error was found, which shows a high reliability of the method and of the examiner.

The mean chronological age, the dental age, and the dental delay score of the control and the experimental groups are shown in Table 1.

The mean dental age of the control boys (13.3 ± 1.0 years, mean ± SD) corresponds well with their mean chronological age (13.4 ± 0.7 years). The Demirjian dental age assessment thus seems valid for Belgian boys in the investigated age period.

The mean dental age of the CDGP boys (13.7 ± 1.2 years) was delayed in comparison with their chronological age (15.1 ± 0.8 years). As the mean dental age of the CDGP boys was approximately the same as the mean dental age of the control group, even though the chronological age of the CDGP boys was two years older, a delayed dental development was present.

The dental delay score of the CDGP boys (–1.292) was 33 times the dental delay score of the control group (–0.039). The dental delay scores of the control and the experimental groups were significantly different ($P = 0.0085$).

Figure 1 shows the distribution of the chronological age and of the dental delay scores of CDGP and control boys. All CDGP boys, except one, had a negative dental delay score.

The control group was normally distributed; half showing a dental maturation retarded relative to their chronological age and 50 per cent being ahead of their chronological age.

Discussion

Methods based on tooth formation are more appropriate than other indicators of somatic development for assessing chronological age (Lewis and Garn, 1960). It has been argued by several authors that the mechanisms controlling dental development are independent of somatic and/or sexual maturation, since the correlation between dental maturity and physical development has been shown to be low (Anderson *et al.*, 1975; Demirjian *et al.*, 1985). Dental development appears to be controlled independently (Steel, 1965; Hägg and Taranger 1982).

However, Pirinen (1995) and Garn *et al.* (1965) stated that in normal, but extremely early or late maturing children, dental development shows a corresponding slight deviation to early or late development. Keller *et al.* (1970) found a significant delay in dental development in CDGP children when comparing chronological and dental age. However, in none of these studies was a control group used.

This investigation extends these results: a marked delay in dental development was demonstrated in patients who were diagnosed as CDGP compared with a control group. The CDGP patients showed a mean delay in dental maturation of approximately 1 year 5 months compared with non-growth retarded children, approximately 2 years younger. These control boys, although randomly taken from the High School Medical Center, showed close correlation of their dental ages with respect to their chronological ages (i.e. dental delay scores were around 0), indicating
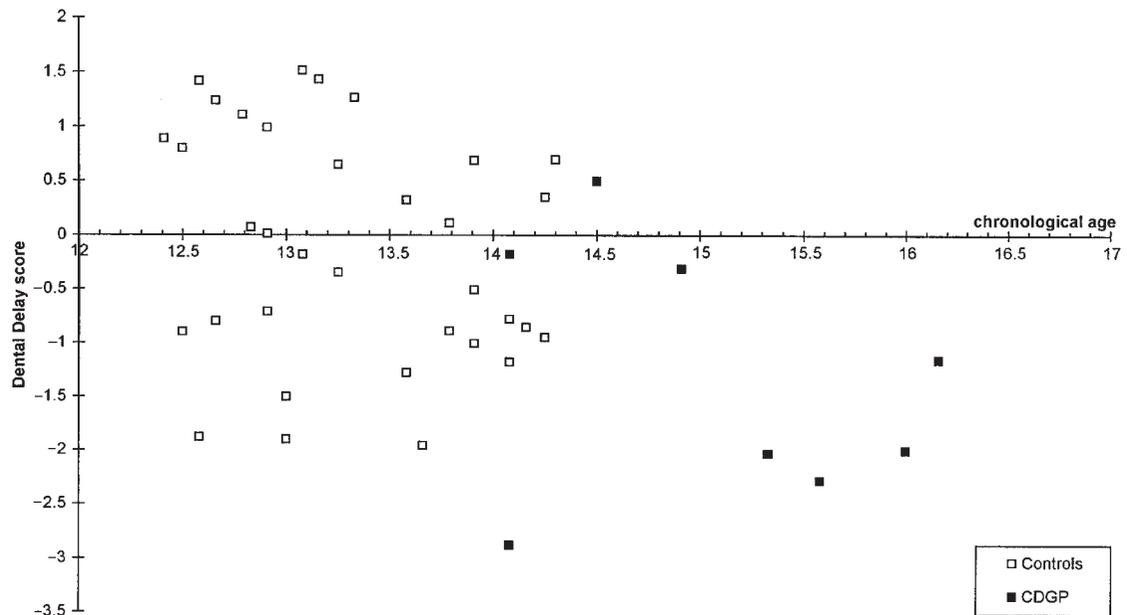
Figure 1　Scattergram showing the distribution of chronological age and dental delay scores of CDGP and control boys.

that they had dental maturation ages similar to the French-Canadian norm values (Demirjian *et al.*, 1973).

All patients except one with CDGP were located in the negative area of dental delay score. In contrast, the mean dental delay score of the control patients approaches zero due to the fact that, in this normal population, the spread for dental age is also normal: as many boys are slightly 'advanced', there are equally those who are slightly 'delayed'. Children of the same chronological age are not necessarily all of the same developmental age (Steel, 1965). This shows that the control group is representative of a normal population of boys, and that the Demirjian dental age assessment method is valid for Belgian boys between 12 and 14 years of age.

However, it has to be stressed that this study population concerns a small number and this has to be taken into consideration when interpreting the results of this investigation.

The dental age was assessed using the method of Demirjian *et al.* (1973), which seems to be the

most precise and accurate evaluation of dental age (Hägg and Mattson, 1985; Staaf *et al.*, 1991; Cameron, 1993). Over-estimation of the dental age using this system has been reported by Hägg and Matson (1985) and Staaf *et al.* (1991) to be from 1 to 9 months in boys. This would mean that the control group has a dental delay score that is slightly behind their chronological age, but it also reveals that the CDGP boys have a dental delay score that is also more negative than it already is. Therefore, since this over-estimation occurs in both groups and seems to be lower when chronological age is between 3.5 and 6.5 years, the results are unaffected (Hägg and Mattson, 1985).

Puberty concerns an interaction in the hypothalamo-pituitary-gonadal axis: both sex steroids and growth hormone are required for puberty (Stanhope and Preece, 1988). Boys with CDGP have a delay in the progressive increase of sex steroid secretion. Our results are in agreement with Garn *et al.* (1965) who noted some sex-steroid dependence in late-forming teeth. Therefore, it can be presumed that the

delay of onset of puberty is responsible for the delay in dental maturation.

As this relates to the orthodontic clinic, orthodontists should also be aware of new developments in pharmacological growth stimulation. Further investigation should be focused on following the dental development of boys with CDGP who have been treated with low-dose testosterone to determine whether there is also a significant acceleration in their dental development, as well as in their pubertal development.

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