Research in Developmental Disabilities 32 (2011) 808–817

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Correlation between dental maturation and chronological age in patients with cerebral palsy, mental retardation, and Down syndrome

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ARTICLE INFO

Article history:
Received 30 September 2010
Received in revised form 15 October 2010
Accepted 25 October 2010
Available online 30 November 2010

Keywords:
Chronological age
Dental age
Cerebral palsy
Mental retardation
Down syndrome

ABSTRACT

Determining a child's chronological age and stage of maturation is particularly important in fields such as paediatrics, orthopaedics, and orthodontics, as well as in forensic and anthropological studies. Some systemic conditions can cause abnormal physiological maturation, and skeletal maturation is usually more delayed than dental maturation. The aim of this study was to determine dental age in a group of patients with the most prevalent congenital or perinatally occurring physical and mental disabilities. The study group comprised 155 white Spanish children aged 3–17 years (35 with cerebral palsy, 83 with mental retardation and no associated syndromes or systemic conditions, and 37 with Down syndrome). The dental maturation indices described by Nolla and Demirjian were used to generate regression lines for the dental age of individuals in a control group (688 white Spanish children aged 3–17 years) and the formulae were then used to determine the dental age of patients in the study group. No significant differences were found between dental and chronological age in boys with cerebral palsy, mental retardation, or Down syndrome. In contrast, dental age (calculated from the linear regression model that included values for the Demirjian index) was significantly delayed compared with chronological age in girls with cerebral palsy or Down syndrome.

1. Introduction

1.1. Determination of chronological age

In the globalized world that we live in, administrative records of chronological age do not always correspond to biological reality in a given individual (Demirjian, Goldstein, & Tanner, 1973). Since age has social, legal, and penal implications, some degree of accuracy is required in its determination. Nevertheless, the number of cases in which a person's exact chronological age is unknown appears, somewhat paradoxically, to have increased in recent years, probably as a result of uncontrolled migration and an increase in the number of adoptions conducted across international borders.

In fields such as paediatrics, orthopaedics, and orthodontics, clinical diagnosis and initiation of the most appropriate treatment for certain diseases require accurate determination of chronological age; similarly, chronological age is a key variable in forensic and anthropological studies, particularly when only immature skeletal remains are available (Demirjian, Buschang, Tanguay, & Patterson, 1958; Green, 1961; Helm, 1990). Chronological age has been calculated using a variety of

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doi:10.1016/j.ridd.2010.10.019

biometric tests in which values are compared with standard curves generated using data from large groups of healthy individuals. Skeletal and dental age, however, are now generally considered the most relevant indicators. It has been suggested that chronological age is more strongly correlated with tooth formation than with body dimensions or skeletal maturation (Lauterstein, 1961; Ubelaker, 1989), probably because skeletal age is more sensitive than dental age to environmental insults (Saunders, Hoppa, & Southern, 1993).

1.2. Dental age and chronological age

The use of teeth as a reference in legal proceedings is not new; in 1836, Thomson (1836) suggested that chronological age could be reliably determined based on the dental emergence profile, and a year later, Saunders (1837) proposed that teeth could be used to determine chronological age in order to unveil attempts by some parents to exploit child labor by falsifying the age of their children.

The chronology and sequence of tooth eruption are subject to large variations and influenced by factors such as caries, premature loss or prolonged retention of deciduous teeth, malposition of teeth, and dental ankylosis (Sierra, 1987). Dental maturation is less variable than dental eruption (Lamons & Gray, 1958) and is progressive, continuous, and cumulative. Consequently, estimation of dental age might prove useful throughout the period of growth of an individual (Prahl-Andersen, Kowalski, & Heyendael, 1979). Various methods have therefore been proposed for the radiographic analysis of chronological age based on mineralization of permanent teeth (Gustafson & Koch, 1974; Haavikko, 1970; Harris & Nortje, 1984; Kullman, Johanson, & Akesson, 1992; Liliequist & Lundberg, 1971); the techniques described by Nolla (1960) and Demirjian et al. (1973), however, have become particularly widespread in recent decades.

1.3. The importance of determining dental age in dentistry

The development of the dentofacial complex is a particularly important indicator for orthodontists and maxillofacial surgeons. Precise estimates of the degree of maturation of a child can help to determine the optimal time to begin orthopaedic treatment involving the application of extraoral force or the use of functional appliances (Athanasiou, Farsaris, & Zarrinnia, 1986; Coutinho, Buschang, & Miranda, 1993) and are also of use in making decisions about the removal of permanent teeth (Grave & Brown, 1976). Determination of bone maturation reveals the extent of agreement with craniofacial growth standards (Fishman, 1987); furthermore, it increases the predictability of the future growth of the facial skeleton, which is essential in order to guarantee success in the treatment of dentofacial deformities (Chertkow & Fatti, 1979). Analysis of dental calcification can be used to establish the ideal point at which to initiate orthodontic treatment, to determine the pace of treatment, to guarantee dental movement, and to assess the prognosis of the remaining teeth. It has been reported that tooth development is not a definitive indicator of peak pubertal development, and in addition to determining dental age, orthodontists must assess skeletal age before designing a treatment plan (Sahin Saglam & Gazilerli, 2002). Certain systemic conditions, however, can lead to abnormal physiological maturation (Coutinho et al., 1993) and it has been shown that skeletal maturation is more acutely delayed than dental maturation in patients with serious systemic diseases (Cardoso, 2007).

1.4. Aims

The literature contains very little information on dental age in patients with severe disabilities and data are unavailable for certain systemic conditions. The aim of this study was, therefore, to evaluate dental age in a group of patients with cerebral palsy, mental retardation, or Down syndrome, 3 of the most prevalent congenital or perinatally occurring physical and mental disabilities.

2. Methods

2.1. Selection of the control group

The control group was comprised of 688 white children and adolescents who attended the Paediatric Dentistry Unit in the Faculty of Medicine and Dentistry at the University of Santiago de Compostela, Spain. Selection was partially stratified to ensure that all age groups and both sexes were adequately represented. Age and sex were recorded for each participant and the following inclusion criteria were applied: chronological age between 3 and 17 years; no congenital syndromes with orofacial involvement; no existing or previous systemic disease that could affect orofacial development or dento-skeletal maturation; no existing or previous disease in which treatment could affect orofacial development or dentoskeletal maturation; no history of severe dental trauma; no history of maxillofacial surgery; no history of orthodontic or maxillary orthopaedic treatment; and availability of a high quality panoramic X-ray obtained on the day of the appointment or within the previous month.

2.2. Selection of the study group

The study group comprised 155 white patients who attended the Special Patients Unit of the Faculty of Medicine and Dentistry at the University of Santiago de Compostela. Age and sex were recorded for each patient and the following