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Radiological evaluation of dental age

Individual growth of an organism is not a homogenous phenomenon as it consists of numerous subsequent progressive qualitative and quantitative processes leading to maturity of the organism. Many indices are applied for evaluation of the growth. Determination of age of an individual is essential, however, the age can be assessed in different ways. For example it can be described as developmental or biological age that determines maturity of all body systems on successive stages of individual development. On the other hand, skeletal age has been used for a long time as a measure of general level and prognosis of the development of a child. Assessment of degree of ossification is done by comparison of a radiogram of the patient with a set of model radiograms arranged according to age and sex in model atlases. On this basis a pattern is sought that is the most comparable to the radiogram of the patient. Morphological age is determined similarly as skeletal age by comparison of height and body mass of a child with a table of normal values and age related to these parameters is noted. The age of sex characters is based on evaluation of the stage of the development of the genitary system in Reynolds-Wines scale consisting of 5 degrees, separately for males and females. Dental age is a very valuable criterion of assessment of the development of a child and is based on evaluation of dentition in comparison with chronological age of the child. Numerous research works were carried out concerning evaluation of the dental age on the basis of morphological and histological features of teeth (4, 6, 12). The aim of the paper is to present radiological methods of assessement of dental age.

The first scientists who assessed dental age by means of a radiological method were Pinney (1939) and Carlson (1944). Pinney studied the development of mandibular teeth of the same individual on subsequent radiograms. Later Glaeiser and Hunt described 15 developmental stages of the first permanent molar basing on the degree of mineralisation of its crown and roots. Many other methods of evaluation of the dental age were derived from their works, for example the methods proposed by • Fanning (1961) • Moorrees, Fanning and Hunt Jr. (1963), who divided the development of a tooth into 14 stages (13) • Demirjian, Goldstein and Tanner (1973), who assigned numerical values to 8 developmental stages of a tooth (3) • Haavikko (1970, 1974) – dental age is evaluated for each tooth separately and mean value is calculated; in this method there are described 12 developmental stages of teeth (6 for the development of a crown and 6 for the development of a root); In children under 10 years of age there are evaluated developmental stages of the teeth: 47, 46, 44, 41, while for the children aged over 10 – teeth: 47, 44, 13, 43.

Other classifications were given by • Nolla (1960) who divided tooth development into 10 phases depending on the type of a tooth (incisors, canines, molars, premolars) • Garn, Lewis and Polacheck (1958 and 1960) who divided dental development into 3 stages: 1) the beginning of mineralisation of a crown, 2) the end of formation of the crown, 3) closing of apical foramen (7) • Liliequist and Lundberg (1971) who described 8 developmental stages of teeth and allocated points, for every mandibular tooth of one side from 0 to 6 points (0, 0.5, 1, 2, 3, 4, 5, 6); the sum of these values supplies information on the level of dental maturity (10) • Mornstad, Staaf and Welander (1994) based their classification on measurements of such dimensions as: height of the

crown, length of the crown, diameter of the apical foramen for various teeth images on panoramic radiograms (15) ● Liversidge and Molleson (1999) – the core of their method were measurements of lengths of various teeth on panoramic radiograms ● Carels, Kuijpers – Jagtman, Van der Linden and Van't Hof (1991) were basing on measurements of length of teeth: canines, both premolars and second molars on panoramic radiograms ●Gustafson and Koch (1974) distinguished 3 stages of formation of teeth and clinical eruption of every deciduous and permanent tooth (apart from the third molars) on the right hand side in the mandible and on the left hand side in the maxilla ● Becker (1998) assumed that closing of the apical foramen of a tooth occurred 3 years after eruption of the tooth and used the information for evaluation of the dental age: 9 years – closing of apical foramens of central mandibular incisor and first mandibular molar, 10 years – closing of apical foramens of central maxillary incisors, 11 years – closing of apical foramens of maxillary lateral incisors, 12–13 years – closing of apical foramens of mandibular canines and first mandibular premolars, while 15 years – closing of apical foramens of upper and lower second molars (1).

Studies on symmetry of individual teeth on both sides of dental arches showed that the development of teeth on both sides occurred in a similar way and observed differences were statistically insignificant (3, 7, 10, 13).

In the worldwide literature the majority of the published papers concerning dental age refers to three radiological methods of its evaluation. These are the methods proposed by: 1– Nolla, 2 – Moorrees, 3 – Demirjian.

Nolla distinguishes 10 developmental stages of 14 teeth – 7 maxillary teeth and 7 mandibular teeth on the left; the third molars are not taken into account. To every stage of tooth development there is assigned a given number of points. The points corresponding to developmental stages are added separately for all maxillary teeth and for all mandibular teeth. Then the results are added in order to obtain the total index of dental maturity. Nolla elaborated yearly categories of age for females and males aged from 3 to 17 years.

The necessity of evaluation of a large number of teeth seems to be the disadvantage of the method. Moreover, the due to anatomy of structures lying in the vicinity of the evaluated teeth, the assessment of maxillary teeth on panoramic images is difficult and additional intraoral radiograms of the studied area are required.

The Moorrees' method (13) is based on evaluation of developmental stages of 10 teeth of the left side: maxillary incisors (central and lateral) as well as 8 mandibular teeth. Every developmental stage is described by a certain letter code illustrating the state of mineralisation and proportions of already formed parts of a tooth– Ci, Cco, Coc, Cr ½, Cr ¾, Crc, Ri, Cli, R ¼, R ½, R ¾, Rc, A ½, Ac. The age of the examined teeth is derived from special charts assigning chronological age to a given developmental stage. The charts are prepared separately for boys and girls. The cutting point of the line assigned to a given developmental stage corresponds to chronological age. The cutting point may be in concordance with mean age or it can be situated within two standard deviation values. If the point is shifted towards the higher number of years, it means retardation of the dental age. Reverse situation – the shift of the point towards the lower number of years (less than two standard deviations) means that the dental age is accelerated.

The Demirjian's method distinguishes 8 stages of development and they are determined for seven left mandibular permanent teeth – central incisor, lateral incisor, canine, the first and second premolars as well as the first and second molars. The stages are described by letters from A to H. Additionally there is introduced stage "0", which means that no signs of mineralisation of a tooth bud can be detected. Panoramic radiograms are used to assign developmental stages to all teeth of the left side of the mandible, apart from the third molars. Then tables are used to calculate numerical value of every assessed stage. The values are added and the calculated sum indicates dental age. The dental age corresponding to a given sum of points can be read out from model tables or from special centile grids. They are prepared for children aged from 3 to 16, separately for girls and boys.

In the past 40–50 years there has been observed acceleration of children's development. It concerns all aspects of development, i.e. development of bones, sexual development or

development of dentition. The acceleration is related to both eruption of teeth (8, 9, 12, 18), as well as the evaluation of the developmental stages (11, 14, 16, 17). The occurrence of acceleration of development in children is usually explained by improvements in conditions of life, higher availability of various products such as nutrition as well as better access to health care facilities, services and medicaments. However, despite general tendency to acceleration of maturation of children, the discrepancies in developmental indices between different populations are significant (2). In some populations there is observed even retardation in tooth eruption (5) or stabilisation of mean age of individual teeth on the level comparable with data from the past (20). Occurrence of differences in given developmental criteria between populations restricts utility of developmental norms obtained for one population in relation to other populations. Many researches comparing the development of teeth of a studied group with the norms for another population concluded that the norms were inadequate both in case of eruption of teeth (8) as well as in case of their development (14, 19). Due to acceleration of development it is vital to determine norms for every population separately and to revise them every 10 years. Therefore, application of standardized methods of evaluation of dental age, e.g. radiological methods is of great importance in clinical practice.

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SUMMARY

Individual growth of an organism is not a homogeneous phenomenon as it consists of numerous subsequent progressive qualitative and quantitative processes leading to maturity of the organism. Many indices are applied for evaluation of the growth. The aim of the paper is to present radiological methods of assessement of dental age. Dental age is a very valuable criterion of assessment of the development of a child and is based on evaluation of dentition in comparison with chronological age of the child. In the worldwide literature the majority of the published papers concerning dental age refer to three radiological methods of its evaluation. These are the methods proposed by Nolla, Moorrees and Demirjian. Due to acceleration of development it is vital to determine norms for every population separately and to revise them every 10 years. Therefore, application of standardized methods of evaluation of dental age, e.g. radiological methods is of great importance in clinical practice.

Radiologiczna ocena wieku zębowego

Rozwój osobniczy organizmu nie jest zjawiskiem jednorodnym, lecz składa się z szeregu kolejnych progresywnych procesów jakościowych i ilościowych, doprowadzających do dojrzałości. Do jego oceny stosuje się wiele wskaźników. Celem pracy jest przedstawienie radiologicznych metod oceny wieku zębowego. Wiek zębowy jest bardzo wartościowym kryterium oceny rozwoju dziecka i polega na ocenie stanu rozwoju uzębienia w stosunku do wieku chronologicznego. W piśmiennictwie światowym najwięcej prac poświęconych zagadnieniu wieku zębowego opiera się na trzech metodach radiologicznych jego oceny. Są to metody Nolli, Moorreesa i Demirjiana. W związku z akceleracją rozwoju istnieje konieczność ustalania norm dla każdej populacji osobno i aktualizowania ich co 10 lat. Stąd zastosowanie standardowych metod oceny wieku zębowego, takich jak metody radiologiczne, jest niezwykle istotne w praktyce klinicznej.