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Age Determination Using Orthopantomograph- A Review

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ABSTRACT

Age is one of the important factors in assessing the identity of a person. Age can be estimated in different methods like, using chronological age, skeletal age and dental age. The use of radiographs for age estimation is characteristic of techniques that involve observation of the morphologically distinct stages of mineralization. The age estimation is based on the degree of formation of root and crown structures, and the developmental stages of teeth. Several methods have been developed to estimate age based on dental tissue and tooth morphology, like morphologic, radiographic, histological and biochemical methods. Some of these methods are especially developed to estimate the age at death as they require sectioning, while others may also be used in clinical situations. Majority of the cases concerning age estimation are performed on living people. Since 1896, an year after the discovery of radiation, Xrays are used in forensic sciences,to demonstrate the presence of lead bullets inside the head of a victim. Dental radiography has been used for age estimation since 1982.Dental findings assessed by radiography are an important source of information in forensic odontological age determination. Age estimation up to puberty can be performed by development process, dental radiographs (intraoral periapical radiographs, bitewing radiographs, orthopantomographs) or by a combined radiographic technique of the third molar tooth staging development and hand wrist and cervical vertebrae radiographs. But, after third molar development, it becomes increasingly difficult to assess age accurately. Only the aging process and regressive changes of teeth are helpful at adult age.

KEY WORDS: ORTHOPANTOMOGRAPHS, TOOTH MORPHOLOGY, BITEWING RADIOGRAPHS.

INTRODUCTION

Age is one of the important factors in assessing the identity of a person. Age can be estimated in different methods like, using chronological age, skeletal age and dental age.(Willems, Moulin-Romsee and Solheim, 2002) Estimation of the age of children at death is currently based on the fusion of bone at secondary ossification centers and the development and eruption status of the teeth. However determination of the age of adults is more complex. (González-Colmenares et al., 2007)Therefore, in that manner, forensic odontology plays a small but significant role.(Raj et al., 2016) The identification of dental remains is of primary importance as teeth are the most durable and resilient parts of the body and, with their physiologic variations and effects of therapy,(Paewinsky, Pfeiffer and Brinkmann, 2005) they resist the influence of many factors and their rate of disintegration is very low.

Compared to bone mineralization, tooth mineralization stages are much less affected by variation in endocrine and nutritional status, and developing teeth therefore

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provide a more certain indication of chronological age. (Raj et al., 2016) Tooth formation is often used to study maturity and predict age. Within clinical dentistry, this information aids in diagnosis and treatment planning. In forensic odontology and archaeology, age estimation methods can help in the identification of age at death of a deceased child and also give important information with regard to past populations. Age estimation is also proving valuable when birth data is lacking or doubted in the management of immigration to help determine physiological age.(Bosmans et al., 2005) They are sometimes the only body part available for study and this makes teeth very suitable for dental age estimation. (Mittal et al., 2016)Saunders a dentist, was the first to publish information regarding dental implication in age assessment by presenting a pamphlet entitled "Teeth A Test of Age" to the English parliament in 1837. While quoting the results from his study on 1000 children, he pointed out the value of dentition in age estimation. (Erbudak et al., 2012).

From 1896, xrays have been used in the forensic radiology, to demonstrate the presence of lead bullets inside the head of a victim. Dental radiography has been used in age estimation from 1982.(Chesne et al., 2000). Dental findings assessed by radiography are an important source of information in forensic odontological age determination.(Maber, Liversidge and Hector, 2006) Several methods have been developed to estimate age based on dental tissue and tooth morphology, like morphologic, radiographic, histological and biochemical methods. Some of these methods are especially developed to estimate the age at death as they require sectioning, while others may also be used in clinical situations.

Majority of the cases concerning age estimation are performed on living people. Morphological and radiographic methods are useful in living individuals at adolescent and adult age, whereas histological and biochemical methods are useful in dead victims (Liversidge, Lyons and Hector, 2003)The use of radiographs for age estimation is characteristic of techniques that involve observation of the morphologically distinct stages of mineralization. Such determinations are also based on the degree of formation of root and crown structures, the stage of eruption and the intermixture of primary and adult dentitions.(Santana, Bethard and Moore, 2017)

As far as dental age estimation is concerned, tooth development is a complex process that takes place from early fetal life to approximately 20 years of age. Both developmental and regressive changes to the tooth can be related to chronological age.(Tunc and Koyuturk, 2008) Age estimation up to puberty can be performed by development process, dental radiographs (intraoral periapical radiographs, bitewing radiographs, orthopantomographs) or by a combined radiographic technique of the third molar tooth staging development and hand wrist and cervical vertebrae radiographs. (Bagherpour et al., 2010) But, after third molar development, it becomes increasingly difficult to assess age accurately. Only the aging process and regressive changes of teeth are helpful at adult age.

Our recent research portfolio in numerous articles in reputed journals(Santosh R. Patil et al., 2018; S. R. Patil et al., 2018; Subramaniam and Muthukrishnan, 2019; Vadivel et al., 2019; Patil et al., 2020). Based on this experience we planned to pursue a review of age estimation using OPG

MATERIAL AND METHODS

This review article compared the different studies on age determination by orthopantomograph and concludes if the method is useful or not. Various articles about age estimation using orthopantomographs were selected and For all the included studies, the information relating to the medico legal importance of age estimation requirements for odontological age estimation and criteria for radiological age determination, phases of age estimation, various dental development surveys or methods used, rationale and advantages of radiological method was extracted.

DISCUSSION

The radiological methods of age estimation carries unique advantages over the other histological methods. The other methods of age estimation require extraction and preparation of microscopic sections, hence these methods therefore cannot be used in living individuals and in cases where it is not acceptable to extract teeth for religious or scientific reasons.(Kvaal et al., 1995) Besides, they are quite expensive and require some sophisticated laboratory. The radiographic methods, are quick, economic and non-invasive in age estimation. Additionally, it can be applied for identifying the age in dead as well as living persons and in all communities(Kolltveit, Solheim and Kvaal, 1998)Age estimation is relatively difficult in pre-natal and neonatal phases compared with the post-natal phase. Though histological examination of tooth germs will be able to decide the age earlier in the prenatal phase, it will be an invasive and time-consuming procedure.

From the prenatal dental development of the fetus until the eruption of the first tooth into the oral cavity post-nasally, the radiological examination of the jaw bones for the developing tooth germs will be the mainstay for the age assessment Similarly, in the post-natal phase, between the ages of 2.5 and 6 years, there is no clinical evidence available to determine the age, so radiography will play a major role in assessing the jaw bones for developing permanent dentition(Solheim, 1993) The best precision and accuracy for radiographic age estimation is achieved when individual growth is rapid and man teeth are under development. After the age of 14 years, estimation becomes difficult since most of the dentition is completely developed.(Erbudak et al., 2012) Age estimation plays an important role in forensic medicine, clinical dentistry, pediatric endocrinology, and

archaeology. Age estimation is of wider importance in forensic medicine, not only for the purpose of identifying deceased victims but also in connection with crimes and accidents. In addition, chronological age is important in most societies for school attendance, employment, social benefits, and marriage. (Kim, Kho and Lee, 2000)

In adulthood, teeth undergo time-related changes representing biological aging, and many studies have shown that several features of aging can be used for age determination . Gustafson developed the first dental method of age estimation in adults based on six criteria: attrition, secondary dentine in the pulp, cementum annulations, root resorption, periodontal recession, and root translucency.(Kim, Kho and Lee, 2000) The methods used in OPG can be applied to living persons. Furthermore, OPGs also provide information regarding individuals' identity and other age-related features such as enamel attrition, secondary dentine in the pulp, root resorption, cementum annulations, and periodontal recession. (Hongwei and Jingtao, 1989)Tooth improvement is a continuous process, but determining the end point of tooth development is very difficult. Thus, the calculation of a mean age for each phase is difficult; further research is needed to determine the apex closure stage of teeth.Measurement using dental radiographs is a non-invasive technique which might be clinically important in living individuals for estimating the age of adults, both living and dead, in archaeological studies and in forensic work, but the method should be tested on an independent sample.(Solheim, 1992)

To minimize the influence of intra-and inter examiner variations, well-defined criteria and careful calibration among examiners are essential for age estimation. (Solheim, 1989) Even though the coronal pulp might be affected by external factors the root pulp remains safe, the scoring systems gave OPGs a strong correlation between age and the amount of secondary dentin for the coronal and for measurements in the root area. (Eckert and Garland, 1984) Age estimations based on measurements of the amount of secondary dentin present seem to be relatively reliable. Methods of age estimation in adults are concerned, and in view of the relative accuracy of the age estimations performed, one should keep in mind that the standard deviations of such age estimations are, in general, about 10 to 12 years. (Matschke, Makrigeorgi-Butera and Stavrou, 2003) Age estimation was made using criteria such as the presence of primary teeth in the mouth, mixed dentition period, presence of third molar teeth in the mouth, maturation stage of third molar teeth, enamel attrition level of teeth, width of root canal and pulp cavity, and level of alveolar bone resorption. However, no measurements were made. (Willems et al., 2001).

Both independent dentists examined the OPGs at the same time. Exact age was not estimated in any study. Bosmans et al, using OPGs in a study, selected 6 teeth and performed age estimation using criteria such as maximum tooth length, pulp length, and root and pulp width.(Sehrawat and Singh, 2017) They classified the study population, whose ages ranged from 29 to 70 years, into decades with time intervals of 9 years. The age estimations were reported to be convenient to the decades of chronological ages, based on a single dentist's evaluation. The methods in this study can be applied to living persons. Furthermore, OPGs also provide information regarding individuals' identity and other age-related features such as enamel attrition, secondary dentine in the pulp, root resorption, cementum annulations, and periodontal recession. the age groups were determined and age estimation must be made in accordance with these groups.In some studies,, considering the necessity of identification and accurate age estimation of cases in daily practice of forensic medicine (age estimation for marriage, penal trials, and legal actions), and in the identification of disaster victims, a subjective age estimation method was implemented by evaluating OPGs.(Schmeling et al., 2007).

Tooth improvement is a continuous process, but determining the end point of tooth development is very difficult. Thus, the calculation of a mean age for each phase is difficult; further research is needed to determine the apex closure stage of teeth.(Olze et al., 2006) Measurement using dental radiographs is a non-invasive technique for estimating the age of adults, both living and dead, in archaeological studies and in forensic work, but the method should be tested on an independent sample(Schmeling et al., 2004) A scoring system for age estimation should be developed to ensure good reliability. To minimize the influence of The criteria used in our study were a compilation derived from the literature; however, the manner of evaluation in this study was different. The authors were inspired by previous studies related to the subject in order to take a further step. OPGs were evaluated considering the age groups of the study population, which is concordant with the previous studies performing evaluation according to decades. (Sehrawat and Singh, 2017).

In parallel to the literature, the author should suggest the use of skeletal measurements in addition to dental methods, for accurate age estimation. Despite the variations related to the practitioners, in this study, there were no significant differences in age estimation between both two participant practitioners.(Mörnstad, Staaf and Welander, 1994) Age estimation through the evaluation of OPGs was the most reliable results for the first decade of life due to eruption of teeth. However, the method showed unreliable results for the fourth decade.The reliability of age estimation reduced in older age groups.(Mörnstad, Pfeiffer and Teivens, 1994) The possible reasons might be the reduction of the criteria and signs for the age estimation of OPGs in older persons and the variability of the oral health status of patients in older age groups.Age estimation with OPGs can be used to make a significant percentage of forecasts in areas such as forensic medicine and forensic dentistry, especially in young patients.

CONCLUSION

Despite the variations related to the practitioners, in this study, there were no significant differences in age estimation between both two participant practitioners. The age estimation by radiographs was highly reliable in the first decade due to eruption of teeth. However, the method showed unreliable results for the fourth decades. The reliability of age estimation reduced in older age groups. The possible reasons might be the reduction of the criteria and signs for the age estimation of OPGs in older persons and the variability of the oral health status of patients in older age groups.

Age estimation with OPGs can be used to make a significant percentage of forecasts in areas such as forensic medicine and forensic dentistry, especially in young patients. In order to achieve accurate and reliable age estimation, in addition to millimetric measurements of the teeth, skeletal measurements and examinations should be performed.

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