NON INVASIVE AGE ESTIMATION TECHNIQUE: A REVIEW

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ABSTRACT

One of the interesting and necessary application of forensic odontology is age estimation by means of changes in dentition and individual tooth. Gradual developmental and structural changes throughout the life in hard and soft tissues are basis for age estimation. Age assessment proves to be a critical factor in the victim identification process and other legal aspect. Teeth and jaws display a number of observable age related variables and they tend to remain intact under various circumstances, which might alter or obliterated in case of the rest of the skeleton. The procedures for age determination are complex.

Different methods are used to estimate age. Broadly the technique can be categorized as invasive and non-invasive. Invasive technique destroys the evidence hence the non invasive technique are considered to be superior in certain aspect, hence gaining the popularity during these days. These noninvasive technique involve Schour and Masler's method, Demirjian's method and its modification , Radiographic method of Kvaal.

Schour and Masler's method include the direct comparison of radiograph with direct comparison to established chart or atlas. Demirjian's method include the calculation of different maturity scores at various stages of tooth development ultimately giving the approximate age. Radiographic method of Kvaal is based on deposition of secondary dentin, thus pulp size : tooth size ratio provide clue for age estimation. The purpose of this article is to highlight advantages of noninvasive technique, different non invasive techniques, which are used to determine the age by means of teeth and status of dentition.

INTRODUCTION

Mental maturity, including the capacity for autonomous choice, self-management, risk perception, and the calculation of future, are dependent on brain development. Based on this biological maturity, the minimum age for marriage, driving, voting, and also criminal responsibility is set in different countries between the ages of 15 and 21 years. In countries with a high number of immigrants, asylum seekers, or refugees, there are frequently people without a legal pass, identification card, or certificate of birth. Some of them are trying to change their status in a criminal court with false statements or witnesses. In such cases, age determination will be necessary to evaluate the accuracy of this information.[14]

Age calculation has become increasingly important in forensic sciences. This is certainly true for unidentified corpses but also for living individuals. Especially in a multicultural society where legal and illegal immigration is rising, an increasing demand exists for age calculation in living persons.[1] Teeth may be better preserved than other parts of the body and thus give a better indication of age. It has application in establishing the identity of living or deceased persons. It also has application in living individuals whose chronologic age is under dispute. Dental age is one of the few measures of physiologic development that is uniformly applicable from infancy to late adolescence. The proofs from the literature suggest that, it can be concluded that both non-destructive dental-age estimation techniques were able to produce reasonably accurate dental-age estimations, at least when these techniques were applied appropriately. However, the forensic odontologist is recommended to use different age estimation techniques and perform repetitive measurements in order to verify the reproducibility of the calculations performed.[18]

Historically, In 1836, Thomson who was one of the pioneers of medical jurisprudence claims that children, where the first permanent molars had not erupted, It was certain that they have not reached the age of seven. Scientific study of Age assessment using teeth was first

published by Edwin Sunders [15] in 1837, who claimed that teeth provided the most reliable guide to age compared to age estimation from height which was a standard method used during that time.

Several authors have reported different techniques for dental age calculation in forensic literature. These may be described in four categories namely, Clinical or visual method (morphological), Radiographic method, Histological method, Physical and chemical analysis. Visual observation of the stage of eruption of the teeth and evidence of changes due to function such as attrition can give an approximate estimate of age. Radiography can provide the gross stage of dental development of the dentition. Histological methods require the preparation of the tissues for detailed microscopic examination, which can determine more accurately the stage of development of the dentition. This technique is more appropriate for post-mortem situations. It is also significant in estimation of age of early development of dentition. The physical and chemical analysis of dental hard tissues to determine alterations in ion levels with age have been proposed.

The methods like histological, physical chemical analysis of age estimation demands extraction of the tooth. Most of the time preparation of microscopic sections of at least one tooth from each individual. These methods cannot be used in living individuals and in cases where it is not acceptable to extract teeth for ethical, religious, cultural, or scientific reasons.

In 1994 Kvaal and Solheim [5] presented a method which combines radiological and morphological measurements, and therefore extraction was still required. At least for some teeth regression formulas were calculated omitting the use of morphological parameters. As a continuation of this method Kvaal et al. [6] reported a method which is based on radiological measurements only. When the age was calculated based on measurements of all six teeth or of all three mandibular teeth, no significant differences were found between the real age and the calculated one. In all other instances using the individual teeth separately or using all three maxillary teeth statistical analysis revealed significant differences.

There are various factors that are used for the age determination using dentition [3,13] The factors are the appearance of tooth germs, earliest detectable trace of mineralization, Degree of completion of the unerupted tooth, Rate of formation of enamel, formation of the neonatal line, Clinical eruption, Degree of completion of roots of erupted teeth, Degree of resorption of deciduous teeth, Attrition of the crown, Formation of physiologic secondary dentin,

Formation of cementum, Transparency of root dentin, Gingival recession, Root surface resorption, Discolorations and staining of teeth, Changes in the chemical composition of teeth.

Age estimation using the dentition can be grouped into three phases

1. Age estimation in prenatal, neonatal and early postnatal child.
2. Age estimation in children and adolescents.
3. Age estimation in adults.

1. Age estimation in prenatal, neonatal and early postnatal child.

Age estimation in this group of individuals can be very accurate. Radiological methods are used to assess the stage of tooth development during the mineralization period. Mineralization of deciduous dentition commences from two or four months in-utero. Enamel formation of all deciduous teeth is usually complete by the first year. Among the permanent teeth the 1st molar shows germ formation 1st at about 3 and ½ to about 4 months of IU. Thus by the use of radiographic technique age can be estimated.

2. Age estimation in children and adolescents

It can broad be divided into 2 main types Atlas approach and scoring approach. Tooth eruption and tooth calcification are the two events that can be used to measure dental age in children and adolescents. Radio graphical evidence of formation of crown and root completion has been utilized for this age group.

Nystrom and colleagues consider estimation of age from study of tooth emergence to convenient clinical method. The use of tooth emergence is under genetic control and relatively regular, commencing approximately six months after the birth and completing by 2 ½ yr.[16]

Schour and massler's chart in 1944 [4] were probably the first attempt to study dental age estimation. They described the 20 chronological stages of tooth development starting from five month of IU life until 21yr of age. The chart was based on histological section and permit direct comparison with radiograph. This chart permits direct comparisons with radiographs. In 1978 Ubelaker also put forth the modification of chart and almost same type of chart has been developed. But Failure to separate the sexes would result in greater aging errors for both the method.

Mooresees at el divided the dental maturation of the permanent dentition into 14 different stages ranging from "initial cusp formation" up to "apical closure complete" and designated different tables for males and females chronological age can be read from tables based on mineralization and stage of development of that specific tooth.[20]

Aderson et al futher develop system of Mooresees et al. for the teeth including 3rd molar. The tables they compiled are considered very comprehensive and can be applied to a much larger age range of juveniles. [20]

Demirjian et al developed an age estimation method [5] that made use of a scoring system. It is considered to be scoring approach. In this method, seven mandibular teeth on the left side were divided into 8 stages and maturity score was evaluated. The development of mandibular teeth as it appears on radiograph was divided into 10 stages and numbered 0 to 9. Then for each developmental stage maturity score has been established. Also maturity score for male and female are different considering sexual dimorphism of development. Based on the developmental stage, each tooth is given an appropriate score. The score assigned for each of the eight teeth is added and total maturity score (S) obtained.[16]

Demirjians method was originally developed for the European origin and its use in other populations has resulted in an overestimation of age. Koshy and Tandon study and other studies suggest the method needs to be adapted to local population before using in age assessment. This method is most widely used and relatively simple.[16]

Age estimation can be measured using mandibular third molars [6] in which formed part of root were digitized but the precision of the age estimation was slightly inferior compared with the standard method. However , Gunset and associates concluded that the age of an individual is 18 yr old or notcan reliably be estimated. When all four third molar have been completely calcified, the probability of individual being 18 year old is 96% and 95% for male and females, respectively.

3. Age estimation in adults

Most of the methods used in adults use various regressive changes of hard and soft tissues of the teeth. Deposition of secondary dentin [9] can be assessed using periapical radiograph to estimate age. Pulp diameter to crown diameter ratio and pulp / root length, pulp / root width was measured. In this context radiographic method of Kvaal's is most widely used. The

method applied to the anterior teeth observed on periapical radiograph.　Vandevdoot et al (2004), reported morphometric method pilot study using microfocused computer tomography on extracted teeth to compare pulp- tooth ratioin determination of age. Yang at el (2006) using cone beam CT scanning acquired the 3D images of teeth in living individuals. Using the 3D images the ratio of pulp- tooth volume can be calculated.

COMPARISON OF VARIOUS METHODS

The panoramic radiographs of 75 healthy children (40 boys and 35 girls) aged between 5-14 years were selected. Demirjian, Nolla, Haavikko, Williams and Cameriere methods were applied for estimation of age. They got the result that the method of Willems was the most accurate, followed by Haavikko, Cameriere, Nolla and lastly Demirijian.[21]

The key to optimal age estimation suggested by Willems and Associates.

1. The investigator should be suffiecently experienced.
2. Multiple investigator or a second option is important.
3. Use of multiple age estimation methods.
4. Careful adherence to suggested protocol, including the use of specific equipment and proper storage of tooth specimen.
5. Use of multiple teeth.

CONCLUSION

Age estimation presents a complex problem and requires considerable experience in recognizing significant changes and allowing for their variability with in any particular population. Teeth are particularly useful in age evaluation because they display a number of observable age related variables and they tend to remain intact under circumstances which might alter or obliterate the rest of the skeleton

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