

## Age determination and the importance of teeth in forensic odontology: A retrospective review

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### Abstract

Because of illegal immigrations, particularly after the so called Arab spring and the growing incidence of natural and man-made disasters which regrettably was very common in the last three to four decades, age determination has gained increasing importance in legal medicine. Forensic odontology is a branch of dentistry which deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings in the interest of justice. There are various methods are used in Dentistry as an Evidence in Forensic Identification. Dental maturity, have a very imperative position in the assessment of age in children and adolescents forensic examinations. As time passes, with the increase in human greed and aspirations to conquer more and more nations in the false name of 'removal of the dictators' and the 'forceful imposition of imported western democracy' that has produced devastating results in the middle east and ultimately resulting in illegal mass immigration occurring towards Europe, eventually resulting in increase of crime and other legal and illegal activities, Forensic odontology as a branch in dentistry will continue to play its important role in legal medicine.

**Keywords:** Dental age, Forensic odontology, Age Determination, Sex Determination.

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### Introduction

Age also plays a critical role in pediatric dentistry, orthodontic treatment planning, and surgeries (1). A person's physiological age is assessed based on his/her somatic maturation, i.e. maturation of functional body systems such as bones and teeth (2).

Teeth undergo various development stages in the first 25 years of a human's life and demonstrate secondary changes in the later years. On the other hand, they are not highly influenced by nutritional and endocrine factors. Hence, Legal Dentistry has turned into a dynamic and active field of medicine during the past two decades (3). Numerous techniques have been suggested to determine age according to dental characteristics. Despite the use of time of tooth eruption in age determination, this index is widely affected by environmental factors including dental arch space, early

extraction of primary teeth, tooth impaction, and tipping. Therefore, a number of approaches to age determination, e.g. evaluation of radiographic images (4),(5) dental structure (6),(7),(8), Gustafson's method(9), Lamendin's method (10),(11), and aspartic acid racemization (12),(13), use tooth development stages as a more logical factor. Among the many advanced imaging technologies and radiographic images utilized to estimate age, viz. panoramic, periapical, cephalometric, and lateral oblique radiographs, panoramic radiographs are an accessible and inexpensive method to provide an outline of a person's dental system maturity (14).

"Forensic odontology is a branch of dentistry which deals with the proper handling and examination of dental evidence and the proper evaluation and presentation of dental findings in

the interest of justice" (15). In the present scenario, forensic odontology has been included as a specialty in the broad arena of Forensic Sciences. Forensic odontology has become an integral part of large international forensic educational organizations like American Academy of Forensic Sciences (AAFS) as well as International Association of Identification (IAI). The primary utility of forensic odontology is in the identification of human remains based upon the individualistic characteristics present in the teeth of different individuals. This discipline plays a significant role in the identification of human remains in incidents such as tsunamis, earth quakes, landslides, bomb blasts and terrorist attacks, air plane crashes, train and road accidents, etc. where highly mutilated and dismembered dead bodies are recovered which is beyond recognition (16),(17). This process of identification of the disaster victims is known as Disaster Victim Identification (DVI). Teeth are the strongest part of the human body, which can withstand high explosion and are not damaged by such incidents (18),(19). Thus, teeth are likely to be recovered in mass fatality incidents where the other means of identification such as fingerprints and facial features are destroyed.

Adult human dentition comprises of incisors, canines, premolars and molars that vary in shape, size, and interspaces between the teeth, with varying occlusions, malocclusions tooth angulations and inclinations among different individuals. The way these teeth are arranged in different oral cavities is unique in every individual (20). At the same time, every tooth possesses a set of unique characteristics called 'tooth class characteristics' which form the basis of identification. The other features which help in identification are a dental pathology, restorations, dental anomalies, etc. (21). Besides, age, sex, race/ethnicity, occupation, and habits etc. can be determined from teeth (22).

Human permanent dentition can be used for age and sex determination of an individual which can be of immense value in the complex modern era and thus of much importance in forensic sciences.

### **1. Age determination**

Dental maturity plays an important role in the estimation of age in children and adolescents (23). The number and sequence of the teeth erupted can fairly determine the age of an individual. Radiographic methods can further elaborate about the various stages of mineralization (24), (25) and further help in a more accurate estimation of age. The teeth mineralization give a better estimate of

chronological age than the bone mineralization (26) mineralization stages in the teeth are less affected by variation in the nutritional and endocrine status of the individual. In this regard, the developmental stages of the teeth as given by Demirjian *et al.* (26) are much in use for estimation of chronological age throughout the world. For estimation of age in adults, Gustafson developed a method of age estimation from a single tooth way back in 1950 (27). The technique utilizes various stages of regressive changes in the teeth such as occlusal attrition, coronal secondary dentine formation, the loss of periodontal attachment, cementum apposition, amount of apical resorption and the transparency of the root (28) Johnson (29) made improvements in the technique described by Gustafson which is now mostly used by forensic scientists for estimation of age in adults. Kvaal *et al.* (30) developed another method of age estimation in adults by measuring the size of the pulp from periapical radiographs of the teeth dependent upon the sex of the individual.

### **2. Sex determination**

Although sex determination from teeth is not conclusive, in the absence of other evidence, teeth can give a clue regarding the sex of the individual. The results can be further correlated and substantiated with other facts and data available to the forensic scientist. Odontometrics, a technique to take measurements of the teeth has been used by the scientists for sex determination (31),(32).The sex determination using this technique is based on the sexual dimorphism of the size of the teeth. Mesiodistal and buccolingual tooth dimensions have been used for sex determination in the past (33),(34). These measurements are termed as linear measurements. However, diagonal measurements are helpful in measuring rotated, crowded and proximally restored teeth (35). Certain dental indices such as Incisor Index, Mandibular-Canine Index, Crown Index etc. have been derived from linear measurements of the teeth to show sexual dimorphism in the teeth (36),(37),(38). The mandibular canines are shown to exhibit greater sexual dimorphism than the maxillary canines. According to Joseph *et al.* (35), the overall accuracy rate of odontometric sex determination is ~72%. Besides, a non-metric feature on both upper and lower canines; 'canine distal accessory ridge' located on the lingual surface between the medial lingual ridge and distal marginal ridge has been found to show sexual dimorphism (39).This ridge is more pronounced and more frequency found in males than females. A more recent method of sex determination from teeth is the

presence of sex chromatin or Barr bodies in the pulp of the teeth (40),(41) according to the method devised by Barr & Bertram (42). The studies have also been carried out to extract DNA from the pulp tissue as well as dentine (43),(44) and its use for sex determination using Polymerase Chain Reaction (PCR). Enamel protein (45) due to its different patterns in males and females has also been used for sex determination using DNA techniques. Amelogenin or AMEL is a major protein found in the enamel of humans. Amelogenin has different patterns of the nucleotide sequence in the enamels of males and females. Amelogenin gene for the very first time was sequenced by Nakahori et al. (45),(46),(47). Two different AMEL genes, one located on chromosome X and one on the Y chromosome are found in males, however, females have two identical AMEL genes located on X chromosome (48). According to Michael and Brauner(49), the amelogenin test for determination of sex should be interpreted cautiously.

### Conclusion

Dental maturity, have an incredibly imperative position in the assessment of age in children and adolescents. The sex determination even though conclusive, the bite marks of teeth and palatal rugae are considered to be inimitable to an individual and their morphology remains invariable throughout life and is well recognized in forensic examinations and in the court of law. Apart from of advances in the primary detection techniques such as DNA profiling, fingerprints and facial re-enactment, the judgment of dental records play a momentous role in the identification of the deceased in mass fatality incidents such as air plane crashes, other major accidents, terrorists' attacks and natural disasters.

Nevertheless, in the determination of age and sex from teeth one should be careful about population specificity as different population groups demonstrate altering the degree of human variations in dental taints. Human permanent dentition can be used for age and sex determination of an individual which can be of enormous value in the complex modern era and eventually of much importance in forensic sciences and will continue to play its important role in legal medicine in the days to come.

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