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Encompassing the Domains of Forensic Odontology as a reliable Tool in determining Age - a Brief Review

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ABSTRACT
The analysis of age at the time of death is a cardinal step in the identification of human remains. If this age can be explicitly estimated, the range of potential individualities that must be compared to the remnants in order to make a definitive identification will be greatly reduced. The forensic anthropologist, pathologist, or odontologist can perform this using a variety of procedures. The measurement of the degree of dental development in relation to chronological age has led to some of the more accurate techniques for estimating children's ages. These techniques use radiographic analysis to determine the individual's estimated chronological age, which is then compared to tables or diagrams of examples of known ages. From the level of dental development to the time of death, this article tries to examine the various approaches to determine chronological age.
KEYWORDS: *Age Estimation, Teeth, Forensic Odontology, Classification, Human Dentition.*

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WHAT IS FORENSIC?

Personal identification of the victim has become a cardinal feature, not only in medical jurisprudence but also in criminal investigation, identification, and genetic research [1]. It serves as a crucial foundation for determining guilt or innocence in legal disputes, moral dilemmas, reports of declarations of death, and the investigation of criminal cases, mass casualty, or war victim cases [2].

The Latin term forensis, which means "around the forum," is where the word "forensic" originates. When someone was accused of a felony in ancient Rome, their case would be brought before the horde in the forum. Both the accused and the appellant would make speeches outlining their respective versions of events. The outcome of the lawsuit would be decided by whoever had the best argument and delivery. This genesis is where the terms "forensic" and "category of public presentation" were coined in the contemporary era [3]. Since the term "forensic" is effectively a synonym for "legal" or "related to court," it is acceptable to use "forensics" instead of "forensic science" in modern usage. The examination of a body—typically one that is dead—and the quiet methodical assemblage of the data it contains, as well as the development of logical inferences based on these observations, are central to forensic science, and they never fail to be fascinating and satisfying [4]. Vagueness and theory have no place in forensics, and the doctor who properly says he does not know, or feels inadequately qualified to give an opinion, acquires more respect than one who "ventures an opinion". Forensic odontology falls within the category of forensic science, which refers to fields of study that can be applied in a court setting and are recognized by the court and the larger scientific community to distinguish truth from fiction. The oral cavity is "where it all begins from".

WHAT IS FORENSIC ODONTOLOGY?

Dentistry is referred to as odontology, which is the study of teeth. So, in the interest of justice, forensic dentistry is described by the Federation Dentaire International (FDI) as "that discipline of dentistry that deals with the right handling and analysis of dental evidence, and with the thorough examination and presentation of dental findings" [5]. One of the most challenging and exciting subfields of forensic study is the use of dental evidence in the authentication of deceased individual by analysis of antemortem and postmortemdata [6]. It has made a name for itself as a significant and frequently crucial science in medico-legal cases, particularly when it comes to the identification of the deceased. Its knowledge is largely derived from clinical experience, fundamental research, and general advancements in dentistry[7]

Since the end of the 1939–1945 war, the spectrum of this forensic specialty has grown as a result of increased international traffic and an increase in aircraft accidents. Dr. Oscar Amoedo, known as the "Father of Forensic Odontology," is credited with establishing the field as a distinct specialization in 1898 when he helped to identify the victims of a fire catastrophe in Paris, France. This branch has become a well-established industry with widespread use. There has been so much interest in the use of dental evidence in forensic investigations recently that forensic odontology is even advised as the only method of identification to solve forensic crimes. [8]

HOW IS HUMAN DENTITION HELPFUL IN FORENSICS?

Due to its unique peculiarities, human dentition can reveal a lot about a person's identity. The least amount of biological turnover occurs in the hard tissues of the human body—the teeth. As a result, teeth will exhibit remarkable structural stability over the course of a person's life, barring disease. The teeth are also favorably situated in that they are among the hardest tissues in the body that cannot be destroyed, both during life and after death, frequently despite decomposition or emollition of the remains or even despite the effects of time [9].

ROLE OF FORENSIC ODONTOLOGIST

In various circumstances, such as during natural or major calamities caused by humans (aviation, earthquakes, tsunamis), criminal investigations, ethnic research, and the Identification of highly disfigured or decomposing bodies such as those of drowning victims, victims of fires, or those who have been in car accidents, a forensic odontologist assist the legal authorities by examining dental evidence. In these circumstances, a family member's identification of the body is neither legitimate nor desirable. Identifying remains that have been discovered in water or those who have been dead for a while creates uncomfortable challenges [6]. Additionally, in such circumstances, the substantial changes in soft tissue may make it hard to acquire fingerprints from the remains, even though the dentition may still be intact. When no other method can reliably identify someone, the dentition's longevity typically makes it possible. In addition to helping with human identification, forensic odontologists also examine and evaluate bite marks, orofacial injuries from trauma or assault, child abuse injuries, personal defense scenarios, age estimation of both living and deceased people, and civil cases involving allegations of malpractice and fraud [10], determining the ethnicity/population affinity, assisting in constructing a portrait of skeletal remains' lifestyle and diet at forensic and archaeological sites, determining the sex of the skeletonized remains and testifying as an expert witness in court [5]. The dentist can be quite important in this procedure owing to the field of forensic odontology.

A new era of genetic and serological analysis, which includes DNA-based forensic investigations in dentistry, has replaced the less sophisticated techniques of age estimation and bite mark analysis in forensic dentistry. Forensic science DNA analysis requires a sample or source from a person (alive or dead) or a crime/incident scene. Because some oral tissues are relatively resistant to environmental deterioration and destruction by thermal, electrical, and mechanical stress, the orofacial region is a good source of such material. Consequently, the significance of dental identity is growing over time [11].

A quick overview of age determination by teeth is provided in this article. An essential stage in the determination of human remnants is the assessment of age at death. The range of potential identities that can be matched to the remains in order to establish identification will be greatly reduced if this age can be determined with accuracy. The forensic dentist, anthropologist, or pathologist can accomplish this using a variety of techniques. In young folks, a comparison of the degree of dental growth compared to chronological age has served as the foundation for some of the most accurate methods of age assessment. These techniques use radiographic analysis to determine the individual's estimated chronological age, which is then compared to tables or diagrams of examples of known ages. From the level of dental development to the time of death, this article tries to examine the various approaches to determine chronological age.

WHAT IS FORENSIC AGE ESTIMATION?

In everyday forensic practice, identifying the living and the dead is of the utmost priority [12]. Along with sex, height, and ethnicity, age is one of the key tenets to defining identity [13]. Age assessment, a branch of the forensic sciences, is a crucial component of the identification process, especially when the deceased's evidence is not easily accessible [14]. The ability to identify oneself is based on having one's age verified, which is a fundamental human right. One's birthdates is the pinnacle of their identity in the culture we live in [15]. In the majority of nations, age is taken into account when determining eligibility for social assistance, employment, adoption, political asylum, and marriage [12]. It also contributes to catastrophic justice-related incidents, allowing for the proper handling of offenders in accordance with

their age and the protection of both the offender and others around them through knowledge of the appropriate age range [15]. Therefore, the scientific method of estimating a person's chronological age by evaluating skeletal and dental growth and maturation has been termed forensic age assessment. In other words, it propels the human life cycle from conception to death.

NECESSITY OF AGE ESTIMATION

Researchers have used a variety of techniques to investigate how humans age. These include anthropological, developmental, histological, and biochemical approaches. Anthropologists examine the fusion of the skull's cranial sutures, the growth of the long bones, the characteristics of the pelvic girdle, and, in collaboration with forensic dentists, the characteristics of the teeth. When developing a profile for an unknown individual, whether they are alive or dead, these methods can be helpful. An initial step in focusing the search for potentially matching information obtained from local, regional, and national missing person registries is the assessment of age at death. When the victims' ages vary and other means of identifying them are lacking, age estimation may also be helpful in occurrences involving a small number of fatalities and in clustered victim cases. Furthermore, age estimation is frequently employed in many nations to help immigration officials or other law enforcement officials determine if refugees or illegal immigrants have achieved the legal age that distinguishes a juvenile from an adult. This might be crucial in situations where unaccompanied minor protection is at stake.

HOW CAN HUMAN DENTITION HELP IN DENTAL AGE ESTIMATION?

According to developmental characteristics like mineralization, gingival emergence, quantification of cementum layers, or decreasing pulpal space, degenerative changes like dental attrition, erosion, resorption of periodontal recession, fluorescence intensity and density of dentin, racemization of aspartic acid, or dentin sclerosis, among others, can be used to estimate dental age [12]. Additionally, it involves tracking biochemical and trace element alterations in tooth tissues. Each of these techniques has advantages and disadvantages in terms of accuracy and usability. Others call for laboratory testing or tooth removal, while some can be carried out by clinical examination, the study of dental or other radiographs, or both. The regulations set forth by each jurisdiction and the odontologist's competence and knowledge will aid in determining the best procedures in each situation.

METHODS OF DENTAL AGE ESTIMATION

1. <u>FACTORS USED FOR AGE ESTIMATION USING DENTITION [16]</u>

a) Earliest detectable trace of mineralization
b) Rate of enamel and neonatal line formation
c) The appearance of tooth germs
d) Eruption of teeth
e) Degree of completion of the unerupted tooth
f) Degree of completion of roots of erupted teeth
g) Degree of resorption of deciduous teeth
h) Attrition of the crown
i) Formation of physiologic secondary dentin and formation of cementum
j) Transparency of root dentin
k) Gingival recession
l) Root surface resorption
m) Tooth discoloration and staining
n) Alterations in the chemical composition of the teeth

2. <u>ACCORDING TO THE TECHNIQUE OF INVESTIGATIONS [FIGURE 1]</u>

2.1. CLINICAL OR VISUAL METHOD:

It is based on the order in which teeth emerge as well as functional changes such as wear and tear, attrition, tooth color, stains, periodontal health, etc. As a result, examining a person's dentition while taking into account these changes might provide important details about their development and age. Considerations for estimating age include the following:

a) The presence of teeth can be used to infer age: According to the eruption of the second molar, the maxillary and mandibular dental arches can visually estimate a person's age up to 12 to 13 years old. One of the visual methods for determining an age that is not thought to be very trustworthy is tooth eruption because it is a continuous process that includes dormant periods in a child's life when no teeth

erupt. Numerous regional and systemic factors, including genetic, functional, environmental, sexual, dietary, and metabolic factors, have little impact on it as well.

b) Depending on whether or not there are mamelons: Melons are the noticeable enamel extensions that can be seen on the incisal edge of permanent incisor teeth. Melons' presence or absence aids in determining if a tooth is primary or permanent. [17].

c) Depending on the shade of the tooth color: A key morphological factor that can significantly affect calculating dental age is tooth colour.The investigation carried out by Vivek et al. compared the enamel's hue to the shade guide.They identified a connection between chronological age and enamel colour Aging caused the enamel's color to change from reddish to greyish, and no difference between genders was seen [17].

d) Depending on tooth attrition and wear: Tooth attrition is frequently utilized to determinethe age of an individual because it is a straightforward and practical procedure. Naturally, tooth wear gets worse as you get older. Two different types of criteria can be used to assess tooth wear: the horizontal factor, which measures the extent of tooth wear, and the vertical factor, which measures the degree of dentin exposure. To get a more precise estimate of age, both elements should be taken into account.

RADIOGRAPHIC METHOD:

Age estimation greatly benefits from radiographic evaluation of the teeth. As it assists in determining age over a lengthy period of time, this method is the most used. It is a straightforward, non-intrusive, and repeatable technique. This non-destructive technique gained popularity due to its applicability to both living and dead people, as well as in archaeological studies and in some legal settings that forbid the collection of tissue from human remains because it uses dental radiographs, obviating the need to extract or section the teeth. The age of a person can be estimated using radiological imaging archives [18, 19].

The radiographs utilized for estimating age are [17]:

a) IOPA [Intra Oral Peri Apical Radiograph]
b) Lateral Oblique radiograph
c) Cephalometric radiograph
d) Orthopantogram
e) Cone Beam Computed Tomography [CBCT]
f) Other advanced imaging techniques

When determining age from radiographs, the following criteria are taken into consideration [18]:

a) Prenatal jawbones
b) Appearance of tooth germs
c) Earliest detectable trace of calcification
d) Degree of crown completion and its eruption into the oral cavity
e) Degree of root completion of erupted or unerupted teeth
f) Measurement of open apices in teeth
g) Third molar development and topography
h) Development of resorption of deciduous teeth
i) Volume of the pulp chamber and root canals/formation of physiological secondary dentine
j) Tooth-to-pulp ratio

HISTOLOGICAL METHOD:

Histological methods necessitate the preparation of the tissues for in-depth microscopic investigation because the pictures of dentin and enamel are not radiopaque enough to be seen on radiographs during the prenatal stage up to 6 months. A more accurate assessment of the dentition development stage may result from this. As a result, mineralization can be determined using histological techniques before it is visible on radiographs. This method is more suited for alterations caused by post-morbidity and post-mortem procedures. It is important for determining the age of early dental development [17].

MORPHOLOGICAL METHOD:

Developmental stages cannot be used to estimate age after dental maturation is complete. The indicators that dental structures alter life are employed instead. For the age assessment of adults, morphological approaches are based on the measurement of ex-vivo teeth. The extracted tooth samples can be examined under a microscope or with the naked eye, with or without sectioning. These techniques might not be regarded as acceptable on ethical, religious, cultural, or scientific grounds though.

BIOCHEMICAL METHOD:

At various ages, ions are continuously deposited in order to build teeth. Radiological methods cannot provide a reliable estimate of dental age since the dentin and enamel are radiolucent during the prenatal

period, up to 6 months.After the growth period has passed for adults, estimating age using radiological means is no longer appropriate. As a result, both physical and chemical approaches can be used to estimate age from variations in ion levels. Carbon 14 dating and aspartic acid racemization are two of the procedures used. These methods demand specific tools and knowledge, are intrusive, and are costly. Additionally, it is unacceptable for those who are still alive [17].

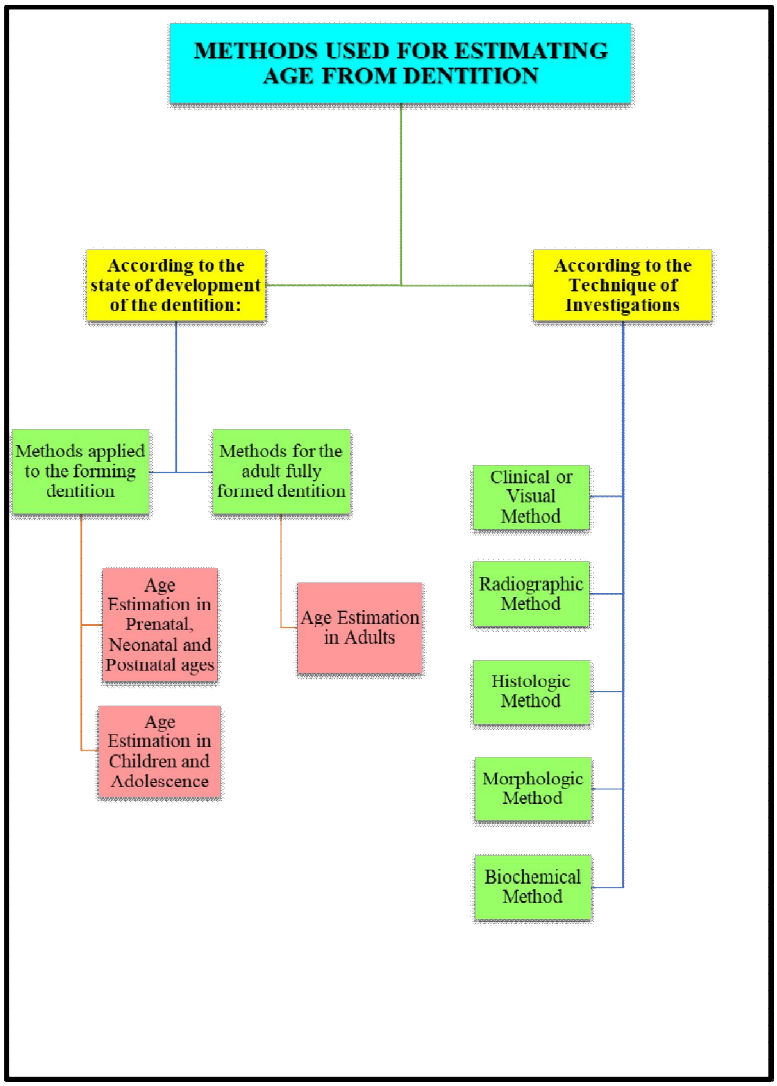

FIGURE 1: Methods used for estimating age from dentition

CONCLUSIONS

Age is one of the variables that can be used to establish identity, along with sex, height, and ethnicity, in normal forensic practice. It is crucial to personally identify both the living and the deceased. Teeth analysis has been shown to be a trustworthy method for estimating a person's chronological age when their birth date is unknown.

LIST OF ABBREVIATIONS:

FDI: Federation Dentaire Internationale
DNA: Deoxyribonucleic Acid
IOPA: Intra Oral Peri-Apical Radiograph
CBCT: Cone Beam Computed Tomography

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