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The Wisdom of the Wisdom Tooth – A Narrative Review on the Importance of Third Molar in Forensic Odontology

[1]Dr. Jyotirmoy Roy, Final Year PGT, Department of Oral and Maxillofacial Pathology, Guru Nanak Institute of Dental Sciences and Research 157/F, Nilgunj Road, Panihati, Kolkata-700114

[2]Prof. Dr. Sk. Abdul Mahmud, MDS, Professor, Department of Oral and Maxillofacial Pathology, Guru Nanak Institute of Dental Sciences and Research 157/F, Nilgunj Road, Panihati, Kolkata-700114

[3]Dr. Sudeshna Bagchi, MDS, Reader, Department of Oral and Maxillofacial Pathology, Guru Nanak Institute of Dental Sciences and Research 157/F, Nilgunj Road, Panihati, Kolkata-700114

[4]Prof. Dr. Mousumi Pal, HOD, Department of Oral and Maxillofacial Pathology, Guru Nanak Institute of Dental Sciences and Research 157/F, Nilgunj Road, Panihati, Kolkata-700114

Corresponding Author: Dr. Jyotirmoy Roy, Final Year PGT, Department of Oral and Maxillofacial Pathology, Guru Nanak Institute of Dental Sciences and Research 157/F, Nilgunj Road, Panihati, Kolkata-700114

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Abstract

The third molar, or wisdom tooth, plays a pivotal role in forensic odontology due to its unique developmental timeline and morphological variability. Erupting later than all other teeth, typically between the ages of 17 and 25 years, the third molar serves as a crucial indicator for age estimation in adolescents and young adults. This becomes particularly important in legal scenarios where chronological age is disputed or undocumented. Forensic age estimation methods, such as Demirjian's and Coronal Pulp Cavity Index techniques, utilize third molar development stages for assessing dental maturity, aiding in civil, criminal, and immigration- related investigations. Beyond age estimation, third molars also contribute to personal identification in cases involving unidentified remains, mass disasters, or advanced decomposition, where other identifiers may be compromised. Their resistance to environmental factors like heat and trauma enhances their reliability in postmortem examinations. The presence, absence, or morphological traits of third molars can also support population-specific data, ancestry estimation, and familial identification. This article reviews the forensic significance of third molars, highlights the advantages and limitations of current methodologies, and underscores the importance of establishing standardized,

region-specific dental databases to improve accuracy in forensic casework. Thus, third molars are invaluable tools in the broader framework of forensic identification and age assessment.

Keywords: Third molar, Forensic Odontology, Age Estimation, Dental Anthropology, Stature Estimation.

Introduction

Forensic odontology, also known as forensic dentistry, is a specialized branch of forensic science that applies dental knowledge to legal investigations[1]. It plays a crucial role in identifying human remains, especially when the body is decomposed, burned, or otherwise unrecognizable. Teeth are among the most durable parts of the human body, often surviving conditions that destroy other tissues, making them invaluable in forensic identification[1]. By analyzing dental records, bite marks, and oral structures, forensic odontologists can establish the identity of individuals, estimate age, and sometimes determine the cause of death or trauma [2]. In addition to human identification, forensic odontology is also instrumental in criminal investigations involving bite mark analysis, such as in cases of assault or abuse. Odontologists may also be called to testify in court as expert witnesses, providing scientific evidence that can support or challenge testimonies [3]. Their work requires a deep understanding of dental anatomy, pathology, and radiographic interpretation, combined with meticulous attention to detail and adherence to legal protocols. Overall, forensic odontology serves as a bridge between dentistry and the justice system, contributing significantly to the resolution of both criminal and civil cases [3]. Its precision and reliability make it a vital tool in modern forensic science. Dental anthropology is a subfield of physical anthropology that focuses on the study of human teeth to understand biological and cultural aspects of past and present populations [4]. By examining dental morphology, wear patterns, and developmental traits, dental anthropologists can gain insights into ancestry, age, diet, health, and evolutionary relationships among human populations [4]. This discipline explores variations in tooth size, shape, and structure across different ethnic groups and time periods. Modern techniques such as digital imaging, isotopic analysis, and 3D morphometrics have enhanced the precision of dental anthropological studies [5]. Dental anthropology not only enriches our understanding of human biological diversity but also supports broader inquiries in archaeology, forensic science, and evolutionary biology. It remains a critical tool for unraveling the complex history of humankind.

The third molar, commonly known as the wisdom tooth, is the last tooth to erupt in the human dentition. Typically emerging between the ages of 17 and 25, third molars are located at the very back of the mouth, one in each quadrant of the jaw [6]. Most adults have four third molars, although some individuals may have fewer or none at all due to genetic variation. With changes in diet and jaw size, over time many modern humans no longer have enough space to accommodate these teeth, leading to impaction [6]. An impacted third molar fails to fully erupt and can become trapped in the jawbone or gums, often causing pain, infection, or damage to adjacent teeth. Dentists often recommend the removal of impacted or problematic wisdom teeth to prevent complications. Despite being considered vestigial in many cases, third molars are still important in forensic science and anthropology. Their development and eruption patterns can aid in age estimation and provide clues about evolutionary trends and population differences. Thus, third molars hold both clinical and scientific significance [7].

In forensic odontology, the assessment of dental development is a key method for estimating age, particularly in individuals between adolescence and early adulthood. Among the various dental markers, the third molar plays a vital role due to its unique developmental timeline. Its late mineralization and eruption make it one of the few reliable indicators for age estimation during the late teenage years and early twenties—an age range where most other teeth have already completed their development [6]. This makes third molar evaluation especially important in forensic cases involving age disputes, undocumented individuals, or juvenile justice proceedings. The developmental patterns, when analyzed radiographically using standardized methods such as Demirjian's, Willems', or Cameriere's techniques, offer reproducible and population-specific age assessments [8]. These evaluations are essential in legal contexts where determining whether an individual is a minor or adult which can influence judicial decisions. Additionally, third molars may contribute to human identification efforts, especially when matched with dental records in cases of missing persons, mass disasters, or unidentified remains [9]. Overall, third molars are a crucial element in forensic odontology offering both practical and scientific value in age estimation and personal identification where other means may be unavailable or unreliable [9].

Third Molars in Forensic Odontology

Radiographic dental age estimation

In humans, age determination is done for various reasons. Age determination of cadavers is carried out for reasons such as criminal cases and very mutilated victims of mass disasters, such as fires, crashes, accidents, homicides, feticides and infanticides, etc. In living persons, the age estimation is done to assess whether a person has attained the age of criminal responsibility or not in cases such as rape, kidnapping, employment, marriage, premature births, abortion, illegal immigration, and when the birth certificate is not available and records are missing or incorrect [10].

Radiographic method of dental age estimation through the eruption of permanent dentition and development of teeth including third molar is reliable in adolescent and late adolescent age but once third molar has erupted, age estimation using the tooth development reference charts becomes extremely difficult and may produce ambiguous result.

Two methods commonly followed for age estimation through radiographic means after dental maturity are the assessment of volume of teeth and the development of the third molar.

1. Volume assessment of teeth

The age estimation in adults can be achieved by radiological determination of the reduction in size of the pulp cavity resulting from a secondary dentine deposition, which is proportional to the age of the individual

A. Pulp-to-tooth ratio method by Kvaal [11]

Using intraoral periapical radiographs, pulp-root length (R), pulp-tooth length (P), tooth-root length (T), pulp-root width at cemento-enamel junction (A), pulp-root width at mid-root level (C) and pulp-root width at midpoint between levels C and A (B) forthird molar is measured. Finally, mean value of all the dimensions excluding T (M), mean value of width ratio B and C (W) and mean value of length ratio P and R (L) are recorded and a regression analysis formula is used to determine the age (Figure 1). The formulae is as follows-Age = 129.8 – (316.4 X M) X ((6.8 X (W – L))

B. Coronal pulp cavity index [12]

The correlation between the reduction of the coronal pulp cavity and the chronological age is examined in a sample, the side where the pulp chamber is more visible is chosen. Panoramic radiography is used to measure the length (mm) of the tooth crown (CL, coronal length) and the length (mm) of the coronal pulp cavity (CPCH, coronal pulp cavity height or length). The tooth coronal index (TCI) is computed for the third molar and a regression analysis formula is used for dental age estimation (Figure - 2). The formulae I s as follows-TCI = (CPCH X 100) / CL.

2. Development of third molar [13]

The radiographic age estimation becomes problematic after 17 years of age as eruption of permanent dentition is completed that age with the eruption of the third molar. Later, the development of the third molar may be taken as a guide to determine the age of an individual. Third molar development by Harris and Nortje method can be used to assess the development of third molar and subsequently age estimation can be performed. The method describes five stages of third molar root development with corresponding mean ages and mean length and is discussed in Table – 1.

Blood grouping through dental pulp

Pulpal tissue is one of the most protected oral tissue being surrounded from all sides by the dental hard tissues, so the dental pulp is used for detection of ABO blood grouping and Rhesus factor. Since tooth pulp contains lot of blood vessels, blood group antigens are most certainly bound to be present in tooth pulp [14]. The absorption elusion method is used for blood grouping from dried pulp sample. In this method, dried pulpal content is scooped using spoon excavator and placed into three test tubes. To each of these test tubes three drops of antiserum A, B, and D, are added and allowed to be soaked sufficiently with antiserum for 2½ h at room temperature for the antibodies to combine with their specific antigens. After removing antiserum, each sample is washed three times with cold saline solution (it is then centrifuged and the supernatant is sucked with pipette) to remove the non-reacted serum. Then two drops fresh saline is added to the sample and the test tubes are heated in a water bath at 56°C for 10 min to elute the antibodies. A drop of 0.5% A or B group red cell suspension is immediately placed into each respective test tube to combine the eluted antibodies with known red blood cells [15]. This results in agglutination of respective antibodies to the group antigen present in the cell surface of red cells. Then incubated at 37°C for 30 min to enhance agglutination, and after this procedure, it is centrifuged at 1500-2000 rpm for 1 min for flocculation formation. By gentle shaking of the test tube the presence or absence of red cell agglutination is ascertained with microscope at magnification of × 100 [15].

DNA analysis from dental pulp

DNA analysis from teeth is a vital tool in forensic identification, especially when soft tissues are degraded. The hard enamel and dentin protect genetic material from environmental damage. Teeth can yield nuclear or mitochondrial DNA, enabling identification of individuals in mass disasters, criminal cases, or historical investigations with high reliability. The DNA analysis has multiple steps such as-

1. Decontamination

An important consideration when working with human DNA from dental remains is the potential for contamination. Although teeth are not immune to contamination their lower porosity makes them more resistant. Numerous methods for decontamination of teeth has been reported including, physical removal of the outer tooth surface, exposure to UV light and immersion in sodium hypochlorite. These methods assume that contamination is limited to the external surfaces. The most frequently reported decontamination method for teeth is the use of bleach. It is generally considered that bleach destroys exogenous DNA whilst leaving endogenous DNA unaffected [16].

2. Sampling strategy

Numerous techniques for sampling teeth are described in the literature. Some aim at sourcing pulp and/or dentine and include horizontal or vertical sectioning tooth whereas others prefer regular or apical endodontic access with subsequent scraping or drilling of the interior of the tooth. Other methods simply grind up all or part of the tooth by; crushing between two steel plates, or by grinding with a mortar and pestle, bone mill, blender, tissue grinder or cryogenic grinder. Cutting or powdering of the tissues increases the risks of contamination and generates heat. Heat can further degrade the endogenous DNA reducing the amount and quality of material available. A non-destructive extraction method involving incubation of intact teeth in EDTA and proteinase K has been suggested on ancient teeth and has reported good results [16].

3. DNA extraction

For forensic purposes, an ideal DNA extraction method should maximize DNA yield, be economical and time efficient, have as few steps as possible and be suitable for automation. Fewer handling steps in the extraction process saves time and materials and also decreases the likelihood of contamination. When working with degraded skeletal remains trace amounts of DNA need to be recovered whilst removing potential inhibitors and minimizing the potential for exogenous DNA contamination. Teeth exposed to the environment are likely contaminated with bacteria, fungi and environmental contaminants such as humic acid, fulvic acid and metals. If these environmental contaminants are co-extracted with the endogenous DNA, they can potentially inhibit subsequent PCR amplifications. Numerous DNA extraction techniques with variable protocols have been described for use on tooth, including phenol chloroform, chelex, silica and magnetic bead systems. Prior to extraction, decalcification of the tooth by soaking in EDTA for several days is suggested as the DNA is tightly bound in dense crystalline aggregates and without demineralization it will not be released into solution.

After successful extraction of DNA quantitative PCR can be performed for the subsequent analysis. Third molar is considered one of the best tooth for DNA analysis due to its location in the oral cavity and because in most modern human it remains impacted in the jaw bone hence protecting it from the external malicious stimuli.

Stature Estimation from Human Third Molar

Stature estimation plays a vital role in forensic anthropology, particularly in the identification of unknown human remains. While long bones such as the femur and tibia are commonly used due to their strong correlation with height, alternative methods are needed when these bones are missing or damaged. One such alternative is the human third molar, or wisdom tooth. The third molar is often preserved in skeletal remains and can offer clues about an individual's stature. Measurements such as the mesiodistal and buccolingual diameters, as well as crown height, are recorded and analyzed statistically [17]. Though the correlation between third molar size and stature is generally weaker than with long bones, studies have shown that there is a measurable relationship, particularly when population-specific regression formulas are used. However, several limitations exist. The third molar is highly variable in size and often impacted or congenitally absent.

Additionally, sexual dimorphism and genetic diversity affect the accuracy of stature estimates [17].

Conclusion

The third molar holds considerable importance in forensic odontology due to its unique developmental timeline, structural resilience, and diagnostic potential. As one of the last teeth to develop and erupt—typically between the ages of 17 and 25—it serves as a crucial marker for age estimation in late adolescence and early adulthood, a period often difficult to assess using other dental or skeletal indicators. Radiographic assessment of third molar development stages provides a relatively accurate and non-invasive method for estimating chronological age, which is particularly valuable in forensic cases involving unidentified remains or age disputes. Furthermore, the third molar is one of the most resilient structures in the human body, often surviving environmental degradation, trauma, and postmortem changes. Its preservation in otherwise compromised remains makes it an essential element for forensic identification. The tooth’s morphology and dimensions can offer supporting evidence in sex and stature estimation, and its presence or absence can contribute to understanding of population-specific dental patterns or anomalies. Although third molars exhibit considerable variation and are sometimes absent, their forensic value remains significant. When used in conjunction with other odontological and anthropological methods, third molars enhance the accuracy and completeness of biological profiles, ultimately supporting the identification process in forensic investigations.

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Legend Table and Figures

Table 1: Stages of Third Molar Root Development by Harris and Nortje method

Stage	Radiographic Findings	Mean Age	Mean Root Length
Stage 1	Cleft rapidly enlarging, one-third root formed	15.8±1.4 years	5.3±2.1 mm
Stage 2	Half root formed	17.2±1.2 years	12.9±1.2 mm
Stage 3	Two-third root formed	17.8±1.2 years	8.6±1.5 mm
Stage 4	Diverging root canal walls	18.5±1.1 years	15.4±1.9 mm
Stage 5	Converging root canal walls	19.2±1.2 years	16.1±2.1 mm

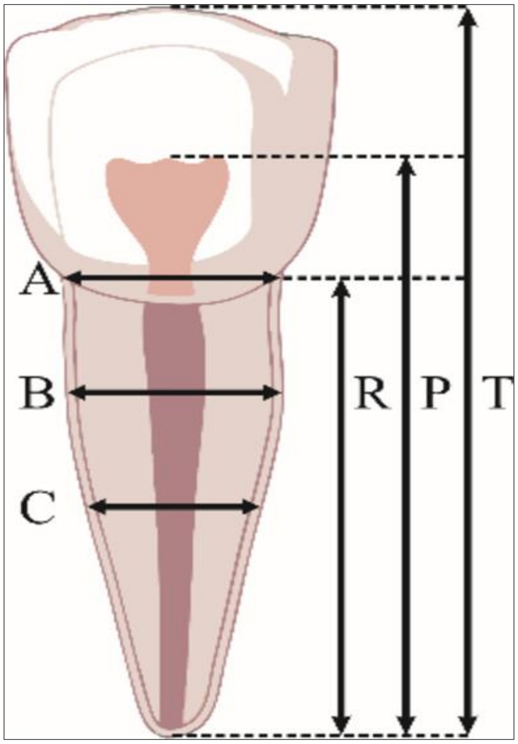

Figure 1: Pictorial representation of pulp-root length (R), pulp-tooth length (P), tooth-root length (T), pulp-root width at cemento-enamel junction (A), pulp-root width at mid-root level (C) and pulp-root width at midpoint between levels C and A (B)

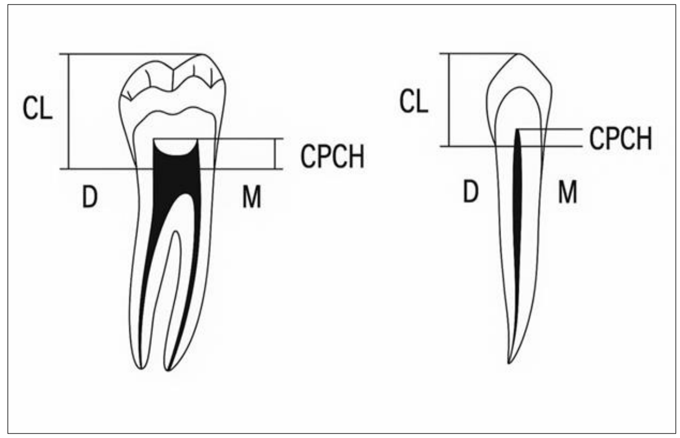

Figure 2: Pictorial representation of tooth crown (CL, coronal length) and the length (mm) of the coronal pulp cavity (CPCH, coronal pulp cavity height or length.)