Literature Review

Dentist's Role and Responsible in Identification and Investigation

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ABSTRACT

Background: A dentist is responsible for promoting oral health and disease prevention to make the world a better place in terms of oral health. Besides, the dentist also plays an important role in the forensic field and law enforcement. Forensic odontology is an area of dentistry that deals with the proper management and investigation of dental evidence, which aids in identifying people and the presentation of dental evidence in the interest of justice. **Purpose:** This article discussed the role and responsibilities of dentists in human identification. **Review:** The world continues to deteriorate as time passes with much criminality and disasters that cannot be prevented. In many cases, the identification process can be done through the unique characteristics of dentition. Various information such as age, sex, and ethnicity are recorded in the tooth. Forensic dentists are responsible to manage and evaluate tooth evidence. **Conclusion:** Forensic odontology plays an essential role in determining individual identity. The unique features of dentition provide accurate results in identification if all procedures are correctly employed. With the advancement of science and technology, dentistry may now assist in the identification and investigation of forensic cases.

Keywords: dentists; forensic odontology; justice; oral health; responsibilities

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INTRODUCTION

As we noticed, there are natural disaster happen interchangeably daily in various part of the world, and there is also mass accident such as terrorism and airplane accident. Indonesia is located in the *Ring of Fire area*, also referred to as the Circum-Pacific Belt. Based on National Geographic, it can be described as a path along the Pacific Ocean characterized by active volcanoes and frequent earthquakes. Other countries include Chile, Mexico, the United States, Antarctica, Russia, Japan, the Philippines, Papua New Guinea, Canada, Peru, Taiwan, and Guatemala.[1] Although the government has already made much prevention, still, some unpredictable natural disasters or accidents occur. Moreover, many criminal cases and rapes are increasing, and most crimes are closed due to a lack of evidence.

According to Keiser Neilson, 1980, forensic odontology is an area of dentistry that deals with the proper management and investigation of dental evidence, which aids in identifying people and the presentation of dental evidence in the interest of justice.

In many criminal cases and large disasters, this area of dentistry provides critical dental evidence to identify victims and culprits. It aids in the detection of both artificial and natural calamities. Many cases that are not identifiable by visual recognition or even fingerprints can be recognized using forensic odontology procedures. It is primarily concerned with identifying a person based on the characteristics of their dentition.[2]

In this review, we will discuss how vital is dentist's role in forensic is and what the dentist's responsibility is daily in their practices to be helpful in the future for the patient or even the forensic department and law department.

Dentist's Role and Responsibility in Forensic

The dentist's role on forensic is already taken part from the earliest 66 A.D when there is a case where a female associated with Emperor Nero, that is identified her death through her unique arrangement of teeth. The first dental identification accepted by law was in the United States, Boston, in 1849; the victim's dentist played a significant role in identifying the diseased because it was mutilated and can not be identified. The first identification in the mass disaster was in Paris in 1987, where a fire in a charity bazaar and

resulted in 126 deaths, and they used the antemortem dental record to be compared with post-mortem dental record. There was also a case in 1835, where there was a burnt and the victim recognized by her gold teeth.[3]

Indonesia has experienced several significant disasters which cause mass fatalities. The Bali bombing in 2002 and 2005, the JW Marriott Bomb Blast in 2003, the Australian Embassy Bomb Blast, the Asian Tsunami Disaster in 2005, and several transportation accidents. Personal identification by using dental characteristics played essential roles in many accidents.[4] The latest transport accident in Indonesia was a Sriwijaya Air Plane that crashed last January.

Why did forensic dentistry help in determining most of the victims in the cases above? It is because teeth provide results up to an individual level or only help estimate the victim's age; this depends on the antemortem data of the victims. Teeth are the most challenging part of the body, and it has a unique signature. Teeth are also resistant to temperature, chemical material, and trauma because it is protected by soft tissue surrounding them. Teeth have the same utility as a fingerprint to identify a person.[5]

Dental Record

A medical record is a document that a doctor is required to maintain. The medical record explains the patient's history, clinical findings, diagnostic test results, pre and postoperative care, patient progress, and medications in considerable detail. Notes, if written appropriately, will assist the doctor in determining whether or not the treatment is correct. Even though computers are now widely used for electronic patient records, but still hard copies are required for several documents, included police cases, road traffic accidents, medical negligence, insurance claim, and others. The police cannot easily access the medical record, and if there is no valid court warrant, doctors are not obligated to surrender their medical records. If a court has issued an official order requiring the production of a medical record in response to a subpoena, the medical record should be given to the court, not the attorney who issued the subpoena. Failure to comply is in contempt of court, and the doctors may be punished. The problem of record management is various types of damage may be found in paper documentation like-aged paper may become weak, color alteration from white to yellow, dirt and dust may be present on the paper, insect and fungus is a significant threat for the records, unexpected water leakage in the storage room also might be a concern to destroy the document. Therefore, proper preservation of the medical record is a must by an institution, hospital, or clinic.[6]

It also applied for the dental record. A dental record was used in a court of law to establish the diagnostic information obtained, and the treatment was rendered to the patient. Another way the dental record may be used is to help provide information to appropriate legal authorities that will aid the identification of a dead or missing person. The most common element of forensic dentistry that a general practitioner is likely to encounter is to supply antemortem records to a forensic odontologist. The dental record should be kept for two years. After finishing any course of treatment and care under continuing care or capitation arrangement, treatment records, radiographs, pictures, and study models should be kept for this period. Children's records must be preserved until the patient reaches the age of 25.[7]

In forensic dentistry, the availability of contemporaneous and clear notes is essential in forensic dental identification; if notes are incorrect, it can complicate and even negate an identification. Many documented cases have used the unique pattern of palatal rugae recorded on an orthodontic study model to identify the young individual with no dental restoration.[8,9]

After several mass fatalities in Indonesia, such as the Bali Bombing, several airline crashes, bus accidents, and natural disasters, the Indonesian public is aware of the importance of having a complete dental status recorded in their dentist's dental record or even keeping a panoramic radiographic for each person. They understand well that the investigator on the scene will need that information.[4]

Age Determination

The development and eruption of teeth help assess age. Each tooth passes through morphological stages such as initiation, bud caps and bell stages, and the eruption process and is well described in histological studies. The eruption time coordinates with the osseous maturity in humans, and this correlation is essential to consider; this can also be correlated with physiological age.[10]

There are four different categories for dental age estimation; (1) Clinical or visual methods, (2) Radiographic methods, (3) Histological methods, and (4) Physical and chemical methods.[10]

There are numerous methods for determining a child's or adolescent's dental age. The first is whether or not mamelons are present. The incisal edge of permanent incisor teeth frequently has mamelons. So, the presence of mamelon can help differentiate primary or permanent dentition; mamelon also more persist in females than males.[10]

The second method is to see the presence of the teeth as we know that primary teeth include 10 in maxillary and ten teeth in mandibular. Furthermore, permanent teeth include 16 teeth for maxillary and 16 for mandibular teeth. However, of course, sometimes some teeth may not be erupted yet, so several methods also included checking the age estimation such as; (1) *Schour and Messier method*, this method describing 21 chronological steps from 4 months to 21 years of age and published the numerical development chart for them. However, the chart does not separate surveys for males and females. (2) *Nolla's Method*, the staging is done on the evaluation of calcification of permanent teeth, and each tooth is assigned reading, and the total sum of the staging of maxillary and mandibular teeth are done which it compares with the predetermined values in the table to determine the age. This method's advantages can be applied

individually with or without a third molar; males and females are dealt with separately. (3) *Moorrees, Fanning, and Hunt Method*; it consists of two separate development schemes, one for single-rooted teeth illustrating 13 stages and the other for mandibular molars having 14 stages of development. This technique requires the odontologist to correctly identify the tooth, assess its proper stage of morphological development, and then read the associated mean age and standard deviation from the gender-specific graph. (4) *Demirjian's method*. It was proposed in 1973 and is one of the widely accepted methods of dental age estimation. It consists of ten developmental stagings from 0 to 9, and each stage has its maturity score for males and females separately. The final score or average sum should be 100 for all the teeth. The standard error rate in the Indian population of the Demirjian method is 1.17 for males and 1.6 for females. The mandibular arch was selected due to the better quality of the image as it is not superimposed by dental and cranial anatomy. (4) *Open apex method*, the dental age is calculated based on the relationship between the age and measurement of open apices in teeth. The seven left permanent mandibular teeth, excluding third molars, are used to calculate the dental age. The height of the calcifying teeth and the width of the open apex measure and their ratio are calculated. The number of teeth with complete root development and closed apical is noted as NO. In the teeth with incomplete root development, the distance between the inner sides of the open apex is measured. For the teeth with two roots, the sum of the distances between the inner side of two open apices and the number of teeth with root development is complete. (5) *Mincer's method* studied the third molar development radiographically to estimate age in children and adolescents. It used Demirjian's eight grade classification. Development of maxillary third molar was found to be more foremost than mandibular third molars, and also root formation was earlier than females. (6) *Kohler's method*, based on the evaluation of the development and maturation of all permanent third molars. It consists of ten stages in grading, three-stage for the crown formation, and seven stages for root formation. Kohler's method, which uses logistic regression algorithms to predict whether someone is a juvenile or an adult, has a high level of accuracy. (7) *Anderson's method*, which uses the Moorress staging system but labels stage 1 as the earliest stage of tooth development, evaluated the mineralization of each tooth in the maxilla and mandible, including all third molars. (8) *AlQahtani's method*, the most recent and widely used method, evaluated the mineralization of each tooth in the maxilla and mandible, including all third molars. The chart consists of 31 diagrams depicting the median dental development observed, starting at 30 weeks in utero and ending at 23.5 years. This method concluded that tooth formation is the least variable in childhood and most variable after 16 years to develop the third molar. This technique is also available online, and in many languages (9) *Balaraj's* method used the radiological study of the closure of the apical foramen of both permanent mandibular second molars to determine adolescents aged 14-16 years.[11,12]

Sex Determination

Either morphological analysis or molecular analysis can do sex determination in forensic odontology. Morphological analysis can be determined by hard and soft tissue. Hard tissue here can be differentiated by the; (1) *Tooth size between female and male*, where to be found that males have more prominent teeth than females (2) *Canine dimorphism* also can be used by looking at the distance between canine tips, a study showed that males have greater distance in inter canine (3) *Mandibular inter-canine arch width* also used, the standards are 0.274 if the measurement is less than standard, the individual is categorized as females (4) *Dental Index*, Aitchison presented the "incisor index (Ii)," which calculated by the formula $Ii=[MDI2/MDI1] \times 100$, MDI2 is the maximum mesiodistal diameter of the maxillary lateral incisor and MDI1 is the maximum mesiodistal diameter of the central incisor. Males have a higher index than females (5) *Root Length and crown diameter*, sex determination can be done with this method with 80% accuracy (6) *Tooth morphology and sexing*, Canine is the most sexually dimorphic teeth in terms of size. Recording to Rao *et al*., canine Distal Accessory Ridge in males shows significantly higher and more pronounced expression than females. Rao *et al*. also reported a greater incidence of four cups on the mandibular first molar in females than males.[13,14] (7) *Frontal sinus dimension*, Uthman *et al*. studied the evolution of frontal sinuses and frontal measurements using spiral computed tomography scanning of ninety patients concluded that frontal sinus measurements are a valuable aid in differentiating sex and states, including skull measurement along with frontal sinus measurements improved the accuracy.

The soft tissue analysis includes the study of; (1) *Lip prints or Cheiloscopy*; lip prints can be identified even after the 6th week of intrauterine life. Recording to Suzuki and Tsuchihashi, there are six types of classification; (I) Clear-cut grooves running vertically across the lip, (II) The grooves are straight but disappear halfway instead of covering the entire breadth of the lip, (III) the grooves are branched, (IV) the grooves are reticulated, (V) the grooves are intersected, (VI) undetermined.[15–17] (2) *Rugoscopy* is the study of palatal rugae to identify a person. Palatal Rugae are located in the internal position, it has stability, and it persists throughout life. The study of Hosmani *et al*.[18] comparisons between the Indian and Tibetan populations showed that Indian males possessed more primary palatal rugae on the left side when compared to females. Indian male also has more curved rugae compared to Tibetan male and Tibetan female have wavier rugae compared to Indian Female.

Racial Characteristic

There are four major anthropological racial group.[19,20] ***Mongoloid***. The most distinctive feature in mongoloid dentition is found on the lingual surface of the incisor infusion of the lateral or marginal ridges, which formed a

raised cingulum and created a deep lingual fossa. The tooth appeared to be a "shovel" or "scoop" shape appearance. On the lingual surface, there may be a groove from cervical margin to root surface, as well as a "Screw-like or Finger-like" projection from the cingulum toward the incisal margins. Frequently the prominent lingual marginal ridges which produce the Mongoloid shovel-shaped incisors extend onto the labial surface; this produces a mesiodistal concavity of the labial surface and is termed "double-shoved." Among Malay adolescents found that the central incisors of the males are more significant than the females. Mogoloids premolar may have a tubercle, usually on the buccal cusp, or called Dens Evaginatus. Singaporean Chinese exhibited bilateral five cusp forms on the upper third molar and second molar in the root of the teeth. Found that root size and length reduce posteriorly and sometimes with extra distolingual root in the lower first molar and third molar. The anatomical roots of most mongoloids are short, but the root trunk is better developed than others. Taurodontism is also observed in Mongoloids. Enamel pearls are low in occurrence. The cusp of Carabelli is usually not present in Mongolids. Mongoloids have a parabolic arch, especially the lower arch with large incisors, small premolar, and large molar.

Caucasoid which usually have a "v" shaped arch that causes crowding teeth. Anterior teeth of Caucasoid are described as "chisel-shaped," having a smaller and smoother lingual surface. Cusp of Carabelli shows in 37% of Caucasoid. Some central Europeans have a wide-based prominent cingulum on the lingual surface of their incisors rather than rolled smooth continuum familiar to most Europeans. Peg-shaped usually appears in the lateral incisors. Shovel-shaped incisors are also exhibited in most Caucasoid.

Australoid have a large arch size with large size teeth. Molar is more prominent among other living races or also called megadontia. The presence of a large premolar is also noted, but the anterior is relatively tiny. The edge-to-edge bite usually appears due to severe attrition. The mesial drift of teeth is another notable feature of this race. Shovel-shaped incisors and cusp of carabelli are rare to be found in this race.

Negroid usually have small teeth size and have a space between teeth, especially midline Diastema. Supernumerary teeth are increasing in tendency. The lower first premolar has two distinct cusps, sometimes even three cusps. The third molar is always present and rarely impacted. Class III malocclusion and open bite are usually common in Negroid.

Dental Evidence as an Expert Witness

As mentioned earlier in sex determination, lip print analysis, and palatal Rugae can also be a piece of evidence to be submitted in court. Lip print is unique for individuals and can be helpful in the identification of humans. Palatal Rugae are usually identified by computer software programs, where digitized images of the plate in which characteristic points were plotted on the medial and later extremities of rugae. Visual comparison of ante and post-mortem rugae can be identified from the denture that the person had. It can determine the shape, size, number, and position of the palatal rugae. The most prevalent palatal rugae shape was sinuously followed by curve, line, point, and polymorphic varieties.[18]

Bite marks also take an essential role in odontology forensic. There are several definitions of bite marks. Sopher (1976) said animal and human bite mark is different in characterized because the animal has different tooth morphology and anatomy also different jaw shape. Based on Wiliam Eckert (1992) bite mark is the executant bite mark found in a victim's body in the form of a wound, skin tissue, and connective tissue under the skin that is forming a pattern in the skin of the victim.[21–23] There are six classifications of bite marks.[24] Condition when there is space between incisive and canine is considered as Class 1. Class 2 is the same as Class 3, the only difference is that in Class 2, the buccal and lingual cusp of 1st premolar is also seen. The degree of injury in Class 3 is more severe than in Class 2 because the incisor's bite becomes one which makes it a deeper bite than Class 2. Condition when there is a scar on the skin and a sligtly separated or ruptured muscle under it that makes an irregular bite pattern is considered as Class 4. When a scar merges from incisive, canine, and premolar of maxillary and mandibular teeth, it is considered as Class 5. If the scar seen from the merger of all teeth from maxillary and mandibular teeth. Skin and muscle tissue are detached due to the severity of the perpetrator's bite of the victims, it is considered as Class 6.

Dentists must help in comparing the bite mark examination with evidence. The first dentist must identify if it is a bite from a human or animal. If the bite is already determined, a dentist must compare the bite with several methods, include: visual, life-size overlays, test bites, digital bite mark overlays, scanning electron microscopy, and matrix analysis. We can get the analysis from the dental record, extraoral and intraoral pictures, dental cast analysis also needed to be compared with the evidence. After all the analysis is completed, odontology forensic can record it into the post-mortem to conclude the case.[25]

CONCLUSION

Forensic odontology plays an essential role in determining the individual that cannot be identified visually or by other means. Dental hard tissue took an essential role in the identification of dead persons, even live patients. The unique features that are found in dentition will provide accurate results if all procedures are correctly employed.

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