

Dental Pulp in Forensic Dentistry

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Abstract

Forensic Odontology, the branch of dentistry that is centered on dental or oro-facial findings has become an essential component of forensic science over the years. The identification of dental remains is of prime significance when the deceased individual is skeletonized, decomposed, burned, or eviscerated. Pulp plays an important role in forensic odontology as pulpal tissue can be used to determine age, sex and blood group antigen by molecular analysis. The present article discusses the uniqueness of pulp and how it can be used as an aid for determination of certain traits when no other remains are available.

Keywords

Forensic dentistry; Pulp; Personal identification; Forensic odontology

Introduction

Forensic Odontology is a sub-discipline of Forensic Medicine and Dentistry that focuses on the adequate assortment and presentation of dental findings. Dental and orofacial findings have shown to play a vital role in the identification of deceased individuals through the comparison of ante-mortem and post-mortem records.¹ Oscar Amoedo is regarded as the father of forensic dentistry.² The Federation Dentaire Internationale (FDI) characterizes forensic odontology as “that subdivision of dentistry that within the interest of justice, deals with the proper handling and examination of dental evidence and the best possible analysis and presentation of dental findings.”³

The first ever utilization of forensic odontology to recognize a dead subject was done in the late 60's AD.⁵ Wide scale use of forensic odontology was made in order to recognize the victims during the incident that occurred at World Trade Center in the United States. Over the last couple of decades, forensic odontology has been utilized in civil as well as criminal cases and has been designated as an integral part of forensic science owing to the fact that dental tissues are unaffected even when exposed to extreme temperatures or situations. Forensic odontology has applications in all disciplines of dental sciences.

The most indestructible constituent of the human body is the teeth which may remain more or less robust for a long time past death. They also contain particulars about the physiological and pathological occurrences during the life of a person which resides as markers inside the hard tissues of the teeth. During a

disaster even after the other tissues are destroyed, teeth have been found to remain intact. Teeth are the most durable organs in the body which can withstand a temperature of 1600°C without the loss of its microstructure.⁴ The dental pulp, the soft connective tissue at the core of the tooth is well protected from external influences like temperature, humidity and pressure. It remains a source of valuable forensic information long after the other less protected tissues of the body are lost. Here, we review the role of the dental pulp in forensic identification.

Dental pulp

Dental pulp can be construed as a lavishly vascularized and innervated connective tissue of mesodermal inception encased by dentin which communicates with the periodontal ligament.⁶ Pulp comprises of fibroblasts, defense cells like histiocytes, plasma cells, pluripotent undifferentiated mesenchymal cells, and stem cells. The apical foramen serves as a passage for blood vessels, lymph vessels and nerves. The pulpal tissue has been clinically proven for determination of certain traits which are discussed below.

Dental pulp in blood group identification

The term blood group is applied to acquired antigens recognized on the red cell surfaces by specific antibodies.⁷ The ABO blood group framework, first laid down by Karl Landsteiner in 1900, remains the rampart of forensic blood group examinations. The utilization of blood group in medicolegal considerations depends on the certitude that once a blood group is established in an individual, it stays unaltered all through life.⁸ Blood grouping from teeth could assist in identification of individuals by narrowing the search via exclusion of persons with different blood groups. Dental pulp contains numerous blood vessels and blood group antigens are present in tooth pulp. It has been suggested that blood group

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antigens in the pulp are preserved even up to 2 years after the death of an individual.⁸ The absorption-elution technique has proved to be markedly more sensitive than others. A study conducted by Saxena et al. proved the sensitivity of blood group determination using dental pulp by the absorption-elution technique to be 80% accurate.⁹ Several other studies conducted by various authors have shown similar results with regard to blood group determination by the pulpal tissue.^{10, 11, 12} Pulp tissue is one of the most shielded tissues, encompassed from all sides by the dental hard tissues. Postmortem changes in pulp are seen very late and since pulp remains one of the most protected tissues, it is easily available for examination. The noteworthy character of teeth as one of the most enduring integral remnants of the human body empowers its effective use in forensic sciences.

Sex estimation and DNA from pulp

DNA is preserved in the teeth and bones for a very long period and thus is a valuable source of information.¹³ Pulp is a good source for extraction of DNA. Restriction fragment length polymorphism, polymerase chain reaction (PCR), and microarrays are various methods to effectively analyze DNA.¹⁴ The most acknowledged strategy for sex estimation is DNA molecular analysis. Soft tissue within coronal and radicular pulp chamber consists of odontoblasts, fibroblasts, endothelial cells, peripheral nerve, undifferentiated mesenchymal cells and nucleated components of blood which are all rich sources of DNA.¹⁵ Sweet and Sweet in 1995 presented a case of human remains identification using a preserved unerupted third molar which enabled 1.35 µg DNA extraction from the dental pulp.¹⁶ In a study conducted by Pötsch, et al. in 1992, the results using DNA extracted from the dental pulp did not show any difference when compared to the patterns obtained from DNA isolated from blood samples or available lung tissues.¹⁷

Barr Bodies

Barr bodies are strongly stained chromatin material present in nucleus of female somatic cells which plays a pivotal role in sex estimation.¹⁸ Barr bodies look like letter sets, for example, V, W, S, or X. In a forensic setting with a time duration of about a month, sex estimation is possible using X and Y chromosomal examination. Simple stains such as Papanicolaou stain can be used to visualize Barr bodies.¹⁹ The investigation of Barr bodies gives important data and adequate proof in remains pertaining to burnt and embalmed bodies. Under entombment conditions, Barr body test can be utilized to estimate sex with 98.9% accuracy.²⁰

F-Bodies

F-bodies are available in Y chromosomes and can be utilized in sex estimation. Various investigations have been done to identify F-bodies from pulpal tissue. The most effective and solid technique to estimate sex is by fluorescent staining of Y

chromosome in sound pulps. A study conducted in the year 2010 determined gender by pulp tissue using fluorescent Y body test and reported 100% specificity for freshly extracted teeth and those examined one month later.²¹ Similar results have been observed in other studies as well.^{22, 23}

Age estimation using dental pulp

Age estimation has applications both in postmortem identification as well as in living individuals where chronological age is under dispute. If age can be precisely evaluated, it will essentially limit the field of potential identities that should be compared against the remains so as to set up a constructive identification.²⁴ As age progresses, continuous deposition of secondary dentin occurs in such a way that it diminishes the dimension of the pulp cavity that can be observed by radiography which might be considered as a guideline for age estimation in a person. Evaluation of coronal pulp tooth ratio in forensic perspective acts as an indicator in age estimation for unidentified individuals.²⁵ Minimal changes in pulp tissue are noted at 6 hours after removal of tooth and pulp tissue can be maintained for three days, something which cannot be done with other body tissues.²⁶ Daud et al. in their study used the histological method for age determination and found that cell density of dental pulp cells of crown and root region changes with age.²⁷ They also reported that fibroblasts of the older age group appeared to be flattened and spindle shaped when compared with the fibroblasts of the younger age group.

Conclusion

The utilization of features of human dentition as a guide to identification is widely acknowledged within the forensic field. Dental pulp can be used as an indicator to estimate age and sex using different methods such as Barr body and F body test. In addition, the dental pulp is a warehouse for blood group antigen and DNA thus facilitating identification of deceased individuals. Further research should be aimed in the direction of establishing the accuracy of various methods using dental pulp as an aid with regard to its forensic application using a large diversified sample size.

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