

Correlation of Oral, Genetic, and Radiological Parameters Involved in Human Identification in Forensic Dentistry

Fouad Ayoub¹, Houssam Jassar², Hassan El Husseini³, Nicole Aoun⁴, Fida Sayah⁵, Ziad Salameh⁶

Contributors:

¹Dean and Professor, Department of Forensic Odontology and Human identification, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon; ²Instructor, Department of Oral Surgery, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon; ³Instructor, Department of Endodontics, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon; ⁴Instructor, Department of Oral Pathology and Diagnosis, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon; ⁵Instructor, Department of Preventive Dentistry, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon; ⁶Professor, Department of Research and Prosthodontics, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon.

Correspondence:

Prof. Salameh Z. Department of Research and Prosthodontics, Faculty of Dental Medicine, Lebanese University, Beirut, Lebanon. Tel.: +961-71-247147. Email: drzsalameh@gmail.com

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Abstract:

Background: Forensic dentistry plays a major role in the human identification, mainly in mass disasters situations. Forensic odontologist applies several techniques and correlates different parameters to establish an accurate scheme toward identification.

Materials and Methods: A PubMed search was carried out for different parameters involved in human identification in forensic dentistry; the results focused on oral and dental correlated factors, genetics, and radiology. 47 articles were included in this review.

Results: The main parameters found to be involved in forensic dentistry procedures were divided into four categories: (1) Comparative identification of oral and dental parameters, especially when ante-mortem records are available; (2) reconstructive identification of oral and dental parameters helping in gender and age estimation; (3) genetics and DNA extraction and printing that can be found in dental structures and biological remains; (4) radiographs and computed tomography images included in the matching procedure that is of great help in identification.

Conclusion: The results of this study reported the correlation and importance of different parameters to be included in the process of human identification.

Key Words: Forensic dentistry, genetics, identification, oral, radiographs

Introduction

Dentistry plays a significant role in forensic odontology; mainly in human bodies identification.¹⁻³ When natural and man-made

disaster situations occur, forensic dentists have always been involved, mainly in mass casualties cases associated with air or sea disasters.⁴⁻⁷

Dental identification includes a comparison between post-mortem dental records with the ante-mortem records of an individual; and identification of victims following mass disasters or catastrophes.

Different identification techniques are used by forensic dentists that include rugoscopy, cheiloscopia (lip prints), imprints obtention, use of molecular techniques.⁸⁻¹² Dental tissues (mainly enamel and dentin) are highly resistant to environmental attacks such as trauma, mutilation, incineration, and decomposition.^{1,4,8,13} Teeth represent an excellent source of DNA for identification mainly dental pulp.^{11,12,14,15} This biological material can establish the needed link when conventional dental identification fails.^{1,16}

The use of the polymerase chain reaction (PCR), which allows amplification of DNA at specific sites, is becoming more popular with investigators.^{1,17} One of the most reliable methods for matching analysis is comparing ante-mortem and post-mortem radiographs, by superimposition and subtraction.^{1,4,7,18} The use of computed tomography (CT) is gaining popularity in oral and craniofacial medicine, for its non-invasive properties in screening dental treatments on completely burned bodies.^{19,20} The major disadvantage of using CT for dental identification is the presence of artifacts due to metal,¹⁸ but metal-free restorations such as resins, fibers, and ceramics are more common nowadays.

The aim of this review paper was to evaluate the correlation and use of different oral, radiographic, and biological parameters in human identification in forensic dentistry.

Materials and Methods

A PubMed-Medline search of the scientific database for the years 1990-2015 was performed. Abstract, case report, clinical research, and review articles were included. Keywords used were forensic dentistry, identification, oral, radiographs, genetics, and DNA. 47 relevant publications were selected for this review.

Results

About 40 relevant publications were selected for this review. The majority of these papers are considered as recent (2015: 9; 2014: 4; 2013: 2; 2011: 2; 2010: 6 papers).

Discussion

This review divided the main parameters involved in forensic dentistry procedures into four categories (Table 1).

Oral and dental parameters in comparative identification

Teeth survive most post-mortem events that can destroy and drastically change other body tissue, representing an important and unique reference for human identification.^{1,4,6,7} The use of data from the ante-mortem dentist record by the forensic dentist depends on several factors among them the location, in which the body was found.¹ The post-mortem record is produced by the forensic odontologist by creating a chart documenting the remaining dental constituents; in case of available ante-mortem records, radiographs should be taken following the same angulation.^{1,21,22} The dental methods still the most important in identification in major catastrophe victims.^{7,23} A comparative study is very useful between available ante-mortem record and post-mortem chart evaluating the similar and differences points.²³

A study of the pattern of the back of the tongue was described as a significant feature in human identification.²⁴

Oral and dental parameters in reconstructive identification

Age estimation

Gustafson and Koch²⁵ was the first to describe a method for age estimation up to 16 years based on dental development. Different methods were later published for age evaluation based on the gingival recession and root transparency.²⁶ An evaluation of the accuracy of cementum annulation in age determination concluded that this method is consistent linking increase in age with a decrease of cementogenesis.²⁷

The palatal rugae anatomical structures are present for life and are different in each person.⁸ The palatal rugae may be used in age estimation evaluating the height, ridges status, and the absence of uncomplicated patterns.²⁸⁻³⁰

Gender estimation

Different techniques were described for gender estimation in identification process; study on canine teeth showed the difference in lower canines that were narrow and the inter-canine distance shorter in females.³¹ Ayoub *et al.* investigate the gender dimorphism by comparing the mesiodistal width of mandibular permanent canines and the inter-canine distance, they concluded that the evaluated parameters are of significant help in gender identification.³² The same author described several evaluation methods in sex determination based on dental features and craniofacial features.³³⁻³⁶

A study reported that the Carabelli's tubercle size as well as the crown is bigger in males than females.³⁷ Lip print morphology can also help in the determination of gender; difference was noted between females with a vertical pattern and males with ramified/reticular patterns.⁸

DNA in human identification

Genetic materials are present in any biological byproducts and constitute a source for DNA extraction and testing.^{1,8}

Time since death and the environmental conditions influence the quality of the genetic material. DNA is found in dental components; depending on the tooth status and the lacking of tissue (e.g., pulp), DNA will be extracted from remaining tooth structure.³⁸

Table 1: Different categories and parameters involved in forensic dentistry procedures.

Categories	Parameters	References
Oral and dental parameters in comparative identification	Comparison of ante-mortem records (if available) with post-mortem record produced by the forensic odontologist	Pretty and Sweet, 2001; ¹ Kolude <i>et al.</i> , ² 2010; Pashinian and Ayub, 1992; ⁴⁵ Nathan and Sakthi, 2014; ⁶ Korkchi <i>et al.</i> , 1995; ²¹ Pretty and Addy, 2002; ²² Bruce <i>et al.</i> , 2005; ²³ Pashinian and Aiub, 1995; ²⁴
Oral and dental parameters in reconstructive identification:		
Age estimation	<ul style="list-style-type: none"> Dental development Gingival recession Cementum annulation Palatal rugae anatomy 	Gustafson and Koch, 1974; ²⁵ Lamendin <i>et al.</i> , 1992; ²⁶ Condon <i>et al.</i> , 1986; ²⁷ Ohtani <i>et al.</i> , 2008; ²⁸ Pashinian <i>et al.</i> , 1993; ²⁹ Beliaeva, 1993 ³⁰
Gender estimation	<ul style="list-style-type: none"> Difference in lower canines Gender dimorphism: Mandibular permanent canine features Carabelli tubercle size Lip print morphology Back of the tongue morphology 	Sherfudhin <i>et al.</i> , 1996; ³¹ Ayoub <i>et al.</i> , 2007; ³⁵ Ayoub <i>et al.</i> , 2008; ³⁴ Ayoub <i>et al.</i> , 2009; ³³ Ayoub <i>et al.</i> , 2014; ³² Aiub <i>et al.</i> , 2005; ³⁶ Noss <i>et al.</i> , 1983; ³⁷ Mowafey <i>et al.</i> , 2015; ¹⁰ Khanna, 2015; ¹¹ Patil <i>et al.</i> , 2015 ¹³
DNA in human identification	<ul style="list-style-type: none"> DNA present in dental structures DNA profile compared to ante-mortem or family data especially in mass disasters Isolation of specific marker in genetic mapping 	Pretty and Sweet, 2001; ¹ Muruganandhan and Sivakumar, 2011; ³⁸ Datta and Datta, 2012; ³⁹ Raimann <i>et al.</i> , 2012; ⁴⁰ Chouery <i>et al.</i> , 2010 ⁴¹
Dental radiographs and CT images	<ul style="list-style-type: none"> Dental radiographs, panoramic are important as ante-mortem records Computed tomography: Comparison of post-mortem CT and ante-mortem CT if present 	Sakuma <i>et al.</i> , 2015; ¹⁸ Leth, 2009; ⁴² Iwase <i>et al.</i> , 2010; ²⁰ Poeschl <i>et al.</i> , 2013; ⁴³ Massey <i>et al.</i> , 2013; ⁴⁴ Pashinian and Ayub, 1992 ⁴⁵

CT: Computed tomography

Forensic dentists should incorporate novel techniques for DNA extraction in their screening protocols.³⁹ PCR-based analysis produces a DNA profile that can be compared with known ante-mortem samples or paternal DNA.⁴⁰

Although the ultimate goal is to obtain a match between two persons or between a biological material and a person, the specific context of each of these applications of human identity testing has its specific problems, ranging from technical approach, through statistical interpretation, to ethical issues.⁸

The non-homogeneous character of the genetic material in identification depends on the circumstances of a catastrophe. In the case of severe fragmentation of victims' bodies, it may compromise the association of body parts while still allowing the identification of the victims.^{1,4,38}

The isolation of specific marker in genetic mapping of a population can help significantly in human identification within forensic investigations.⁴¹

Genetic profile is sometimes difficult to determine even after extraction and screening of a sufficient amount of DNA from biological remains.

Dental radiographs and CT images

Routine dental practice includes dental radiographs for screening and treatment follow-up; they are considered as an important tool in identification when compared with post-mortem radiographs.¹⁸

The use of CT is becoming very popular in forensic medicine and dentistry that is due to its precision, ease of use, and fast results.^{20,42} Post-mortem CT (PMCT) is of great help, especially when an ante-mortem CT (AMCT) is available, as CT imaging became a routine procedure in implant therapy and treatment planning.^{43,44} Matching procedure between PMCT, AMCT, and radiographs is likely to be more used and integrated into forensic odontology procedures.

Published paper reported that the use of dental radiographs is not as accurate due to distortion occurring in the radiographs, difficulty in alignment between ante-mortem and post-mortem ones; thus, the use of a PMCT is likely to increase that will improve the accuracy of dental identification using radiological images.^{18,42}

A study reported that visual examination of dental status; the use of odontograms and application of panoramic roentgenography will help improve forensic medical personal identification.⁴⁵

Human identification occurs for different reasons and in different situations: Crimes, fires, motor vehicle accident, and work accident. In case of mass disaster due to natural events (earthquake, flooding, volcanic eruptions...) or due

to crashes of mass transportation (airplanes, boats, trains...) dental identification is the widely used methods but it is more complex and sensitive.^{4,46}

Conclusions

The results of this study reported the correlation and importance of different parameters to be included in the process of human identification within the frame of forensic dentistry and the role of the forensic odontologist in helping mainly in the case of mass disasters.

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