Review Article

Oral mark in the application of an individual identification: From ashes to truth

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Abstract

Forensic odontology is the branch of dentistry which deals with the proper handling, examination, evaluation and presentation of dental findings in the interest of justice. After major disasters and perimortem assaults such as earthquakes, fires, severe head and neck trauma or gross decomposition, accurate and early identification of dead and injured becomes important. In the absence of other records in such cases, identification is based on restorations, missing teeth and prosthetic devices such as partial and complete removable/fixed prosthesis or implant retained devices. This brings out the major role of prosthodontics to investigate the identity of suspects in the criminal cases as well as the deceased human beings in traumatic injuries or in disasters. Denture identification systems are being used as means of postmortem identification of edentulous persons which has evolved from the inclusion of some form of printed label in a denture to more high-tech methods. The provision of implant retained complete lower denture, antemortem, and postmortem radiographs of edentulous persons and correlation of bite marks using special impression techniques provide another potential source of evidence for human identification. Hence, this literature review throws some light on the role played by prosthodontist in forensic odontology.

Key words: Bite marks, cheiloscopy, dental records, denture marking, forensic science, palatal rugae

Introduction

Human identification can be a challenging task in mass disaster situation, in crime investigation, in ethnic studies and in the identification of decomposed and disfigured bodies such as that of drowned persons, fire victims, and victims of motor vehicle accidents.[1,2] The prosthetic dentistry has played a key role in assisting the forensic science to reproduce more accurate reliable and investigatory data. The various methods employed include palatoscopy or palatal rugoscopy, cheiloscopy, prosthesis marking system, implants, preprosthetic surgery records, and bite marks. Identification is based on a comparison between known characteristics of missing individual (termed antemortem data) with recovered characteristics from an unknown body (termed postmortem data). Both the antemortem and postmortem records can be retrieved and correlated to establish identity positively. Antemortem dental records will contain written notes, charts, diagrams, dental and medical histories,

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radiographs, clinical photographs, study models, results of specific tests, prescriptions and referral letters, and other information.[3] Their accuracy and availability have a huge impact on the speed and efficacy of identification. Not only should the teeth be assessed, but also the findings should come from examining both clinically and radiographically, the oral cavity and all its structures. Although teeth are more durable than other parts of the body, identification through dental records might also prove to be inconclusive, because dental treatment might have been performed between the creation of a dental record and person's death[4,5]

When a victim has no teeth available methods for forensic identification becomes much more limited. For edentulous victims, some identification methods are available such as comparing the anatomy of paranasal sinuses and comparing bony patterns seen on radiographs.[6,7] Furthermore, the victim's dentures themselves, which are usually found inside their mouth or within their homes, can provide us with more personal information with regard to denture making, denture materials and their unique shapes, for use as antemortem data or postmortem evidence.

Rugoscopy

Palatal rugae have been considered relevant for human identification due to its stability and is equivalent to the fingerprint in that it is unique for each individual, it is known as palatoscopy or palatal rugoscopy.[8] The application of palatal rugae pattern to personal identification was first suggested by Allen in 1989.[9] Indentations of palatal rugae are often visible on the fitting surface of maxillary dentures, and these can be compared using high definition impression materials to the decease. Another technique is using computerized recording and compare.[10]

Palatal rugae comprise about three to seven ridges radiating out tangentially from the incisive papilla. These ridges can be classified as curved, straight, wavy, and branched. The pattern of these rugae is considered unique to an individual. In instances where postmortem dental identification is not possible, as in edentulous mouths, palatal rugae can be used as a supplement. The shortcomings in applying rugoscopy as a definitive tool in forensic odontology are many. Postmortem identification is not possible without the antemortem records.

Complex rugae patterns (patterns that cannot be classified under one particular group can cause intra- or inter-observer errors. Kapali *et al*. have observed that denture wear, tooth malposition, and palatal pathology can cause alterations in rugae patterns.[11]

Further, Thomas and Kotze have stated that rugae patterns are genetically determined, and so can be rather used in population differentiation than individual identification.[12]

In a situation involving fire, palatal rugae are often destroyed, and also since decomposition and skeletonization can occur in <6 weeks in summer and 4 months in winter, rugoscopy does not have application after this stipulated period.

Cheiloscopy

Another approach in forensic science is cheiloscopy, which is the forensic investigation technique that deals with the identification of human based on lip traces. Lip prints and palatal rugae patterns are considered to be unique for an individual and hence hold the potential for identification.[13] The presence of lip prints at crime scene can form the basis for evidence regarding number of people involved the presence or absence of a suspect and sex of an individual.

The external surface of the lip has numerous elevations and depressions that form a characteristic pattern referred to as lip prints. Lip prints can be obtained at the crime scene from clothing, cups, glasses, cigarettes, windows, and doors. Using lip prints for personal identification in forensic odontology is an accepted method in the criminal justice system worldwide. Impressions are made from the middle portion of the lower lip, an area always visible in any trace made, and the characteristic patterns are studied.

The various patterns identified include vertical, intersected, branched, reticular, and undetermined. The anatomical landmarks of the lip include chelion (the lateral-most point in mouth opening), stomion (the contact of upper and lower lips in mid-sagittal plane), and labrale superius and labrale inferius (the highest and lowest points of upper and lower lip margins in the mid-sagittal plane, respectively). Various factors can alter lip print recording. Lip prints have to be obtained within 24 h of the time of death to prevent erroneous data that would result from postmortem alterations of the lip.[14]

Lip print pattern depends on whether the mouth is opened or closed. In closed-mouth position, lip exhibits well-defined grooves, whereas in open position the grooves are relatively ill-defined and difficult to interpret. Any pathology of the lip such as mucocele or any postsurgical alteration of the lip can change the lip print pattern. Furthermore, loss of support due to loss of anterior teeth can cause changes in lip prints. Any debris or fluid on the lip surface, application of a thick layer of lipstick, or over stretching of cellophane tape can alter lip print recording. Although lip prints are unique to an individual, when the lines are not clear, individual identification based on this trace is extremely difficult unless the trace contains more individual characteristics such as scars and clefts.[14]

Lip prints can be taken as a part of pretreatment records of a patient undergoing prosthetic treatment. Lip prints recover

even after trauma inflammation and diseases like herpes and can be recognized without difficulty.

Bite Marks

Bite mark is also vital evidence in case of crime and abuse and can go unnoticed by untrained individuals. Knowledge on the arch alignments and specific tooth morphology of animals is also required for a forensic odontologist to distinguish human bites from nonhuman. Bite marks are usually documented taking photographs or taking impressions. Bite records taken by the prosthodontist can prove to be a good antemortem record preserved in the laboratory and can be used for comparing with the available postmortem findings to make a decision. Measuring the size of the tooth of the suspect and comparing it with bite mark can be done with metric analysis. When a good impression of the bite is left behind the physical characteristics such as distance from cuspid to cuspid, shape of the arch, evidence of mal-alignment, spacing, teeth width and thickness, missing teeth and wear patterns are taken into consideration for comparing bite mark wound and suspect's teeth.[15]

The drawbacks encountered in recording bite marks are however many. Due to inherent alterations, the shape and clarity of bite marks found on the skin of the victims change in a relatively short duration (10–20 min) both in living and dead, and this necessitates their recording at the earliest possible time. Although photographed immediately, the three dimensional bite marks on the two-dimensional photograph will be associated with changes in color and spatial relations. In addition, incomplete bite marks are not conclusive and a minimum of four to five teeth has to be present for reliable bite mark analysis.[15]

Fixed Prosthesis and Implants

Dental implants for prosthetic rehabilitation with fixed crown or mobile partial/total dentures is a very common oral treatment among the population nowadays.[16] There is a great number of implant systems of different designs. However, a catalogue of radiographic images and a description of the dental implants available would be useful to identify the manufacturer and the type of implant encountered in forensic casework. When an unidentified body is found with one or more implants in the jaws, and no dental record is available, clues gleaned from the type of implants used could give direction to the investigation.[17,18]

Component analysis of dental porcelain assists in dental identification. The fluorescence of porcelain crowns of murdered victim and several control porcelain samples were examined by fluorescent examination lamps. To increase the objectivity of the results by quantitative analysis, the composition of each porcelain crown and control sample was also evaluated by wave dispersion X-ray microanalyser. Although component analysis of dental porcelain may be an effective means of assisting dental identification, a more rapid and nondestructive analysis for detecting the elements is required.

Denture Marking

The frequency of edentulousness has decreased in recent years due primarily to improvements in oral health brought about by factors such as fluoridation and increased patient awareness. However, owing to a wide variation in the oral status of populations in different countries, the need to address the issue of denture identification still remains since it is more difficult to identify an edentulous person than a dentate one.[2,19] In such cases, in the absence of marked dentures, dental identification is problematic and hence may only be established by well-trained examiners through the comparison of bone trabeculation patterns that have been recorded in antemortem and postmortem radiographs.[3] Given that only one marked denture can reveal the identity of a deceased person when all other methods fail to do so makes the practice of denture marking worthwhile.[4,5]

Denture marking system includes:

1. Surface marking methods: Identification (ID) marks are scratched, engraved, or written to the surface of denture
2. Inclusion methods: ID marks are enclosed within the denture base polymer.

Various denture marking and labeling methods[20-25] are as follows:

- Label (A) – showing a technique in which the patient's name was typed on a piece of "onion skin" paper and incorporated within the fitting surface of the denture during the packing procedure [Figure 1]
- Label (B) – showing a method involving the use of a typed, commercially produced metal strip (trade name: ID-Band) embedded into the polished surface of the denture
- Label (C) – showing a radio frequency ID (RFID) system consisting of a data carrier, generally known as a tag or

Figure 1: A technique with patient's name typed on a piece of ''onion skin'' paper and incorporated within the fi denture

transponder. The tag consists of a torpedo shaped microchip with a coiled antenna, measuring 8.5 mm × 2.2 mm. The transponder may be embedded into either the polished or fitting surface of an existing denture [Figure 2]

- Label (D) – showing an example in which a fine fiber-tipped pen was used to mark a label made from a partially polymerized strip of polymethyl methracrylate before including in the fitting surface of the denture base during the trial packing procedure
- Label (E) – shows an example of an ID label that had been produced in a "P-touch" electronic lettering system. The label used consisted of a 103-lm thick, white or clear laminated strip onto which 2 mm characters are typed, after which it is incorporated into the denture subsequent to its fabrication [Figure 3]
- Label (F) – utilizing a standard soft metal band that is either typed or engraved with the patient's details before being rolled up and inserted into a predrilled cavity c. 2–3 mm wide. A small wax plug is then placed over the metal band before filling the remainder of the cavity with self-cure resin [Figure 4]

Figure 2: A radio frequency identification system consisting of a data carrier, generally known as a tag or transponder

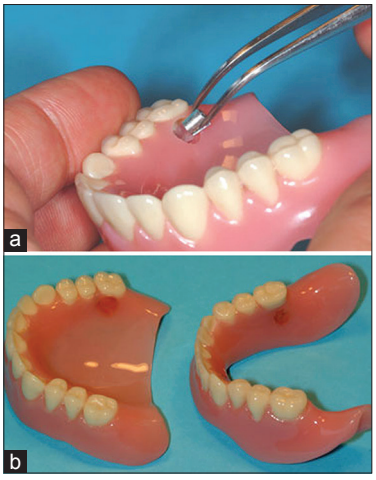

Figure 4: (a) Utilizing a standard soft metal band that is either typed or engraved with the patient's details before being rolled up and inserted into a predrilled cavity. (b) A small wax plug is then placed over the metal band prior to filling the remainder of the cavity with self-cure resin

- Label (G) –is made from a label printed on 35 mm photographic slides through the use of a computer graphics package[26]
- Label (H) – utilizing piece of 0.125 mm thick stainless steel tape onto which the patient's details are engraved. The tape is then incorporated into the fitting surface of the denture during the trial packing stage [Figure 5]
- Label (I) – showing an example that involves cutting a groove of c. 0.5–1 mm deep into the buccal flange of the denture; the length of which would correspond to the length of the patient's name. An ordinary ballpoint pen or felt-tip pen is then used to print the patient's name in the recess before being sealed with fissure sealant
- Label (J) – showing an example that allows the dentist to write on the surface of the denture using a spirit-based pen or pencil before covering the ID mark with a clear denture base polymer dissolved in chloroform [Figure 6].

Millet and Jeannin 2004[21] implanted a RFID transponder into a complete upper denture. The system consisted of a data carrier, known as tag or transponder, and an electronic handheld reader. Engraved fixed restorations also facilitate

Figure 3: ID label that had been produced in a "P-touch" electronic lettering system

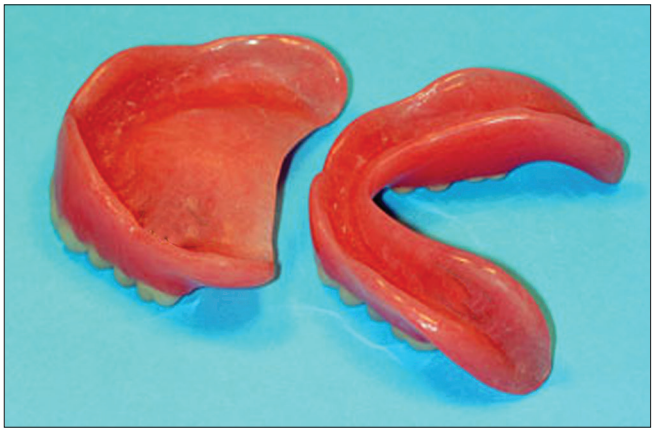

Figure 5: 0.125 mm thick stainless steel tape onto which the patient's details are engraved

Figure 6: The surface of the denture using a spirit-based pen or pencil prior to covering the ID mark with a clear denture base

identification in forensic dentistry. An electric engraver is the instrument used to mark the fixed denture or crown chairside before final cementation. It provides for rapid identification of deceased victims as metal restorations have a high resistance to all insults and they are cemented to the teeth and cannot be readily removed.

Conclusion

Prosthetic dentistry plays a major role in assisting the forensic science for the identification of those individuals who cannot be identified visually or by other means. The unique nature of our dental anatomy and the placement of custom prosthesis ensure accuracy when the techniques are correctly employed. In this brief overview, some of the traditional and upcoming techniques in this fascinating field are highlighted.

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