Review Article

RECENT CONCEPTS IN FORENSIC ODONTOLOGY: A REVIEW

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ABSTRACT

Forensic dentistry is an upcoming branch of dentistry that utilizes the dentistôs knowledge to serve the legal system. Despite breakthrough in science and technology, natural calamities and crimes continue to persist in human life. Identification of human remains is essential for various reasons including legal, criminal, humanitarian and social grounds. Dental remains can be used for identification. Forensic odontology analyzes dental evidence to overlap the dental and legal profession. Various methods have been developed to determine age, sex, and ethnicity of the person, using dental tissues. This article reviews the evolving trends in conventional methods and the recent advances in the field of forensic odontology.

Key Words: Current trends, dental identification, forensic odontology.

INTRODUCTION:

ñThe Forensic odontology was defined by Keiser- Neilson in 1970 as ñthat branch of forensic medicine which in the interest of justice deals with the proper handling and examination of dental evidence and with the proper evaluation and presentation of the dental findingsò[1] It can be characterized as the field to determine the physical, chemical and biological changes that occur in living or dead man's skeleton and even human parts or facts.[2] It involves dentist participation in assisting legal and criminal issues.[3]

Forensic odontology has three major areas of utilization:

(1) Diagnostic and therapeutic examination and evaluation of injuries to jaws, teeth, and oral soft tissues.

(2) The identification of individuals, especially casualties in criminal investigations and/or mass disasters.

(3) Identification, examination, and evaluation of bite marks which occur with some frequency in sexual assaults, child abuse cases, and in personal defense situations.[4]

Some of common methods used for individual identification are visual, personal or medical information(height, weight, build, age, presence or absence of hair, eye colour , facial hair), specific information (scars, tattoos, birthmarks, operations, implants, old injuries, medical conditions, body piercings), radiological information (foreign bodies - prostheses) , clothing, personal effects and documentation, dentistry , fingerprints and DNA profiling.[5]

Evolving trends have been observed in the conventional methods used such as dental record maintenance, dental imaging techniques, bite mark analysis, DNA analysis using oral tissues, cheiloscopy and rugoscopy. In addition, the recent concepts such as facial reconstruction, denture identification, comparison microscopes and tongue prints have been introduced in the field of forensic odontology. This article provides an overview of the evolving trends in conventional methods and the recent concepts used in forensic odontology.

METHODS USED IN FORENSIC ODONTOLOGY

Conventional Methods

Maintenance of dental records is the duty of a dentist and is an essential component, serving as an information source for the dentists and the patients, in medico- legal, administrative, and for forensic purposes. Forensic dental identification most of the times are dependent on the availability, adequacy, and accuracy of antemortem dental records. Dental records are available in various forms such as dental notes, dental charts, radiographs, photographs, and models.[6] Computer generated dental records gain more importance due to the fact that it can be easily networked and transferred for routine professional consultation or forensic cases requiring dental records for identification.[7]

Dental imaging techniques

Historically, the application of radiology in forensic sciences was introduced in 1896, just one year following the x-ray discovery by Roentgen, to demonstrate the presence of lead bullets inside the head of a victim.[8]In cases where

the identification of a corpse is required, radiographic images of the deceased can be obtained and compared with any ante-mortem radiographic image of the presumed person.[9]

The identification technique utilizing conventional radiography is based on the comparison between ante-mortem images recorded in dental offices and centers with post-mortem radiographic images. This method allows the observation of anatomical characteristics such as coronal shape and size, pulp anatomy, positioning and shape of the alveolar bone crest, besides unique and individual characteristics resulting from dental treatments.[10]

Computed tomography (CT) images reveal the cross-section of the areas exposed and produce multiple images. Antemortem CT images provide information which can be used in the construction of a postmortem facsimile image, considering that craniometrical points

can be precisely located and measurements can be accurately performed.[11]

Bite marks

It is defined as the physical alteration in or on a medium caused by the contact of teeth. In few of criminal cases it is seen that suspect or victim has left his or her teeth marks on another person or inanimate object. Bite marks change over a time on living as well as dead. If the bite is on living person there will be post injury changes in the tissue, where bleeding, swelling and discoloration can be seen. If the bite is on dead person, then photographs of marks are taken with standardized technique.[12]

The standard techniques for examining bite marks are based on interpreting photographic evidence, in which a bite is compared with the models of the teeth of suspects. There are a number of different ways to produce overlays from a suspectõs dentition : Hand tracing from dental study casts, hand tracing from wax impressions, hand tracing from xerographic images, the radiopaque wax impression method, and the computer-based method.[13]

DNA analysis

DNA analysis is a new tool used in the field of forensic odontology, gains importance when conventional identification methods fail due to the effects of heat, traumatism or autolytic processes, distortions, and difficulties in analysis. There are many biological materials such as blood, semen, bones, teeth, hair, and saliva that can be used to accomplish DNA typing. With the advent of polymerase chain reaction (PCR) which allows enzymatic amplification of a specific DNA sequence even in a negligible amount of source

material, forensic identification using DNA analysis becomes increasingly popular with investigators.

In the field of forensic sciences, the genomic and mitochondrial DNA (mtDNA) are used.[4] The genomic DNA is found in the nucleus of each cell in the human body. The teeth are an excellent source of genomic DNA (Fig.1). mtDNA can be used when the extracted DNA samples are too small or degraded, such as those obtained from skeletonized tissues. The amplified DNA is then compared with the antemortem samples such as stored blood, hairbrush, clothing, cervical smear, and biopsy specimens.[14]

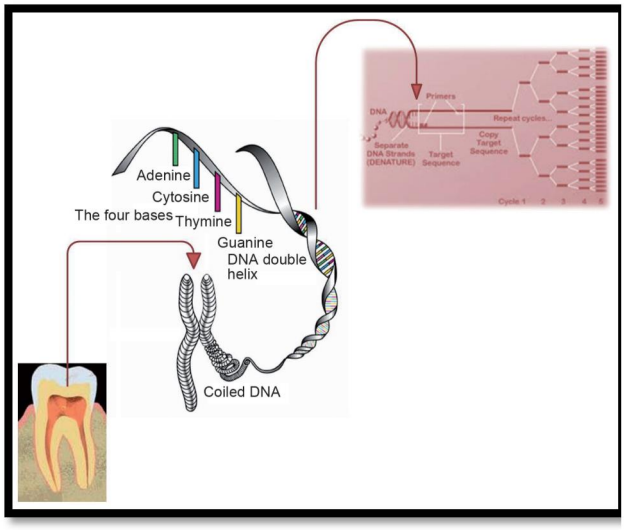

Figure 1: Schematic photograph showing replication of DNA by PCR

Cheiloscopy and palatoscopy

Cheiloscopy is the study of lip prints. Lip prints remain the same throughout life and are uninfluenced by injuries, diseases or environmental changes.

Applications of Cheiloscopy in Modern Science-

- A deterministic aid for forensic sex determination
- A tool in crime investigation
- An aid for personal identification
- Cheiloscopy and palatoscopy: aid for human identification

The following methods may be used for recording lip prints- on non porous flat surface such as mirror, enlarged and overlay tracings made of the grooves, rouge can be applied to the lips and then lips are photographed, after applying lip stick the impression should be taken on a paper until the lipstick has exhausted or applying special creams on the lips (Fig.2).[15]

Figure 2: Impression fixed on bond paper

The print taken is directly photographed or covered by a cellotape to maintain a permanent record. Nowadays, softwares are used for the recording of lip

prints.Recent studies have proven lip prints as a superior tool compared to fingerprints and mandibular canine index in gender determination.

Palatoscopy, or palatal rugoscopy, is the name given to the study of palatal rugae in order to establish a person's identity. The palatal rugae are located on the anterior portion of the maxilla. Palatal rugae are irregular, asymmetric ridges of mucous membrane extending lateral from the incisive papilla and the anterior part of the median palatal raphe (Fig.3).[12] Palatal rugae analysis may serve as an important aid in forensic odontology as they remain consistent in shape, pattern, direction and unification throughout the life of an individual except change in their size with growth of the palate.[4]

Figure 3: Delineated palatal rugae patterns

Materials and methods used to analyze the rugae patterns includes, photographs and impression of maxillary arch, computer software programs (for e.g., RUGFP‑ID), calcorrugoscopy or overlay print, stereoscopy (through which three-dimensional [3D] image of palatal rugae can be made), stereophotogrammetry (which is comparatively accurate).[4]

Recent Methods

Forensic Facial Reconstruction (FFR)

FFR refers to a process that aims to recover the morphology of a face at the moment before death, from the observation of a skull.[16] It is the scientific art of recreating the facial appearance of an individual from the skull for the purpose of personal identification.It allows recognition and assists the process of human identification when it is not possible to obtain optimal conditions, as a comparison of ante-mortem and post-mortem data.

There are currently two basic approaches ï two-dimensional and three-dimensional types of reconstruction. Both techniques employ either a manual or a computerized approach. The earliest scientific endeavour towards facial reconstruction began in the late 19th century with various measurements of the facial thickness from cadavers.[17] Nowadays, the advancement in technology a new computer-based techniques emerged that claimed to be quicker and more flexible.

With the advancement in 3D technology, computerized 3D forensic facial reconstruction - a fast, efficient and cost effective computer aided forensic facial reconstruction method was developed.[18] This method uses a laser video camera interfaced with a computer or with CT scanning. Skull data are then imaged as a fully shaded 3D surface. The face can be drawn with the help of computer software (Fig.4).[19]

Denture identification

Medicolegal importance of denture marking systems in identification of the dead or deceased when all other means have failed, identification of individuals for forensic, social and legal reasons, victim identification in case of mass disasters like terrorism, bombings, earthquakes, hurricanes, typhoons, air crashes and other transportation mishaps and identification of mutilated and decomposed bodies when all other parameters like scars, tattoos, and facial features have failed.

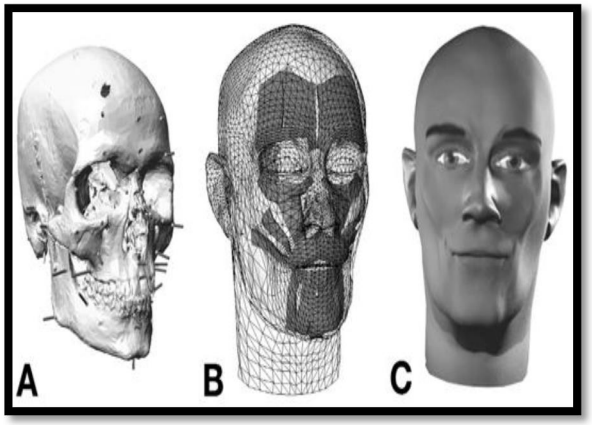

Figure 4: Facial reconstruction using computer software.

(Image courtesy of KoljaKähler, MPI Informatik Saarbruecken, Germany).

Methods of denture labeling falls under two categories: the surface marking method and the inclusion method. The surface marking methods include scribbling or engraving the denture and marking with embossed letters. Inclusion methods include metal identification bands, computer-printed denture micro-labeling system, lead paper labeling, embedding the patient photograph, denture bar coding, T-bar, laser etching, lenticular card system (using a

polyethylene terephthalate, in which the first flip shows patient's name, sex, and age, and the second flip shows address and driving license number, when viewed from

a different angle), radiofrequency identification tags, electronic microchips.[4]

Comparison Microscopes

The use of microscopes in forensic sciences has an impact on the accuracy. Examination of teeth under microscope can confirm sex by the presence or absence of Y-chromatin. The phase contrast microscope is useful in analyzing the cemental annulations for age estimation.

The forensic technology has developed a prototype virtual comparison microscope (VCM).[4] VCM utilizes images of

deformed bullets, bullet fragments, and various types of rifling from the companyôs BulletTrax-3D system. With the VCM, it is easy to find significant markings in any direction while maintaining a consistent appearance.[20]

Tongue prints

Tongue is very unique vital organ and its vitality is well inscribed in Traditional Chinese Medicine as ñTongue of lifeò The dorsal surface of the tongue is unique for each person. The characteristic features of the tongue exhibit remarkable difference even between identical twins. Lingual impressions (impression of the dorsal surface along with the lateral borders) together with its photographic image, have been proved to be useful in forensic dentistry identification when used in conjunction with methods such as cheiloscopy and rugoscopy.[4]

CONCLUSION

Forensic dentistry plays a major role in identificatin of those individuals who cannot be identified. At the crime scene, the forensic odontologists play a major role in investigating

and interpreting the dental evidence. Recent tragedies and past and present situations have increased awareness concerning the importance of forensic dentistry in identification of victims.

To maximize dental application in forensic cases, it is necessary to train dentists in the practical aspects of forensic odontology. And there is necessity in exposing dentists to the basic principles and techniques of the subject.

Hence dependence on latest technologies alone does not always help in solving cases.Thus a combination of reliable conventional methods and potentialities of advanced sciences can make wonders in the science of forensic dentistry.

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