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Current Trends in Forensic Odontology

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Abstract:

Every person has a distinct identity in life. An developing field of research with the most potential for growth is forensic odontology. Identification of dental remains, retrieval, and examination of evidence that matches with the suspects' is the most difficult aspect of forensic dentistry. The legitimacy of the evidence in forensic dentistry would be improved by an impartial comparison employing modern technologies. It has been proven to be an indispensable science in legal and medical situations involving the identification of the deceased. In cases of child abuse, domestic violence, and bite mark analysis as well as identification fixing in mass disasters, the forensic odontologist uses his or her understanding of dentistry. As a result, in recent years, forensic odontologists have been given more duties and responsibilities in a variety of medicolegal cases. The field of forensic dentistry is expanding and has a wider scope. It has established itself as a science that is essential in identifying the deceased and in medicolegal situations. Even if the deceased person is skeletonized, decomposed, burned, or dismembered, the dental tissues are frequently still there. Using dental tissues, a number of techniques have been developed to establish an individual's age, sex, and ethnicity. Forensic dental identification techniques for data collecting and supporting technologies have changed significantly. The trends that are now being used in the field of forensic odontology are summarised in this article.

Keywords: *Child Abuse, Domestic Violence, Forensic Dentistry, Mass Disaster Medicolegal Cases, Bite Mark Analysis, Recent Advances.*

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Introduction

The word "forensic" comes from the Latin "forensic," which means "before the forum." The primary focus of forensic odontology is dental evidence.Teeth are the hardest portion of the human body, and each person has a unique dental pattern.When it comes to solving instances involving tooth tissues, forensic dentistry is crucial **(Balachander *et al.*, 2015).**

Recent concepts in forensic dental identification:

There are many process to identify and analyse the teeth tissues like :

- **Facial Reconstruction**

Accident victims frequently end up decomposing or becoming skeletonized. In such circumstances, the human skull and bones will endure for a long time without modification, serving as a guide for identification. We can rebuild the victim's face using that evidence.The facial reconstruction process also makes use of laser cameras and tomography scanning **(Verzé & Laura, 2009).**

- **Denature identification methods**

Denature labelling is the most easiest method for identification and also can reveal the positive identification of an individual . they are 2 types:
Surface labelling and inclusion method **(Debnath *et al.*, 2016).**

- **Tongue prints**

When an anti-mortem picture impression is available, this technique performs best. A safe way for enhanced identification is a lingual imprint combined with a photographic image. Every person has a unique tongue type and tongue print. Combining both extraction technique approaches will be used to promote matching **(Anuja *et al.*, 2018).**

Role of saliva in forensic odontology

Additionally, saliva is crucial in the identification of suspects. For blood testing, saliva from bite marks can be collected. We can also perform some quick tests to see whether the person has any viral illnesses **(Bhandari *et al.*, 2011).**

- **Portable dental x-ray generator**

The NOMADTM portable dental X-ray generator features cordless operation, rechargeable 14.4 V nickel-cadmium battery packs, and can produce 100–700 exposures on a single charge. It is one of the portable dental X-ray generators that enables hand-held portability in X-ray technology. produces images at a quality that is suitable for forensic odontology. The image quality is identical to that of standard x-rays **(Ramesh & Gayathri, 2018).**

- **WINID**

It is dental software that can help forensic odontologists in their efforts to identify people. To rank potential matches, windIn uses anthropometric and dental data **(Sharma *et al.*, 2018).**

New trends in DNA analysis

- **Smartphone application in facial analysis**

The facial analysis is done using algorithms and other internet methods. The algorithms were initially created in MATLAB and then implemented on a Droid phone. The application of algorithms and some template codings will aid in face detection and recognition **(Chao *et al.*, 2016).**

- **Three-dimensional-analysis in Bite marks**

To maximise their analysis, bite marks must maintain their three-dimensional aspect.A surface scanner could be used to record bite marks. In clinical dentistry, look for prosthetic design in the dental relief **(Evans *et al.*, 2013).**

- **Automated Dental identification system**

Computer aided software for the post-mortem is called the Automated Dental Identification System.Identification of the deceased is done using dental characteristics and entails a search and recovery stage **(Delahunt *et al.*, 2005).**

- **Digital teeth reconstruction**

The procedure that restores the lost tooth using the skeletal remains is known as forensic digital tooth reconstruction. For dental reconstruction, implants are typically employed; this reconstruction takes many months, and perhaps much longer **(Anslinger *et al.*, 2005).**

- **Reflected ultra violet –photograph in forensic odontology**

Some digital cameras are enhanced by UV light, which aids in image capture when UV light from various dental items is absorbed.And the enamel test and age estimation are made easier by these photographs **(De Angelis *et al*., 2020).**

- **Software in forensic odontology**

These days, software uses several strategies to play a significant part in forensic dentistry. Age estimation, data analysis, Adobe Photoshop, and Gimp software are just a few of the other programmes utilised. Additionally, it controls the computer's elements of repetitive chart-by-chart comparison of ante and postmortem records **(Dadu *et al*., 2013).**

- **Forensic Bio-robots**

This helps to maintain dental records,Dental imaging and bite mark analysis **(Anslinger *et al*., 2005).**

Molecular Advancements

- **AMEL Gene**

The 'amelogenin' protein that the AMEL gene encodes is extremely conservative. This gene is located on the X and Y chromosomes of human allosomes. the intronic sequence is comparable. Each female chromosome contains two identical genes [AMEL], but each male chromosome contains two distinct genes [AMEL].Genetic material can be used to determine sex **(Abruzzese *et al*., 2015).**

- **Telomere Senescence**

Since then, age estimation based on information gained from teeth has received more attention in the field of forensic science. Telomere length and terminal restriction fragment length are used to estimate age. When dental pulp DNA is employed, the average TRF length shows a tendency to decrease with ageing. Telomere shortening, which is based on the DNA of the dental pulp, is a novel technique for figuring out the subject's age at death **(Naini *et al*., 2020).**

- **Aspartic acid is racemized**

The level of AAR was determined using gas chromatography, which is equivalent to the measurement of pentosidine.Twenty milligrammes of dentie were hydrolyzed in one millilitre of 6N HCL for six hours at 100 degrees before being dried in a dessicator overnight. A nitrogen stream was then used to dry the hydrolysates. One millilitre of isopropanal and 0.1 millilitres of sulfuric acid were used in the esterification process.Derivitization was used to isolate amino acids **(Takasaki *et al*., 2003).**

- **Levels of 14 C**

The amount of the carbon 14 isotope in enamel is measured and compared to the air's current levels using this procedure. Its is used to determine age **(Alkass *et al*., 2013).**

- **Removal of T-cell receptors in a circular fashion**

Specifically, the blood is used to detect DNA molecules that are created as a result of the rearrangement of T-lymphocyte DNA. T-lymphocytes have specific receptors known as T-cell TCR receptors that allow them to rearrange foreign antigens **(Greis *et al*., 2018).**

- **DNA Methylation**

Use this technique as a general reference for age estimation. Covalent nucleotides like cytosine and guanine, which are CPG dinucleotides, are changed when methyl groups are added to DNA. The term "DNA methylation" refers to this procedure **(Hartomo *et al*., 2019).**

Feasibility based on real-time application of advanced trends in odontological evidence analysis

- Integration of 3D imaging and analysis
- Big Data Analytics for pattern Recognition
- Gather Dental Records and Imaging Data
- Evaluate Hardware and Software Requirement
- Establish Direct Feeds from Dental Clinics
- Utilize AI Algorithms for Diagnosis and Prediction
- Continuously Review accuracy in analysis
- Adhere to medical and Dental Data Regulations as per AIIMS
- Handling Complex Algorithms and Processing
- Deviation from cost – effectiveness based evaluation **(Keizer-Nielsen *et al*., 1980).**

Application of dentistry in forensic odontology

- **Determination of species**

Unless only fragmentary evidence is found at the crime site, species identification is usually not difficult. Mandibular tooth fragments or at least a small piece on a single tooth no bigger than a few mililiters in size may be present. There has lately been evidence that dental fluids can store specific species information. utilising electrophoresis with countercurrent and artificial antisera. This technique can be used to identify species at least a year after a death **(Ehrlich *et al*., 2003).**

- **Age determination based on dental data**

Age estimation is the most important aspect of forensic odontology. Human dentition development proceeds according to established patterns. Radiography is a key component of methods for observing the many morphological stages of mineralization.

The same techniques are used to determine the stages of eruption, the mixing of primary and adult dentitions, and the extent to which root and crown structures are created **(Gustafson *et al*., 1950).** One may accurately estimate a child's age to within.1.6 years by looking at tooth development and then comparing the results to development charts. Both attrition and the development of third molars have been suggested as signs of ageing in people under the age of 18, but neither is reliable **(Ram *et al*., 2010).**

Adults can estimate their age by measuring the size of the pulp cavity and the development of their third tooth. The shrinking of the pulpcavity caused by the accumulation of secondary dentine with ageing can be measured using radiography to calculate an individual's age **(Douglas & Olshaker, 1995; Endris & Rolf, 1979; Borgula *et al*., 2003; Gatliff & Betty, 1984).**

- **Cone beam Computed tomography and x-ray**

Contrary to x-rays, which can only provide low-resolution, two-dimensional information, computed canal technology allows users to visualise the relationship between pulp and tooth volume in three dimensions. In a forensic scenario, the coronal pupl cavity ratio is a reliable biomarker for establishing age, especially when used to living people with unknown data **(Vandevoort *et al*., 2004).**

Bite Marks

Biting is typically a sign that the perpetrator wants to completely dominate the victim and is making an effort to make them look bad. The bite mark may appear as a result of a physical alteration in the medium caused by tooth contact or as a result of a pattern left by an animal's or person's dental structures in an object or tissue. The markings, which can be one or many in number, can vary in severity from a slight tearing of the tissue to a deep piercing of the epidermis.To avoid confusion and increase the reliability of bite mark analysis, the American Board of Forensic Odontologists has created guidelines for the collecting and preservation of bitemarks **(Lessig *et al*., 2003).**

Healing process

The healing of bite marks can be used to determine when the bite mark was inflicted in relation to the moment of death when strangulation results. The date the bitemark was sustained in relation to the murder can be determined by comparing its redness to the redness of the bruises on the victim's neck, which stop healing once they have passed away **(Verma *et al*., 2014).**

Radiographic examination

Dental models and radiographs are useful medical, legal, and record-keeping tools. The forensic odontologist meticulously charts, describes in writing the characteristics of the teeth, and takes radiographs to compile the post mortem records **(Ram *et al*., 2010).**

X-ray flouresence spectroscopy and scanning electron microscopy using energy dispersive X ray spectroscopy

Both x ray fluorescence spectroscopy and scanning electron microscopy with energy dispersive X ray spectroscopy use an energetic source to trigger the different X ray emissions. The radiation type used to trigger the emissions is the only difference between the two approaches.By measuring the energy emitted by x-ray peaks, spectroscopy helps to produce a spectrum that resembles the chemical fingerprints of the sample.Even in small amounts, XRF can detect these components. In addition to the dental records, a second aspect that enables the investigator to draw more exact conclusions is the brand of the restorative material **(Yang *et al*., 2006).**

Conclusion

In the last ten years, there have been major technological developments in the fields of 3D

imaging, automatic identification software with dental data feeds, and virtual autopsies for imaging processes, according to odontology investigations. These advancements not only improve identification accuracy but also expedite the criminal investigation process, which ultimately improves the effectiveness of forensic investigations by leading to more convictions for physical and sexual assaults after bite mark analysis and DNA validation from saliva traces in bite marks.

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