Importance of Dental Radiography in Forensic Odontology: A Review

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ABSTRACT

Introduction: Forensic odontology is an important and evolving branch. It has been established for critical issues like medicolegal cases and identification of a dead person. Radiographic assisted documentation will provide objective information including the precise recording of the uniqueness of every individual where it has been used extensively in dental identification based on anatomy and by comparing maxillofacial skeletal landmarks in antemortem and post mortem records.

Main body: Human Identification is mainly based on a dead body decomposition state. More likely of missing persons and the identification of individuals in conditions like criminal investigations and mass disasters. Odontological method for human identification is used commonly as it is simple by comparing with other methods, but complex in execution and requires skills and expertise. There are so many radiological techniques for forensic purposes like Computer tomography, cone-beam computer tomography, Orthopantomogram, 3D facial reconstruction, Radiovisiography, and Virtopsy.

Objectives: This review highlights the different radiographic techniques and procedures and its application in forensic odontology.

Source search criteria: Data were obtained and analyzed from previously published literature and electronic database searches of relevant published literature from PubMed and Google Scholarfrom the 2001 to 2021 year.

Conclusion: Imaging technologies and radiographs have become a vital component of modern medical practice and forensic odontology. The application of any of the mentioned techniques depends on the availability of previous images, data, or skeletal findings for Identification. So forensic radiology has a potential for crime-solving and is useful in conventional dental identification based on anatomy and by comparing maxillofacial skeletal landmarks in antemortem and post-mortem records, as they have become a crucial part of dental practice as well as in forensic odontology for diagnosis of disease, treatment planning, identification of tooth structures, and age estimation.

Keywords: Cone beam computer tomography, Computer Tomography, Dental Radiovisiography, orthopantomogram

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INTRODUCTION

Forensic odontology is an important and evolving branch. It has been established for critical issues like medicolegal cases and the identification of a dead person. In this branch radiographs are an implicit part of practice used mainly in identification and age estimation. Digital dental radiography, intraoral and extraoral, is evolving more popular in practice. It offers convenience, like lower exposure to radiation, simple storing of images, and elimination of chemical processing.

Dental radiographs form a significant part of the antemortem records of patients undergoing dental treatment. To the forensic odontologist, the radiograph reliable snapshot of part or all of the dentition at a point in time.[1] In recent times, the Odonatological method for human identification which is being used widely as it is simple by comparing with other methods, but complex in execution and requires skills. Human identification through dental remains is a well-established and reliable method.[2] Teeth are resistant to environmental factors like fire (up to 1600 degrees) and alkali.[3–5] Teeth provide important information in identifying a person, such as Odontometric (tooth form and size), metallic and non-metallic restorations, prosthetic placements etc., which are

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critical determinants of identity.

Forensic radiology is an essential branch of forensic medicine.[6–8] Radiographs preserve the details and provide objective data in the form of their unique dental- osseous details or specific dental restorations.[9] Human error can lead to inaccuracies in written records, but an image provides accurate information when compared to written records.[10]

It plays a key role in criminal investigations, which helps determine identity, evaluation of different injuries, several criminal and civil cases, using shapes and structure of restorations that are not visible at clinical examination. When the usual identification methods have failed and skeletal remains are only available for identification, virtual 3D facial reconstruction can be used as a useful tool for recognition.[11,12]

Till now obtaining data from a post mortem is mainly through Autopsy, a conventional procedure in post mortem examination involving dissection, interpretation, and cataloging, the forensic expert might need to reconsider his decision over previously gathered data, which may be difficult and not feasible to evaluate. To overcome this, a unique method is developed.

'VIRTOPSY' means virtual Autopsy or Touch-free Autopsy; it's a less invasive method. It is a multidisciplinary approach that mixes forensic pathology, radiology, image processing, physics, and biomechanics,[13,14] it's three processes.

1. 3D Surface scan using 3D photogrammetry–based optical surface scanner.

2. Post mortem computer tomography- guided biopsy

3. Post-mortem MRI

When compared to other techniques it is complicated and more sensitive non-invasive method, which facilitates the medicolegal process. This paper reviews the present contribution of postmortem dental radiography to forensic dental investigation, discussing its applications, equipment and techniques used and their relative advantages and drawbacks. It discusses the possible future developments within the sector of forensics.[1]

OBJECTIVES

This review highlights the different radiographic techniques and procedures and its application in forensic odontology.

Source search criteria:

Data were obtained and analyzed from previously published literature and electronic database searches of relevant published literature from PubMed and Google Scholar from the 2001 to 2021 year.

Recent advances:

3D scanners will become essential tools in the arsenal of forensic dentists. Majority of 3D scanners have standardized accuracy.[21] Limitation- It requires skill, and really expensive

DVI System International – Disaster victim identification system international is a software that operates on PC – windows are capable of managing within the identification of cases in mass disasters. It has two sets of data sheets: yellow for recording the most recent known data of the missing person and pink form for recording findings of the body. The yellow and pink forms have sections for recording the same kind of data. C form contains (clothing, jewelry, documents), D form contains physical characteristics and F form contains dental information. Advantage - Simultaneous display of comparable antemortem and postmortem in same window can be performed as an area of Microsoft Office Word Function.[22]

WinID3–WinID3 is a free computer-assisted dental identification application created by Dr. James McGivney WinID3 has been bridged with DEXIS, which can be a radiography application for the capture and management of dental radiographs and each one other photographic document. This permits WinID3 to combine dental charting with radiographic and photographic records for an integrated system of case review and comparison.[22]

Advantage- It has the ability not only to sort for requested identification of a person and may not eliminate identification changes that have occurred because of reasonable and explainable reason. As an example, if a victim's particular tooth isn't restored in ante mortem record and is restored in postmortem then it'll not be limited from consideration thanks to the time lapse that allow possibility that it could be restored later.

DISCUSSION

Technique	Description
Computed tomography[15,16]	**Forensic odontology-** 1. 3D reconstruction of teeth is possible. 2. Gunshots- To give the bullet's exact location and entry and exit of the wound. 3. In a drowning case, massive vital decompression with pulmonary barotrauma and a fatal gas embolism was identified in the radiological image.
	Advantages- 1. Assessment of bone width is possible with this technique
	Limitations- 1. Not fully developed for 3D virtual models. 2. Post mortem CT in cases of self- poisoning has little value. In stabbing cases- On post-mortem CT, it is not possible to correlate the width and length of the wound with the measurements of the weapon if the latter was withdrawn, but it is possible to locate a fragment of blade if it has been broken.
Cone beam computer tomography[17]	**Forensic odontology-** 1. Estimation of biological age in infants by using tooth development data. Superimposition of the skull on photography of missing boy for identification. Ante-mortem and Post-mortem skull reconstruction.
	Advantages- 1. Single tooth evaluation, detail panoramic image and skull volumes can be obtained precisely
	Limitations- 1. Metal alloy artifacts are commonly encountered with this technique.
Orthopantomogram[17–19]	**Forensic odontology-** 1. Individual identification- Using antemortem and postmortem OPG radiographic data 2. Age of an unknown immature or young adult upto 22 years can be reliably estimated from the dentition and its eruption sequence.
	Advantages- 1. Usual dental identification can be done with this technique

	Limitations- 1. Being a 2D plain image we cannot correlate with all aspects as we do in 3-dimensional. 2. Distortion of teeth, magnification of the image and overlapping of teeth can occur.	
Radiovisiog-raphy (RVG)[17]	**Forensic odontology-** 1. Individual identification- Using antemortem and post-mortem radiographic data. Example- shape, size and placement of restoration.	
	Advantages- 1. The radiation exposure is comparatively less.	
	Limitations- 1. With this technique only a small area is covered, so for large areas to be examined it is not of much use. 2. Incorrect vertical and horizontal angulation of sensor results in reverse image.	
Virtual 3D facial recon-struction[11,20]	**Forensic odontology-** 1. 3D facial reconstruction with skeletal findings by using software (reconstruction software Autodesk 123D version 4.2) with possible levels of accuracy for comparing with the ante-mortem image. 2. Human identification by facial comparison after reconstruction. Extended DNA can be tested to confirm identification by using its structure.	
	Advantages- 1. Individual identification can be made in case of any mass disasters by using the reconstruction method.	
	Limitations- 1. It is possible only when a supportive structure for facial reconstruction is present.	
Virtopsy[13,14]	Forensic odontology 1. Estimating the time of death and also can appreciate the changes in multislice computer tomography and MRI in case of head injuries. 2. Identification of missing individuals using antemortem CT scan by comparing multiple cranium landmarks and images with corresponding features. 3. Toxicological examination- It is used as a tool to determine the death of a person in case of drug abuse. 4. Hanging- Neck findings can be compared with those discovered during forensic autopsy. 5. Death due to burns- By MSCT and MRI made possible by forensic relevant vital reactions (air embolism, blood aspiration). 6. Age and sex determination- Mainly done on sexually dimorphic bones by measuring bone structures pelvic bone. 7. Drowning deaths- Radiological images show the vital with pulmonary barotrauma, lethal gas embolism	

	Advantages- 1. Accuracy of this technique is very high 2. Minimal risk of infection. 3. 3D analysis can be made with this technique. 4. Digital storage of data and re-examination can be done at any time with this technique. 5. With the help of this technique, after analysis, we can match the probable weapon. 6. Accurate interpretation of fractures and pathologies can be made by this technique.
	Limitations- **1.** It is very expensive compared to the other techniques. 2. Artefacts are very difficult to identify in this technique. 3. Very fine surface details cannot be studied with this technique. 4. Odor and color changes on the skin at the time of arrival cannot be recorded. 5. We cannot experience the Touch, feel and smell senses while examining because it is not done by manual.

Conclusion

Imaging technologies and radiographs have become a vital component of modern medical practice. They significantly contribute to decision-making situations in forensic medicine and which is beyond a reasonable doubt. However, applying any of the mentioned techniques depend on the availability of previous images, data or skeletal findings for identification. So, the radiographic images and data acquired during treatments must be recorded by health care professionals. Forensic radiology is a specialized aspect and is a potential crime solving technique that can be used beneficially.

Abbreviations

CT- Computer Tomography
OPG-Orthopantomogram
MRI- Magnetic resonance image
MSCT- Multislice computer tomography
CBCT-Cone beam computer tomography

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