Review Article

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Maxillofacial Radiology: A Boon for Forensic Dentistry

Akhilanand Chaurasia*, Divayjeet Goel**

*Assistant Professor, **Junior Resident, Department of Oral medicine & Radiology, Faculty of Dental Sciences, King George Medical University, Lucknow-226003, Uttar-Pradesh (India).

Abstract

Forensic dentistry is the application of dental knowledge to those criminal and civil laws that are enforced by police agencies in a criminal justice system however Forensic maxillofacial radiology is a specialized area of maxillofacial imaging which utilizes various radiological techniques to assist forensic odontologists in issues related to law enforcements. The major role played by maxillofacial radiology is related to identification of an individual engaged in criminal activities or during mass disasters by matching the ante mortem and postmortem records. The second most significant role is, in age estimation of an individual by various radiographs and radiographic techniques. Thus maxillofacial radiology can be called as backbone of forensic dentistry.

Keywords: Forensic Dentistry; Radiology; Age Identification; Dental Jurisprudence**.**

Introduction

Forensic Odontology is a legal branch of dentistry which is concerned with dental evidence investigation, proper handling, precise evaluation and presentation of dental findings in the interest of justice [1]. However forensic maxillofacial radiology; is a specialized area of maxillofacial imaging utilizing various radiological techniques to assist forensic odontologists in issues related to law enforcements. The use of maxillofacial radiographs in identification of individuals in mass disaster and in routine has been recognized since long time. The identification by maxillofacial radiographs is relatively swift, easy and efficient [2]. In 1921 Schullerin first proposed the comparative identification of the radiological images of the frontal sinuses with formerly taken radiographs however in 1927 Culbert and Lawin were the first to describe the complete radiological identification of the skull by using pneumatic cells of the sinuses [3]. Currently maxillofacial radiology can be utilized in two ways in forensic dentistry, comparative type identification or reconstructive type identification [4]. The comparative type maxillofacial radiology identification compares radiographs exposed prior to death (antemortem) to those exposed after death (postmortem) however Reconstructive maxillofacial radiology identification uses radiographs as an aid in the generation of a biological profile of an individual whose identity remains unknown [4]. Thus maxillofacial radiology plays a key role in forensic dentistry.

Corresponding author: Dr. Akhilanand Chaurasia, Assistant Professor, Department of Oral medicine & Radiology, Faculty of Dental Sciences, King George Medical University, Lucknow-226003, Uttar-Pradesh (India).

E-mail: ChaurasiaAkhilanand49@gmail.com

Discussion

The contribution of maxillofacial radiology is very important in identification cases, mass disasters and age estimation cases [5]. Radiographs have another superb advantage that they are accepted in courts of law as legal evidence in all countries of world irrespective of languages and different classification

systems [6]. The radiographs have wide range of information such as anatomical structures, bone patterns, bone pathology, teeth and pulp morphology, root number and form, retained roots, impacted teeth, the type, extent and position of fillings, the type of prosthetic restorations, endodontic treatments**,** the placement of retention pins and posts, the placement and type of implants and the placement of osteo-synthesis plates [7]. The forensic odontologist takes intra-oral radiographs of tooth bearing sites and edentulous areas to screen for the possibility of un-erupted teeth and retained roots and to view the anatomic structures [8]. The identification in forensic dentistry is based on the comparison of ante mortem and postmortem observations with resultant matching or exclusion [9]. The comparative identification use radiographic evidence for restorations, root fillings, crowns and extractions as key points of identification. Despite relying solely on dental anatomical findings it is possible to match ante mortem to post mortem radiographic examinations using the spatial relationships of the posterior teeth one to another [10]. Bowers and Johansen reported that digital resize of ante mortem and postmortem radiographs enables the investigator to accurately measure and superimpose static physical dental features especially when root shape is the only common reference between the postmortem and ante mortem evidence [11]. Balagopal S while conducting a study on simulated ante mortem and postmortem intraoral periapical radiograph concluded that examiners who were inexperienced in forensic identification showed acceptable sensitivity, specificity and accuracy of 0.877,0.734 and 0.816 respectively. He further concluded that intraoral periapical radiograph can be used as a good tool for individual identification [12]. Fitzpatrick et al reported that digital enhancement techniques allowed us to identify human remains in cases that would otherwise have been unrecognizable [13]. During post-mortem intraoral radiography the major concern is placement and retention of radiographic films in the mouth due to rigor mortis. The problem of film placement and retention of radiographic films in rigor mortis is overcome by use of balloon catheters which can be inflated within the oral cavity. These catheters will hold the radiographic film in position during exposure [14]. The exposure parameters are second most challenging aspect of maxillofacial imaging in post mortem cases. Exposure parameters are reduced in postmortem cases where decomposition of soft tissue is detected [15].

The maxillofacial imaging procedure can be summarized as follows:

Examination of the ante mortem radiographs for quality, type and time of examination

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Examine the postmortem specimen

↓

Analysis of the radiographs, taking into account ancillary information such as dental chart notations, dental models and photographs

↓

Tabulation of the points of concordance and discordant points

↓

Decision to be reached as to whether the materials provided allow the observer to make a positive identification, a possible identification or a negative assessment [2].

New advancements in maxillofacial radiology pertaining to forensic dentistry

There are several imaging modalities which have been developed from time to time. The first in these modalities are transportable multi-slice CT which performs postmortem dental scans in a short time as well the processing software allows comparison of every possible ante mortem dental radiograph for the purpose of identification [16]. Dental biometrics is another new innovation which utilizes dental radiographs for human identification. This system matches dental radiographs in two stages. The first stage is called extraction which uses anisotropic diffusion to improve the images and a mixture of Gaussian's model to segment the dental work. The second stage termed as matching involves tooth level matching, computation of image distances and subject identification. By using these two steps a comparison of the ante mortem and post mortem radiographs is carried out [17]. The Virtopsy (virtual autopsy) is another new technique which involves

radiological determination of manner of death in medico-legal cases by using multi slicing computed tomography, magnetic resonance imaging and ultrasonography [18]. In a recent study done on publication trends of a forensic odontology journal from India, regarding the relationship of forensic odontology with various dental specialties, the maximum numbers of published articles were related to oral medicine and radiology followed by oral pathology and microbiology, prosthodontics, orthodontics and community dentistry [19].

Radiological methods for age determination

The radiographic age determination is done by two methods. First is 'atlas method' in which radiographic dental development is observed with published standards and the second is "Scoring method" in which dental development is divided into different chronological stages that are then allotted the scores and area assessed through statistical analysis [20]. Kvaal et al and Solheim advocated the radiological methods of age estimation using periapical radiographs and orthopantomograms both conventional and digital versions and also volume rendering CT and CBCT imaging. The basis for this is the gradual reduction in the pulp volume due to secondary dentin deposition with age and can be performed on both living and deceased individuals [21]. Other methods used in age determination are Demirjian method [22], Nolla [23], Cameriere's [24].

Conclusion

Maxillofacial radiology is an integral part of diagnosis process but utilizing it for forensic identification is an adjunct which cross language nations barrier. Basic principles lies in comparing of ante-mortem and postmortem radiographs and finding out similar features based on tooth, bone, root, crown, restorations and prosthesis. With recent advances in maxillofacial radiology and increasing numbers of crime war mass casualties further boosts the need that field of forensic dentistry will heavily depend upon radiological analysis for identification in disputed legal matters.

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