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REVIEW

The Role of Radiography in Forensic Dental Practice

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ABSTRACT:

Identification of the deceased is important for social and legal framework. One can make out the identity through the evidences available from the corpse or utilize methods to make the best use of the biologic features unique to that individual. Traditionally finger-print method is the most acceptable method of identification. However, because of difficulty in retrieving these records as they are not readily available or destroyed in case of disasters the utility of this evidence is minimal in forensic practice. Under these circumstances, identification utilizing dental evidence is scientific and comparable utilizing stored records. In many ways, these evidences could be preserved as they could be stored in the form of radiographic records. Radiographs preserve the details and provide objective data in the form of its unique dento-osseous anatomy or specific dental restorations. This paper highlights the inevibility and inimitability radiographic evidence in the field of forensic dental science.

Key words: ***Dental radiographs and Forensic science***

INTRODUCTION:

Post-mortem identification is an integral component of forensic science as the identity of an individual is important both for medico-legal and humanitarian reasons. Common methods used for the identification of the deceased include the visual, personnel and scientific approaches. The scientific method is the most appropriate as it is reliable, valid and less error-prone. Conventionally, finger-prints, palm-prints, foot—prints are some of the science based forensic approaches. However, these methods rely largely on the preservation of soft-tissue components of the body in question. Regretfully, it can't be used if the remains are most burnt, decomposed, skeletonized, mutilated and destroyed. [1]

Dental identification is the preferred scientific approach wherein the variation of teeth, jaw bones and sinuses could be exploited to its best use. Since teeth and bones being are resilient, they are able to withstand decompositional/destructional forces well. In addition to this preservation of this in the form of pre-existing record or odontogram makes it well-suited for identification. As radiographs will be able

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to capture these distinct anatomical features, medical and dental radiological methods are invaluable in forensic sciences. Radiographic-assisted identification will provide objective information including the precise recording of uniqueness of every individual. [2] Radiographic identification of the deceased in the unlikely event of an unexpected as in mass disaster is routinely practiced. This article is aimed to highlight the overall scope of oral/dental radiology in forensic sciences.

The purview of dental radiographs in forensic sciences is (Figure1) for the identification, bite mark analysis, evaluation of death and injury, criminal and civil litigation and research.

Identification

Identification includes not only detection of unknown human remains but also determination of age, race or gender discrimination or sometimes socio-economic status.

Age determination:

Determination of age at the time of death is an important step towards identification of unknown remains. During life, bone tissue develops from ossification which is a continuous process. This development can be followed—up and studied by radiological method in order to establish the chronology. Sassuoni (1958) has reported numerous methods for age estimation based on chronology of 3rd molar eruption, dentition development and sutures. Other parameters that can be included for age estimation through the teeth evaluation are as follows: deciduous eruption, crown and root mineralization, tooth/ pulp chamber area ratio and dental erosion.[3]

It a well-known fact that by analyzing the developmental stages of primary/permanent teeth radiographs observed on panoramic radiograph and then classifying according to the table of dental mineralization chronology can be used to estimate the age in children. On the other hand, age estimation in adult individuals can be achieved by radiological determination of the reduction in pulp cavity size resulting from secondary dentine deposition which is proportional to the age of an individual. There are dozens of published papers on age determination using this methods.[4]

Gender Identification:

Gender is not determinable from dental radiographs although postero-anterior (PA) view has been used. Nortjie and Harris used PA view to measure total cranio-facial height, mastoid height, bicondylar width and mandibular width resulted correct sex identification with an accuracy of 88%.[2]

Racial determination:

Though not feasible in whole population except in rare instances. Shovel-shaped maxillary incisors are visualized radiographically and can be seen in 90% of Asians & Native Americans. Absence of radiographic shoveling can't be used to exclude Mongolism. Another trait of Mongolic populations is an extra-root on mandibular molars. Caucasians commonly have cusp of Carabelli which is an accessory cusp found on the mesio-lingual cusp of maxillary first molar.[5]

Socio-economic Status determination:

The importance of dental care can be co-related by/reflected on the social status. Severe active dental caries without any dental intervention suggests lower socio-economic status while crown, bridges or RC fillings are of well cared dentitions. All four premolars are missing and closed spaces are suggestive of previous orthodontic treatment. Such a clue might focus an inquiry of area orthodontist in the search of ante-mortem dental records.[5]

Human Identification:

The first recorded use of radiographic technique in the identification was by Schuller in 1921. The subjective records consists of written notation can include error and less specific as other people can have similar findings. A radiographic interpretation of that filling will show its precise contour as no two

dentist hand work can be same. In the absence of restoration/teeth, radiographs are especially important as they are apt to show distinctive anatomy. Radiographically assisted dental identification may be comparative or reconstructive type. In comparative identification ante-mortem records are compared to that of suspected post-mortem record. A record of recovered ante-mortem radiograph that can be bitewing or IOPA (Intra-oral peri-apical) or panaoramic radiograph spanning many years and the latest films are chosen to compare among that. The post-mortem films should reproduce the angulations of ante-mortem films to duplicate the same results.[6]

Anatomical details adopted as parameter include: number/arrangement of teeth (present/missing/rotated/impacted/extra teeth), shape of teeth-crown and roots, anatomic landmarks, nutrient canals, sinuses, caries or periodontal pathology, dental restoration, endodontic treatment, intra- & inter-coronal posts. Many studies also highlight the use of: trabecular bone pattern, cephalometry analysis or frontal sinus pattern.

The facial bones are difficult to use for radiological identification because of their innate complexity and the large number of overlapping structures. Frontal sinus grows only after puberty and stabilizes by the age 20. The frontal sinus configuration is peculiar to each individual and also commonly exposed in sinus series investigation. The view commonly used to demonstrate it is O-M/Water's view which provides excellent depiction. Seven parameters: septum, scalloping of the superior border, partial septum, ethmoid & supra-orbital extensions, height, breadth and midline are compared on post-mortem & ante-mortem radiographic images. Identification by frontal sinus pattern is a well-established pattern.[7&8] Many authorities have undertaken it as an identification tool and have found that it has been useful. However, frontal sinuses are absent only in 10% of population. [9-11]

In mass disaster victim identification (DVI):

In mass casualty incidents involving multiple bodies, radiographs often made on location. A tripod-mounted portable dental X-ray unit such as Min-X-Ray® is used. All bodies and recovered dental fragments are X-rayed where in full mouth radiograph is preferred. Through computer, images can be electronically digitize and export the images for rapid comparison. Digital radiography provides objective data thus permitting accurate and legally acceptable identification.[12]

Bite-marks analysis

The most challenging area of forensic odontology is the analysis of bite marks which are considered to be the examples of physical and biological evidence that could be the part of/in response to the defensive/offensive behavior. Methods to analyze bite marks involve detailed clinical examination, measurement and comparison of evidence from the victim and the suspect. Several comparison techniques including freehand tracing of the bite mark, photocopied acetate overlays of suspect's teeth, test bites in wax or radiographic/scan images or the combination of these methods.[13] A technique referred as toneline photography (also known as line prints) uses radiographic image of metal models of the suspect's teeth to produce clear acetate films with life-sized image of incisal edges.[14] The photographic and radiographic approaches produce consistent, reproducible and accurate images. It is a relatively easy, inexpensive and is considered to be valuable method.

Evaluation of death and cranial injury

Radiology is used to demonstrate fractures as osseous skeleton is the prime target of forensic radiological evaluation. Post-mortem radiography of skull is difficult to perform because of anatomical superimposition. Modified Parma radiographs can provide excellent view of calvaria fractures in which collimator of dental unit is removed and exit port of dental X-ray unit is placed on the contra-lateral side of the fractures.[15]

Criminal/Civil litigation

Tsang *et al* (1999) reported in his study that digital manipulation of radiographs to produce disease even in the absence of disease originally to mislead is very successful. In the western countries, there is an increasing number of patients who sure their dentist for actual/perceived negligence.[16] The written record, radiographs or other objective data (models/photographs) can be used. If radiographs are used as evidence, then the radiologist may be called as an expert/ordinary witness in cases dealing with professional liability or malpractice to obtain the opinion.

Research

As technical advances have appeared in radiology and other medical branches, they have been embraced and modified by the forensic science community. Facial re-construction is one such technique that allows human skeletal remains to build a facial image of target individual. It is based on database of facial soft —tissue thickness. This is considered when no other putative identification or ante-mortem records are available or when body is skeletonized or missing for a long time. Clinical or radiological examinations aid in recreating an individual's profile prior to death. Oral radiological examination aids in reconstructive identification by two means. The first is to assess and define the angulation of anterior teeth that have been lost post-mortem. The second is to examine re-assembled macerated remains prior to facial approximation exercises. It is important to have information on the state of dentition and the alignment of anterior teeth for facial approximation. Radiographic examination of dental socket in 2-Dimensions (A-P and occlusally) affords the number and alignment of teeth, periodontal or peri-apical condition that can make approximation more accurate. Forensic odontologist should be consulted whenever macerated skull requires re-assembly.[17]

Like any other techniques even radiography has some pitfalls. In age determination of an adult who is claiming to be juvenile, exact calculation will not be possible. For most of investigation, panaromic view is taken which is not a plane radiograph rather a tomograph so anything placed outside the focal trough will appear blurred. Teeth placed outside or even slight bucco-lingual tipping will give misconceptions. Degree of overlapping of soft and hard tissues can also influence the pulpal width-tooth height ratio. Even inconsistencies can be produced if there is a gap between ante-mortem and post mortem image. During mixed dentition period, radiograph taken say after 6 months can't be recognized even if it is of same individual. Position of X-ray tube can influence trabecular pattern, root length etc. Objects like non metallic restoration, fractures, defects, artifacts etc — all will appear RL which will be difficult to distinguish but important.

Conclusion

Even though radiographs give 2-D view of 3-D objects but still can be utilized as a vital aid in forensic sciences. There are numerous radiographic techniques especially with the refinement of technical and adoption of new technologies; radiographic image can prove as an essential tool in the field of forensic medicine. Definitely applications of it depend upon the availability of previous records for comparison. Thus, it is the duty of the dentist to maintain these records well so that it can be used as good diagnostic tool whenever required.

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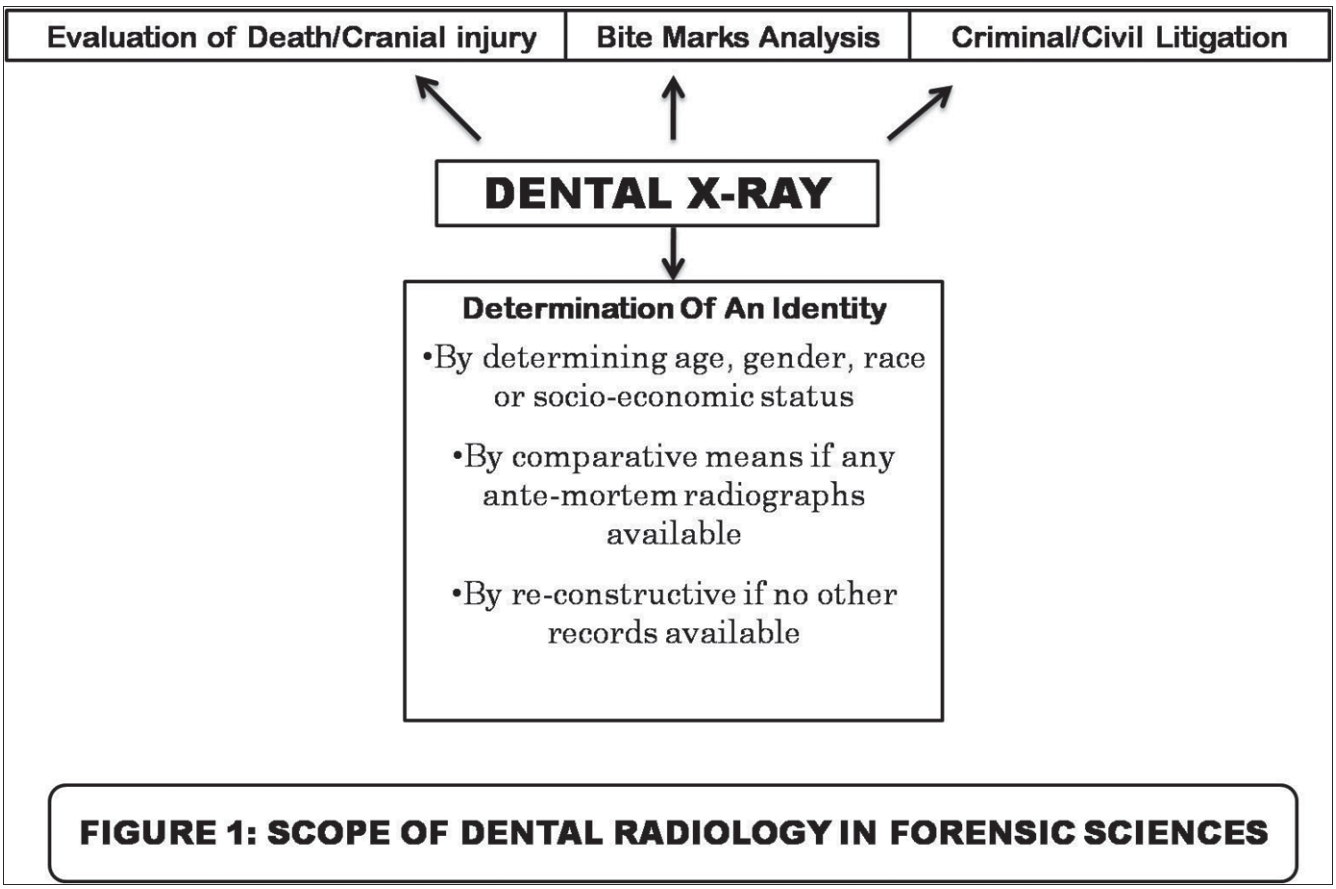

FIGURE 1: SCOPE OF DENTAL RADIOLOGY IN FORENSIC SCIENCES