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Maxillofacial radiology in Forensic Science

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ABSTRACT

Forensic maxillofacial radiology is a specialized area of medical imaging utilizing radiological techniques to assist physicians and pathologists in matters pertaining to the law. Radiology has been used extensively in conventional dental identification, anatomically based identification and identification using maxillofacial skeletal landmarks such as the frontal sinus. The purpose of this paper was to revisit the role of dentomaxillofacial radiography in forensic science where radiographic methods may be used to determine identity using the teeth, root structures and frontal sinuses. Newer modalities, such as com¬puted tomography (CT) and magnetic resonance imaging (MRI) are gradually being added to the forensic arsenal.

Keywords: Forensic, maxillofacial,radiographs,reconstruction

INTRODUCTION

Forensic maxillofacial radiology is a specialized area of medical imaging utilizing radiological techniques to assist physicians and pathologists in matters pertaining to the law.The importance of maxillofacial radiographic techniques in clinical forensic medicine is widely recognized. The multidisciplinary nature of forensic science necessitates a team approach that includes forensic radiology and forensic odontology and an awareness of the role of the dentist in our criminal justice system.

Forensic maxillofacial radiology encompasses the per¬formance, interpretation, and reporting of radiological examinations and procedures connected to the courts and the law. Expertise of the maxillofacial radiologist proves invaluable in forensic consultations and medico legal investigations. Use of radiographs in routine and mass disaster identification has long been in effect, & its application in necro identification is efficient, swift, and relatively easy1.

Until recently, forensic maxillofacial radiology depended almost exclusively on the x-ray and the static image captured on the radiograph. The newer modalities, such as com¬puted tomography (CT) and magnetic resonance imaging (MRI) are only gradually being added to the forensic arsenal.

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Dental Identification

Dental identification through visual method was used prior to Roentgen's discovery of X-rays on November 8, 1895. Within a few days of discovery, radiographically assisted dental identification was carried out. The modern use of maxillofacial radiology may be comparative or reconstructive in type2. The former ''compares'' radiographs exposed prior to death to those exposed after death. Reconstructive identification may use radiographs as an aid in the generation of a biological profile of a person for whom the putative identity remains unknown. Comparative identification utilizing dental radiographs is now common in the evaluation of human remains. When the identity is suspected, and comparative means of identification are contemplated, the basic algorithm for dental radiographic identification is:

1. Examining the ante mortem radiographs for quality, type and time of examination.

2. Examining the post mortem specimen and expose radiographs that will duplicate the areas of interest seen in the ante mortem films using similar image geometry, suitable exposure factors and archival processing

3. Using a system of marking or mounting the films so that their identity as post mortem or ante mortem films is known

4. Visually analyzing the radiographs, taking into account ancillary information such as dental chart notations, dental models and photographs

5. Tabulating the points of concordance and explain, if possible, discordant points between the ante mortem and post mortem radiographic examinations

6. Making a decision as to whether the materials provided allow the observer to make a positive identification, a possible identification or a negative assessment.

Most cases of comparative identification use radiographic evidence of dental intervention (restorations, root fillings, crowns, extractions, etc) as common points of identification. In the absence of dental radiographs, dental charts may be used. Positive body identification may be ascertained via visual means, fingerprint records, dental charts, radiographs, and study models3. In the Western world, water fluoridation and improved dental care have resulted in a decrease in dental caries 4. Studies have indicated that pre-eruption exposure was required for a caries-preventive effect and that exposure after eruption alone did not lower caries levels significantly. The results supported water fluoridation as a public health measure in view of the need for continuous exposure for the maximum benefit. This decrease is associated with a concomitant decrease in the number of restorative interventions.

Dental materials and restorations have provided clues to assist identification. Teeth and dental restorations are resistant to destruction by fire and the elements and are, therefore, useful in identification. Many features of the teeth and numerous characteristics of dental treatment are quite unique. This permits accurate and legally acceptable identification of the remains

Anatomic Identification

If there is no evidence of dental intervention then the forensic odontologist must rely on the anatomical structures common between ante mortem and post mortem radiographic examinations. Such anatomical features might include crown morphology, root shape, size and curvatures, pulpal morphology, and the spatial relationship between the teeth. Aside from relying on solitary dental anatomical observations it is possible to match ante mortem to post mortem radiographic examinations using the spatial relationships of the posterior teeth one to another5. This concept relies upon the alignment of radio graphically visible anatomical structures one to another. It requires no information from the crowns of the teeth, so it is also useful in macerated and partially incinerated remains where the clinical crowns may be damaged or lost. This often occurs in cases of found human remains where the body has been skeletonised or missing for long periods of time.

Facial bones are more difficult to use for radiological body identification because of their innate anatomical complexity, the comparative rarity of ante mortem radiographic radiographs

and the large number of overlapping structures in the radiographic projections of these structures. One maxillofacial anatomical structure that is amenable to comparison between ante mortem and post mortem radiographs is the frontal sinus8. It may be used because it is commonly exposed in ''sinus series'' investigations. The view used to demonstrate it, ''Waters'' view provides an excellent radiographic depiction of it 9.

Dental Profiling

Clinical and radiographic examinations can help to recreate a profile of the individual prior to death. Other means by which oral radiological examination may aid in reconstructive identification are to assess and define the angulation of anterior teeth that have been lost post mortem. The other is to examine re-assembled macerated remains before facial approximation exercises. Radiographic examination of the dental sockets of anterior teeth in two dimensions (antero-posteriorly and occlusally) affords the reconstructive dentist or facial approximation scientist information as to the number and alignment of anterior teeth.7

Medico-Legal Cases

Forensic maxillofacial radiology plays a crucial role in medico-legal cases where it helps in identifying the suspect whether he is a juvenile or an adult 13. Dental radiography as objective evidence provides an invaluable means of person identification in mass casualty incidents. Dental identifications continue to be a rapid and accurate means of establishing identity in such situations 14. A new hand-held battery-operated portable X-ray system (NOMAD,TM) has been tested for possible leakage radiation through the existing heavy metal compounds surrounding the X-ray tube, backscatter radiation through the lead-filled acrylic shield attached at the end of the exit tube and patient exposure 15. Results have shown that the NOMAD presents risks that are no greater than with standard dental radiographic units to the patient or operator and the measured doses are well below recommended levels, so it is used in mass casualty incidents.

Another vital aspect of forensic maxillofacial radiology is to evaluate injuries sustained by the deceased or the factors that resulted in death. This evaluation leads to a determination of whether the death was accidental or intentional. The arrangement and direction of skull fractures can indicate the point of impact and the direction of impact. Occasionally, the radiograph can suggest a sequence of repetitive blows and at times the shape of the object or weapon that inflicted the injury. Strangulation is indicated by fractures of the hyoid bone or thyroid cornua. Further many diseases such as metabolic abnormalities, infections and dietary deficiencies may leave signs on the skeleton that can be appreciated radiographically. Computer assisted tomography & Micro-computed tomography can be used in the assessment of the degree of fit of a weapon to a wound in cases of blunt force skull injury and sharp force injury cases respectively10 .

Age Determination

It is well recognized that in the sub-adult estimation of the age of subject, deceased or not may be attempted by examination of the maturation of the primary and permanent dentition11. The goal of age determination in found human remains is to assist in the development of the biological profile of the deceased. If radiological examination demonstrates incomplete formation of the permanent dentition then the forensic odontologist can assist the investigation by narrowing down the population age group to which the deceased belonged.

Racial Distinction

Using skeletal remains to determine a person's race is a difficult task, as no single trait is racially distinct. It may, however, be possible to assign a skeleton to one of three racial groups: Caucasoid, Negroid, or Mongoloid. Caucasians tend to have high, rounded, or square skulls with a straight face and a narrow nose. Negroid skulls are lower and narrower with wider, flatter noses. Monogoloids have broad, round skulls with an arched profile. Eye sockets can be distinctive as well; Caucasians' are triangular, Negroids' more squared, and those of Mongoloids tend to be rounded12. If someone is of mixed racial origin, they will have a blend of these features making determination of race extremely difficult.

Socio-Economic Status

Quantity and presence or absence of dental treatment may give an indication of socio-

economic status of the individual. The quantity, quality, presence or absence of dental treatment may give an indication of socio-economic status or likely country of residence. For example, dental treatment of high quality may be consistent with North American and European standards, unusual dental treatment involving the use of permanent acrylic and stainless steel crowns may be consistent with developing countries like Russia13.

Cranio-Facial Reconstruction

Cranio-Facial Reconstruction (CFR) is founded on the science of forensic dentistry, medicine, anthropology and anatomy. Most agencies consider reconstructive identification only when there are no putative identification or ante mortem records available6. Sometimes, the two basic identification procedures (teeth and fingerprints) are often insufficient for the identification of exhumed victims of war. The results also stress the importance of the inclusion of trained forensic odonto- stomatologists in the team for identifications after mass disasters such as wars16. CFR is widely used in the identification of an unknown body. The progress in computer science and the improvement of medical imaging technologies during recent years has significant repercussions on this domain17. Rapid technical advances have occurred in radiology in recent years. Usefulness of MRI and CT in forensic radiology has been well demonstrated.

CONCLUSION

Thus the maxillofacial radiologist is an essential member of the forensic team. Medical practitioners should be aware of the importance of storing radiographs for prolonged periods of time and of efficient record keeping methods because of various legal problems that might arise requiring the films for later interpretation or for their presentation in court. Careful record keeping in medical facilities and in private practices is extremely important. In most countries (unlike developing countries), radiographs pertaining to inactive patients' files are stored for at least five years. Radiographs can also be given to the patient for safekeeping, thus releasing the medical department from any legal responsibility in case of loss18. All states should enact laws that govern the retention of radiographs and other medical and dental records. The time period should vary between five and thirty years after patient discharge or last treatment.

Each practitioner has a responsibility to understand the forensic implications associated with practice of his or her profession. Appreciation of forensic dental problems involving body identification permits clinicians to maintain legally acceptable records & assist legal authorities in the identification of victims of multiple fatality incidents and crimes. The reliance of legal community on the dental profession to continue to provide expertise in civil & criminal proceedings ensures that forensic dentistry will remain a viable component of forensic sciences and the practice of dentistry.

REFERENCES

1. Wood RE. Forensic aspects of maxillofacial radiology. Forensic Science International. 2006;159: S47–S55.

2. Kahana T, Jehuda H. Forensic Pathology Reviews. Forensic Radiology 2005; 3(10): 443-460.

3. Vincent MF. Charts, Radiographs, Study Models: A Forensic Trilogy. Office of the Chief Medical Examiner, New York City, New York, USA Dent Today. 25: 100-1.

4. Singh KA, Spencer AJ. Relative effects of pre- and post-eruption water fluoride on caries experience by surface type of permanent first molars. Commun. Dent. Oral Epidemiol. 2004; 32: 435–446.

5. Wood RE, Kirk NJ, Sweet DJ. Digital dental radiographic identification in the pediatric, mixed and permanent dentitions. J Forensic Sci. 1999; 44: 910–916.

6. Gamal F, Nasar D, Chen H et al. Toward an Automated Dental Identification system. Journal of Electronic Imaging. 2005; 14(4): 043-018.

7. Brkik H, Slaus M, Keros J. Dental evidence of exhumed human remains from the 1991 war in Croatia, Coll. Anthropol. 2004; 2(6): 259–266.

8. Kirk NJ, Wood RE, Goldstein M. Skeletal identification using the frontal sinus region: a retrospective study of 39 cases. Journal of Forensic Science. 2002; 47(2): 318-23.

9. Rhonan F, Rodrigo NP, Geovane MF. Importance of frontal sinus radiographs for human identification. 2008; 74(5): 798.

10. Lois R. Forensic Radiology. Cewebsource. com, Continuing Education Inc. (ECEI) 1938.

11. Soomer H, Ranta H, Lincoln MJ. Reliability and validity of eight dental age estimation methods for adults. J. Forensic Sci. 2003; 48: 149–152.

12. SteynM, Iscan M Y .Sexual dimorphism in the crania and mandibles of South African Whites. Forensic Sci International. 1998; 98: 9-16.

13. Pretty IA, Sweet. A look at forensic dentistry-The role of teeth in the determination of human identity. British Dental Journal. 2001; 190(4): 359-366.

14. BrkikH , Slaus M, Keros V. Dental identification of war victims from Petrinja in Croatia. Int J Legal Med. 1997; 110: 47–51.

15. Goren Ad, Bonvento M, Biernack J. The British Institute of Radiology, technical report, radiation exposure with the nomadtm portable x-ray system. Dentomaxillofacial Radiology. 2008; 37: 109–112.

16. Anand SC, Balwant R. The Internet Journal of Forensic Science ISSN: 1540-2622, Role of Forensic Odontology in Tsunami Disasters.

17. Jiang L, Yaolei L, Lewei Y et al. Proceedings of the 9th WSEAS Int. Conference on applied computer and applied computational science, computer-aided craniofacial reconstruction. Electrical and Computer Engineering series (Reference books and Textbooks), WSEAS Press. ISSN 1790-5117.

18. Kahana T, Almog J, Shmeltzer E et al. Forensic Radiology. British Journal of Radiology. 1999; 72: 129-133.