Radiology - A Specific Tool in Identification A Review

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Abstract

Now a days in Forensics, Radiology or Imaging plays a major role in identification of criminal and civil proceedings. Why Radiology here means, it is making bit sensible that to analyze the bony structures like skeletal remains and other body parts. The main aim of the manuscript is to unite the two disciplines in one part majorly "Radiology and Forensics". The forensic application of diagnostic medical radiology can be applied in many fields; the prime target of evaluation is the osseous skeleton, but soft tissues which may offer several key findings. Essential, methods consist of radiological methods such as conventional radiography, computed tomography, and magnetic resonance imaging, but other techniques such as 2D and 3D surface scanning along with printing are also employed.

***Key Words**: Radiology, Forensics, Investigations, Identification*

Introduction

Forensic science deals with the identification of the dead using numerous techniques. Forensic odontology has a lot of scope in human identification. Methods like Rugoscopy, Bite marks, Photographs, Lip prints, Age Estimation and Sex Determination etc. are used for identifying the individuals.[1] Due to the increased use of imaging for forensic purposes as well as the establishment of specific research projects, the number of published studies in this field has increased rapidly in recent years. This new domain of research is interesting to radiologists as well as to forensic pathologists; radiologists have been involved in most forensic imaging projects from the beginning, underscoring the field's integration of two distinct medical specialties. While radiologists read the obtained images, forensic pathologists focus on findings important for medico-legal reconstructions, which are not necessarily important from a clinical point of view. Pathologists are also able to explain certain phenomena visible on images due to their knowledge of thanatology. There was much speculation about the role of these methods and their relationship to forensic autopsy. Unclear study designs and unscientific terms were often used, leading to unsupported conclusions that were questioned. Confusion was further increased by the use of undefined or unclear terms such as "necro-radiology", "forensic radiology", "virtual autopsy", and "minimally invasive autopsy", which were rarely explained in the articles.[2]

Recent Methods of Radiology Imaging:

1) Intra Oral Periapical Radiography (IOPA)
2) Extra – Oral Radiography
3) Computed Tomography (CT)
4) Magnetic Resonance Imaging (MRI)
5) Postmortem Computed Tomography (PMCT)

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6) Multi-detector Computed Tomography (MDCT)

Anatomical and Forensic Identification:

Medico-legal cases, Natural disasters like tsunamis, earthquakes, explosions, etc. For confirming death in monetary issues, Septum deviations, Upper and Lower skeletal bone readings, Head and Neck bony remains identification, Teeth related identifications, etc., Digital radiography when used along with dental matching software fastens the forensic victim's identification. Also, digital radiography reduces the exposure times by requiring 90% less radiation than that required to expose a standard type D film radiograph and 50% less radiation than that required in exposure of type E film radiographs.[3]

MRI

More recently, MRI has been used to increase forensic investigations, particularly in musculoskeletal, cardiovascular and angiographic fields and in forensic imaging of the living (such as cases of child abuse), survived strangulation and age estimation. Virtual Autopsy is one new technique that offers several advantages over the traditional approach and helps connect radiology with forensic medicine. The most important advantage is its non-invasive approach that doesn□t harm the body or tamper with forensic evidence. MRI involves no ionizing radiation; it is based on the principle of nuclear magnetic resonance. When a patient is placed in a magnetic field, the hydrogen protons in the body align with the field. A radiofrequency pulse is emitted from the scanner, exciting specific atomic nuclei and rotating the protons to a 180° position. As the energy from the pulse decreases, the protons return to their initial state within the magnetic field and generate an MRI signal that is digitally transformed into images. The interval between arrival in the initial state and signal emission is called the relaxation time. Contrast between anatomical structures is possible due to the specific relaxation time of atoms within each tissue. MRI offers high spatial resolution as well as excellent soft-tissue contrast, as it distinguishes muscles, fat, parenchyma, and neurological structures. [4-5]

Conventional Radiography:

Conventional radiography is the oldest radiological imaging method used in forensic medicine. In this technique, the body is investigated via direct exposure to X-rays; structures exposed to the beam are projected onto a radiographic image. The image is composed of different tonalities of black and white, corresponding to the number of X-rays that reach the detector. Contrast is possible due to the distinct absorption properties of body structures (bone is associated with high absorption and soft tissues display less attenuation). Conventional radiography employs two types of devices available in medical institutions: 1) analog equipment that uses radiological film for the impression of images, and 2) newer equipment that is completely digitized. In digital and digitized analog equipment, images are acquired in digital DICOM format, which is currently used for all imaging modalities. [2]

Conventional radiography is one of the most common imaging modalities in forensic medicine worldwide. Most forensic institutions possess their own X-ray devices, which are often used to evaluate the osseous system in cases of trauma or to characterize the presence of a foreign body. Radiography is advantageous, as it is simple to perform, rapid, and cost-efficient. Radiography is often implemented for infant corpses, for highly putrefied, charred, or otherwise altered bodies, and for bodies of unknown identity. Conventional radiography can also provide important information that is integrated with other complementary exams for age determination (Figure 1), not only of deceased but also of living persons. [6-7]

Figure 1: Showing the Hand wrist and Skeletal part of the Unidentified Person.

PMCT:

Currently, one of the most-used radiological modalities in modern forensic imaging is MDCT. This extensive use means that the term PMCT often refers to MDCT. Unlike conventional radiography, MDCT uses a computer to generate images that are saved in DICOM format. MDCT is based on the principle that the density of each tissue can be measured by calculating the attenuation coefficient of an X-ray beam passing through it. The body is examined through direct exposure to X-rays via a rotating tube. The attenuation values of the X-rays are expressed in Hounsfield units; these units are characteristic of various tissues and body fluids. Radiographic data are interpreted through the evaluation of various cross-sectional images. While 3D reconstructions are very clear and intuitive, enabling better understanding of the images for a medical layman, radiological assessment and diagnosis should always be based on axial views. Three-dimensional models are always at risk of artifacts, and the assessment of 3D models alone may cause discrete findings to be overlooked. [8]

CT:

CT is the ideal method for detecting radio-opaque foreign bodies. For example, it visualizes medical implants, projectiles and/or their fragments, and swallowed or aspirated foreign bodies. CT makes the discovery of small or fragmented objects much easier than does classic autopsy and allows rapid orientation for targeted extraction during autopsy. [9-11]

3D scanning:

Three-dimensional surface scanning is a technique that was developed for the car industry; it is extensively used for forensic investigations in Switzerland by police and medico-legal institutions. Its main fields of application are the reconstruction of traffic accidents, the correlation of a lesion and the presumed injuring-causing instrument, and the comparison of bite marks with dental models of the supposed perpetrator. [12-14]

Radiology in Age and Sex Determination:

Estimating age is the most important prerequisite for identification of the dead. Age estimation can be done by various factors like: Jaw bones, Tooth germs, Process of mineralization, Stages of crown development, Completion and their eruption into oral cavity, Volume of pulp chamber, Third molar development and eruption pattern, Root morphology, Maxillary Sinus height and width, Nasal Septum area, Pulp Tooth Area Ratio (PTR), Height and Width of the crown, Estimation of sutural closure, (Figure 2) etc.,[3]

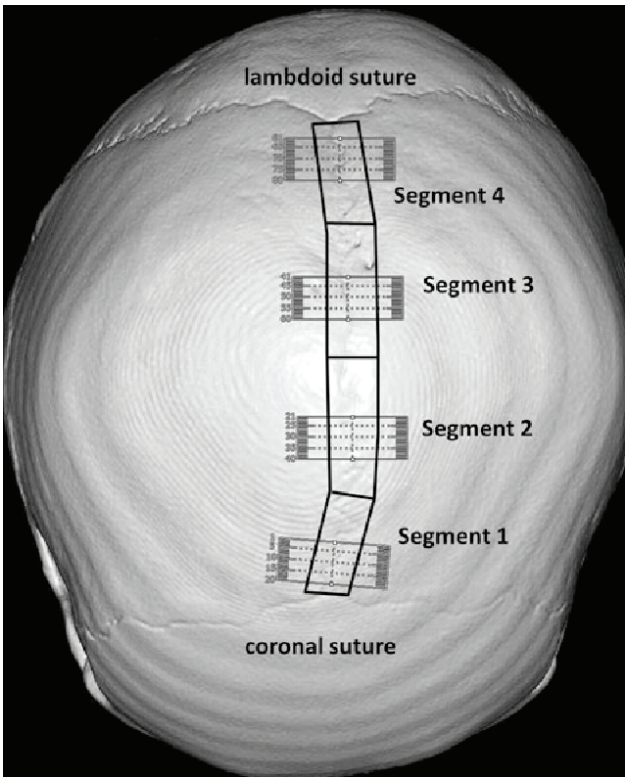

Figure 2: Age Estimation showing between Coronal and Lambdoid suture

Conclusion

Forensic radiology has modest and early origins. Previous evidence shows that medical principles have been applied to medico legal issues for thousands of years. It was not long after Roentgen discovered "a new kind of ray" that advanced forensic scientists established its value in forensic science. Radiologic imaging is better defined as the practice that lies at the many interfaces of medicine and law. Radiologic imaging plays a vital role at many of those connections, from the identification of dead to the confirmation and validation of precious sculptures.

Ethical Certificate: Since it is a Review article, we do not take ethical.

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