Review Article

RADIOLOGIST A PROMISING MEMBER IN FORENSIC TEAM
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Abstract:

Forensic medicine as a science is not new, however forensic medicine has received more recognition from the general public in recent years. The importance of radiographic techniques in clinical forensic medicine is widely recognized. The forensic scientist is in the truest sense of the word, a detective—solving a mystery, telling a story, and often uncovering a crime. In recent years many newer advances have developed in forensic medicine. Branches like forensic radiology, forensic odontology, forensic bioinformatics, forensic microbiology, forensic psychiatry etc…. Forensic radiology is one of the most upcoming, entrusting, eligible and reliable branch. The scope of application is broad, sometimes underutilized and largely undefined. The situations in which forensic radiology can be applied to resolve legal matters are many and varied. This article reviews different important and useful aspects of radiology in relation with forensic medicine.

Keywords: Forensic radiology, forensic medicine, current trends, newer advances.

Introduction:

Forensic science is a unique scientific discipline requiring its practitioners to have, in addition to technical skills and knowledge, critical and analytical thinking skills, communication skills, and an awareness of the role of the scientist in our criminal justice system (1). The multidisciplinary nature of forensic medicine necessitates a team approach. Forensic radiology is one among them. Wilhelm Conrad Roentgen’s discovery of the x-ray in 1895 led to increased use of the noninvasive technology to help diagnose disease. The first use of x-rays in criminal forensics actually occurred a few days before Roentgen submitted his discovery for publication when a radiograph helped demonstrate a bullet fragment lodged in a shooting victim’s leg. Physics professor in Canada had conducted the x-ray examination; the radiograph was submitted as evidence of attempted murder in court (2). The modern forensic system developed in the 20th century. Radiologic technology not only has provided evidence for legal cases but has helped lead to the development of new legal theories and practices regarding visual evidence. Forensic radiography is more than imaging of human remains or bullet fragments; it is the application of diagnostic imaging technology and examinations to questions of law (3). Regardless of the current state of forensic radiography in the world, one fact remains clear: the law has influenced medicine, and medicine has influenced the law. Specifically, early use of medical x-rays was influenced by legal legitimization of the radiography as credible evidence and radiographs have helped influence legal decisions (4). The article mainly reviews useful aspects of the implications of radiology in forensic medicine.

Discussion:

Forensic Medicine has come to be recognized as a special science or discipline that deals with relationships and applications of medical facts and knowledge to legal problems. Some prefer to call it legal medicine or medical jurisprudence. Forensic radiology encompasses the performance, interpretation, and reporting of radiological examinations and procedures connected to the courts and the law (5). The forensic radiologist is an essential
member of the forensic team. By its nature, the science of radiology solves mysteries as it reveals secrets that may be hidden within the body. However, unlike standard diagnostic medical radiology, forensic radiology is not limited to the human body. It has also proven useful in a wide range of nonhuman applications, such as uncovering faked art, authenticating antiques, and detecting forged documents.

History of Forensic Radiology:
Evidence of legal medicine, in one form or another, extends throughout human history. Ancient Egyptian writings have shown that the scholar, physician, and pyramid architect, Imhotep (2980 BCE) applied medical principles to legal issues of the day. In ancient Babylon (modern-day Iraq) in approximately 2200 BCE, the king Hammurabi set formal medical laws into practice. Another early application of forensic medicine concerned the determination of suicide in the first century of the Christian era (CE).

Wilhelm Conrad Roentgen discovered the x-ray in 1895, physicians, scientists, jurists, and journalists realized that the potential Roentgen’s “new kind of ray” might have an application in legal medicine. In the October 1898 issue of the American X-ray Journal, Dr. Fovau d’Courmelles wrote, “Knowing the existence of a fracture in a person who has been burned or mutilated beyond recognition, we can hope to identify him by the x-ray.”

Actually, the first court case involving the x-rays in North America commenced on Christmas Eve, 1895 (three days before Röntgen submitted his first communication to the Physical-Medicine Society of Würzburg. The x-ray plate was submitted to the court during the trial, with the subsequent conviction of Mr. Holder for attempted murder. He was sentenced to 14 years in the penitentiary. The first instance in which a roentgenogram was brought to court in England was a personal injury case tried by Mr. Justice Hawkins and a special jury in Nottingham.

Implication of Forensic Radiology
Forensic radiology plays an important role in various medico legal investigations like identification, evaluation of various injuries, non violent crimes like smuggling, child abuse cases and civil cases etc.

Identification: Identifying the dead is the major challenge and responsibility for medico legal professionals. All the cases of unknown deaths need proper identification. It is not only related with civil and criminal cases but also with human emotions. Identification is required not only for individual but also in cases of mass casualty situations like railroad and aircraft accidents, natural disasters such as earthquakes, floods, hurricanes, collapse or fire in high-occupancy buildings such as hotels and factories etc. where multiple victims are involved. Forensic radiology is one of the most reliable parameters (like fingerprint, dental status, cranial sutures etc.) for identification.

Radiographs in Dental Identification: Dental identification is a comparative technique; the dentition of the decedent is compared to dental records of a suspect or comparison of ante-mortem and post-mortem radiographs. Number and arrangement of teeth (missing teeth, rotated teeth, spacing, extra teeth, impacted teeth), Caries and periodontal bone loss, Hidden restorations (bases under fillings, pins, root canal fillings, posts, and implants), Bony pathology, Dental anatomy, Trabecular bone pattern and crestal bone topography, Nutrient canals, Anatomic bony landmarks, Maxillary sinus and nasal aperture and Frontal sinus all these are compared.
**Bite marks analysis**: The analysis of human or animal bite marks found on skin or objects at a crime scene are another challenging area in identification. The teeth are often used as a weapon when one person attacks another, or in self-defense against an attacker \(^{(13, 14)}\). Analysis of bite mark involves the examination, measurement, and comparison of victim and the suspect. Usually, the life-sized photographs of the bite mark are compared to models of the suspect’s teeth.

**Identification of Individual Remains** can be done by comparison of skeletal tissues and also by soft tissues.

- **Identification by Comparison of Soft Tissues**: Soft tissues may play a role in comparative identification with radiological techniques by some physiological or pathological calcification. Vascular calcifications and calcified falx cerebri have been matched on occasion. Calcified scars or posttraumatic calcifications/ossifications (e.g., post-traumatic myositis ossificans) can be distinctive. Enteric accretions (gallstones,\(^{(15)}\), kidney stones, bladder stones, phleboliths, parasitic encrustations, etc.) can be used for identification. Inclusions of foreign material in soft tissues (opaque clips, sutures, stents, filters, and connectors in surgical procedures, bullets, shrapnel, glass, gravel, etc.) may have unique appearances and locations.

- **Identification by Comparison of Skeletal Tissues**: bones are the most durable of body tissues used for radiological identification. The identification is done by matching radiographs of (1) anomalous or unusual development; (2) disease or degeneration; (3) tumor; (4) trauma; (5) iatrogenic interference; and (6) vascular grooves and trabecular patterns.

**Evaluation of Injury or Death**: The forensic experts uses x-rays in evaluating gunshot wounds in several ways like location of the bullet (which saves much time and may avoid needless effort in searching for bullets that are inaccessible), number of bullets/ pellets, type of bullet, type of weapon, angle and direction of fire, range of fire and path of the wound \(^{(16,17)}\). By these we can say position of assailant/ victim and manner of death suicide/homicide/unintentional.

- The location, type, severity of fracture can be assessed by configuration and direction of fracture. It can tell the impact point, direction of the impact and also the type of weapon. It is very much useful in vehicular injuries and in cases of asphyxia injuries like hanging/strangulation etc… Other foreign bodies One may find the snapped-off point of a knife, fragments of broken glass, bomb fragments or shrapnel, parts of the automobile or aircraft in which the victim was riding, and animal, mineral, or vegetable matter embedded, aspirated, or injected.

- Aggressive bite mark injuries have been found in cases of homicide, attempted homicide, heterosexual and homosexual assault, aggravated assault, battery, and in cases involving the physical and sexual abuse of children. Bite marks are considered to be examples of physical evidence as well as biological evidence. \(^{(18)}\)

- Radiology is useful not only in injuries but also in situations like natural diseases, infections, infestations, metabolic processes, dietary abnormalities, tumors, poison, demonstrating air embolism, pneumothorax, pneumopericardium, pneumomediastinum, pneumoperitoneum.

**Radiology in nonviolent crimes**: Radiology is used in cases of non violent crimes like body packer, larceny, auto theft and auto forgery \(^{(19)}\).
The “Body Packer”: In the 1970s the smugglers discovered a new method for smuggling, which could be recognized by the radiologic method.\(^{(20)}\) That is “body packer”, who smuggled contraband drugs (mostly Cocaine, heroin, amphetamines, hashish, and marijuana) across borders in specially devised packages (condoms, the fingers of surgical gloves, or even toy balloons) secreted in the carrier’s rectum, vagina, or alimentary canal.\(^{(21,22,23)}\) These can be traced by radiology which looks regular shaped round or oval foreign bodies outlined by arcuate or encircling thin air shadows, sometimes in multiple layers.

**Larceny** is swallowing diamond/precious stones or jewels by thief. This can also be identified by roentgenography.\(^{(24)}\) It is possible that computed tomography would offer greater sensitivity in the search for swallowed gemstones.

**Radiology of Abuse:** Domestic violence is a serious public health problem with a potentially fatal outcome. Abuse is an improper usage or treatment of an entity, often to unfairly or improperly gain benefit. It can be physical, sexual, emotional, maltreatment or neglect of any person. Battered women, children, and elderly persons reside in all segments of society. In children it is used as “Le Syndrome de Silverman” in France, “Le Syndrome de Caffey”, “Caffey’s Third Syndrome” and “The Syndrome of Ambroise Tardieu”\(^{(25)}\). Finally, in 1962, Kempe\(^{(26)}\) intentionally coined the name *Battered Child Syndrome* to attract attention to this neglected clinical and social problem. Child abuse is newly arising problem in developing country like India. Spectrum of Child Abuse can be of any form like Physical abuse, Nutritional deprivation, Emotional abuse, Neglect of medical care or safety, Intentional drugging or poisoning, Sexual abuse. Following radiographic features are seen: traumatic bowing of the ends of the diaphyses, metaphyseal cupping, ectopic ossification, involucrum formation, metaphyseal fragmentation, and fractures of differing durations. Shaken baby syndrome subdural heamatoma and intracranial bleeding is noted.\(^{(27)}\)

The usefulness of radiological images in cases of criminal litigation in violent crimes like murder, suicide, attempted murder, assault, battery, abuse, terrorism and nonviolent crimes such as smuggling, larceny and fraud, faking, or counterfeiting is now well established. In civil litigation the radiologist may be called as a defendant, witness, or expert witness in the court cases dealing with liability, be it professional liability or malpractice, personal liability, property liability, or product liability.

**Conclusion:**

Radiologic imaging plays a vital role at many of those intersections (both civil and criminal cases), from the identification of the dead to the authentication of priceless art. The various modalities of radiology can be used in routine investigations as well as confirmation of various medico legal cases, death reports etc. There is no set standard for a “Forensic Radiologist”. There is no specialized training or fellowship available in that field. The proper communication of the Forensic dept. and Radiology dept. both can help to solve various sequels in certain genuine cases. If we improve the support of forensic radiology field, truly it will be a promising member in forensic team.

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1. CEWebSource.com is produced by Enterprises for Continuing Education Inc. (ECEI), PO Box300, Brighton, MI 48116-0300, (810) 229-3354. FORENSIC RADIOLOGY, Lois Romans, BS, RT (R) (CT) University of Michigan Hospitals Ann Arbor, MI E-mail: loisroma@med.umich.edu expirES August 15, 2013


