The field of forensic radiology

Dr Ashok Sharma[1], Dr Sumit Ghosh[2], Dr Parnita[3], Dr Ayushman[4]

[1]Professor, Department of Radiodiagnosis and Imaging, Santosh Deemed To Be University, Pratap Vihar Ghaziabad, U.P India

[2,3&4] Senior Resident, Department of Radiodiagnosis and Imaging, Santosh Deemed To Be University, Pratap Vihar Ghaziabad, U.P India

ABSTRACT

In the field of forensic science, imaging techniques are a very useful tool. Although medical examiners and forensic anthropologists are not as well-versed as radiologists in the more nuanced aspects of radiology, they are nonetheless necessary to interpret findings from imaging studies in order to enhance medico-legal investigations. The forensic investigator should frequently seek the assistance of the radiologist, whose knowledge and experience may prove to be invaluable in the course of forensic consultations. Because various legal issues may require the radiographs for additional interpretation or for their presentation in court, the radiologist should be aware of the importance of storing radiographs over prolonged periods of time as well as of efficient record keeping methods. This is because various legal problems may require the radiographs. In this study, we take a look at some of the most significant challenges that may crop up when working in forensic radiology.

Keywords: forensic, radiographs, imaging techniques, fracture, anthropology.

INTRODUCTION

It is well knowledge that radiographic techniques hold a significant amount of importance in the field of clinical forensic medicine. During postmortem examinations, radiographs are obtained to look for foreign bodies, document fractures and other forms of injuries, and detect any injuries that may have occurred. Radiological examinations play an important part in the diagnosis of non-accidental injuries sustained by children, as well as in situations of medical negligence and the establishment of biological ageing in cases where there is a dispute. One of the most important aspects of forensic anthropology and odontology is the comparison of ante-mortem and post-mortem radiographs. This is one of the primary ways that human remains can be positively identified. The purpose of this article is to provide an overview of the many applications of radiography in forensic medicine. Radiologists who work in clinical settings and forensic specialists need to be mindful of the weight of duty that comes with testifying as an expert in a legal proceeding. In spite of the fact that the regulations in each nation vary greatly from one another, we will provide some recommendations concerning the archiving and record keeping of radiography.

Necroscopic examinations

The majority of contemporary forensic institutes perform post-mortem radiological examinations on a regular basis. During an autopsy, the stage at which radiology is utilised will differ depending on the specific circumstances; however, in most cases, it will be performed after the exterior inspection and prior to the dissection [1].

Radiographic methods allow for the detection and examination of foreign bodies such as shards of glass or gunshot fragments. This is essential not only for their in-depth examination, but also for the recovery of the objects as evidence, therefore it should not be overlooked. When trying to determine

where the bullets entered the body, it is essential to keep in mind that they may move away from the entry point; hence, the search for their specific location should involve the entire body. Injuries to bone and soft tissue could be very different depending on the type of bullet that was fired (high or low velocity). Radiographs provide for the diagnosis and localization of post-abortion complications such as pneumothorax, pneumoperitoneum, barotrauma injuries, and air embolism. Vertebral angiography is something that should be done when there is a possibility of a traumatic subarachnoid haemorrhage [1].

Radiographs to detect fractures are not typically necessary, but they may be necessary in certain circumstances, such as when there is a suspicion of neck pressure and the involved structures are relatively fragile and could be broken during direct examination or when there is a suspicion of child abuse. Post-mortem exams frequently make use of other imaging modalities in addition to MRI and CT, such as ultrasound and CT scans. The link between pre-mortem and post-mortem MRI signal changes, as well as changes in CT attenuation, has not been adequately examined. This is possibly due to the fact that few radiology departments are able to afford scanner time for the examination of a deceased individual [2].

Non-accidental injuries of children

The diagnostic process for child abuse frequently involves the use of radiology. In point of fact, more than 80 percent of all child abuse-related injuries that have been documented in the United States are found through the use of medical imaging [3]. In order to obtain accurate results from a radiographic skeletal survey, it is necessary to examine both the axial and appendicular skeleton. A single radiograph of the kid taken from all angles (often known as a "babygram") is not sufficient for diagnostic purposes [4]. Skeletal scintigraphy has a limited sensitivity for detecting cranial fractures, but it has a high sensitivity for detecting rib, spinal, and diaphyseal fractures. This method should be considered as a supplementary evaluation in cases when it is suspected that the injuries were not caused by an accident [5].

In the literature [4–7], the different types of fractures and the processes of trauma that are related with those fractures have been discussed. Only the clinical findings that are currently receiving the most attention will be highlighted in this review.

The diaphyseal, spiral-oblique, and transverse fractures are the types of fractures that are seen most frequently in children who have sustained non-accidental traumas. Metaphyseal-epiphyseal fractures are not as common as other types of fractures. All of them are indicative of an injury that was not caused by an accident because it is impossible for simple falls or other types of mishaps to deliver the requisite forces to induce fractures of this nature. Caffey (194b) [b] came up with the term "bucket-handle frac- ture" to characterise the metaphyseal fractures of long bones that are common in abused children. Bucket-handle fractures can be found in children's long bones.

The presence of multiple rib fractures is yet another pathognomonic indicator of abuse, which can be present in anywhere from 5–27% of abused children. In the event of a collision involving a motor vehicle or during an effort at resuscitation [b], these are extremely uncommon. In the acute context, these rib fractures may be difficult to identify with radiography, and bone scanning may be the method that is most effective in detecting them [7].

In babies, cranial fractures caused by accidents are often straightforward, linear, and unilateral. They involve the parietal bone and do not branch off into other sutures or cross over. Injuries sustained as a result of falls from beds, sofas, nappy changing chests, or stairs (often referred to as "short falls") typically result in relatively minimal trauma [8]. The majority of the time, abusive fractures are complicated, wide at the time of presentation, numerous or depressed, and bilateral [5, 9]. There are a few descriptions of fatal "brief falls" in the published research; nonetheless, the vast majority of experts agree that these are extremely unlikely [10].

When a newborn is shaken severely, subdural haemorrhages are a typical complication that can occur. The head is predisposed to violent acceleration and deceleration forces in the "whiplash shaken syndrome," which causes disruption and bleeding of the bridging veins into the subdural space. The head is relatively large, heavy, and poorly supported, so it is more likely to be subjected to these forces. The CT [b] and MRI [4] scans are what are used to make the diagnosis of the condition. There is not a broad opinion regarding the most effective imaging approach for the diagnosis of cranial injuries that were not caused by an accident. Different types of head trauma call for unique treatment strategies, according to forensic radiologists. MRI is superior to CT when it comes to identifying subdural haematomas, concussion injuries, and shear injuries. CT is recommended for the identification of subarachnoid haemorrhages.

Although CT and MRI are just as effective at demonstrating epidural haematomas, however CT is the method of choice when it comes to identifying fractures [8].It can be difficult to determine an individual's age after suffering a brain injury. When characterising acute (up to several days old), extracerebral blood collections, cranial CT is generally believed to be both sensitive and specific [11]. New blood samples taken from the subdural space had a high density on CT. After an injury, the density will begin to lessen progressively over the course of the first week [12]. When it comes to portraying subacute (a few weeks old) and chronic (more than three months old) extracerebral haemorrhage [12], as well as deep cerebral lesions [11], MRI is better to CT. T1-weighted images that have a short echo time (TE) and a short relaxation time (TR) exhibit a distinguishing high signal intensity when there is subdural bleeding that is subacute or early chronic. When T2-weighted pictures (long TE and long TR) are used to study the progression of subdural blood, the images show an increasing signal strength [12]. A histological examination is necessary in order to arrive at a more precise age estimate. On a head CT scan, signs of post-traumatic brain swelling can be seen as early as 1 hour and 17 minutes after the injury [13].

Forensic anthropology

Forensic anthropologists investigate questions concerning the determination of a person's biological age as well as the identification of human remains.The question of a person's biological age may be brought up in legal proceedings for a variety of reasons, including determining whether or not a defendant should be tried in juvenile court, determining whether or not a person has reached the legal age for marriage, or deciding whether or not statutory rape has occurred.

It is not possible to arrive at an accurate estimation of the biological age of a live human in an adult who is older than 25 years. Dental radiographs and hand

radiographs are the kind of radiographs that are used the most frequently for age determination up to 1 billion years old [14]. When attempting to determine an individual's true age, post-cranial radiographs of particular ossification centres can be quite helpful. The relevance of these radiographs increases with the individual's supposed age.

The technique of using radiography to identify human remains is prevalent not only in the aftermath of large-scale disasters but also in day-to-day forensic work [15]. The availability of the ante-mortem data as well as the speed with which it may be collected are two factors that significantly influence the degree to which an identification method is successful and helpful. An average of ten percent of medico-legal cases involve unidentifiable remains, according to the authors' experience gained from practising medicine in the United States of America, Great Britain, and Israel. Radiographic methods are used to identify around 80% of these cases.

Radiographs of the skull, dental, chest, and abdominal areas are the ones that are utilised the most commonly for positive identification [1b], despite the fact that it has been claimed that all parts of the body can be useful in this process. A conclusive radiographic identification can only be attained by a painstaking examination of the radiographs' respective details and characteristics. However, there is no predetermined minimum number of characteristics that must be present in order to make a determination of identification. In most cases, sufficient evidence for positive identification is deemed to be between one and four distinctive concordant traits, with no discrepancies present [17].

It has been suggested that panoramic radiographs, which can visualise most of the structures of the jaws and areas connected to them on a single scan, should be used for screening large groups of people, such as members of the military [18]. As part of the enrollment process for their identifying database, the Israeli Defense Forces have been taking routine panoramic radiographs and dental charts since 1973 [19]. Additionally, they have been taking dactiloscopic recordings of all 10 fingers since the same year.

In cases involving widespread devastation, determining the identities of people who have been completely severed from their bodies is one of the most challenging undertakings. Numerous radiological comparisons are used to positively identify approximately 55% of the bodies found in the aftermath of big disasters on average. Due to the close proximity of the victims to the epicentre of the explosion, the identification team has been presented with extremely fragmentary human remains as a result of the trend of suicide bombings that has been implemented in Israel over the course of the past five years by a variety of fundamentalist groups. [20] The positive identification of all victims and perpetrators was facilitated, in large part, by the utilisation of radiography techniques, in addition to a variety of other investigative approaches.

Record keeping

It is of the utmost significance that meticulous record keeping take place in medical facilities and private practises for as long as it is practically possible. Radiographs that are associated with inactive patients' files are kept for a period of at least 5 years in the majority of nations [21]. Despite the fact that patients are guaranteed access to their radiographs under the law, radiographs are typically considered

to be the property of the medical facility or office in which they were produced. Following receipt of legal authorization from the patient [22], radiographs may be distributed to the patient or to other practitioners. Some facilities have a pattern of only releasing copies and keeping the originals for themselves. The patient is responsible for the safekeeping of the radiographs in various countries; this absolves the medical department of any legal obligation in the event that the patient misplaces the radiographs.

All of the states in the United States have passed legislation that mandates the storage requirements for x-rays and other types of medical information. This time span might range anything from five to thirty years after the patient has been discharged or received their final treatment [23]. In the event that legal action is being pursued, radiographs must be stored safely until the applicable statute of limitations for acts of medical negligence has passed. According to this guideline, a paediatrician may be required to preserve the record for as long as b years after the patient has reached the age of majority. The National Institute of Forensic Medicine has proposed that the current minimum instruction of medical record keeping should be extended from 5 to 20 years due to the high number of victims who have been maimed as a result of terrorist attacks and military actions in Israel. Because of the limited amount of space available, this measure would need the information to be saved on magnetic media. It is essential to keep in mind that courts of law in some countries will only accept originals, not magnetic or optical data, and it is crucial to remember this fact. When planning storage facilities, this aspect ought to be taken into account [22].

Expert testimony

When testifying as an expert witness, it is in your best interest to confer with the attorneys who are actively involved in the case in order to formulate an overview of the information that will be delivered. It is essential to keep in mind that the radiological data must be presented in a scientific as well as an understandable manner. Before sending in the data, the radiologist is obligated to provide an explanation of how the radiographs were made and under what conditions they were taken. The knowledgeable person should always be aware of the location of the radiograph as well as whether or not it is an original or a copy of the radiograph.

In conclusion, a word of caution: maintain your composure without appearing condescending, present only what you are familiar with, and avoid going beyond what has been unquestionably and irrefutably established radiologically and what can be supported on the basis of one's professional experience and knowledge. It is important to refrain from stretching the limits of validity in order to widen the interpretative findings. It's possible that the opposing counsel will try to discredit the expert by provoking them personally. Above all else, restrain yourself from being angry or becoming involved in a dispute; instead, keep a professional demeanour at all times [24].

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