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CASE REPORT

Application of Postmortem Radiographs: Advantages & Disadvantages A Case Report

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ABSTRACT

Postmortem radiograph skeletal surveys serve as imaging adjuncts to autopsy and forensic documentation in hospitals with no available forensic computed tomography and magnetic resonance imaging services. Despite this, modern literature pertaining practical applications of postmortem radiographs have gradually been superseded by interests in advanced imaging modalities. The main advantages are characterizing or excluding violent traumatic bone fractures or abnormalities, locating foreign bodies, identifying medical devices as well as acting as secondary adjuncts to anthropologic assessment. Limitations that test diagnostic value of postmortem radiographs include lack of direct visualization of soft tissue as well as postmortem artefacts that obscure natural causes of death and can be misinterpreted as antemortem pathology. The roles and limitations of postmortem radiographs are illustrated in a case of a decomposed but complete and identified adult male decedent with reference to autopsy findings and literature review.

KEYWORDS: Postmortem radiograph, roles, advantages, disadvantages, limitations

INTRODUCTION

Postmortem radiograph skeletal surveys are used to compliment forensic medicine investigation and documentation when advanced imaging such as postmortem computed tomography (PMCT) and magnetic resonance imaging (MRI) are not accessible due to financial constraint, lack of technical expertise in forensic radiology and local policies that prioritize resources for the higher number of living patients relative to the lower number of decedents [1]. Post mortem radiographs (PMXR) are especially useful in localizing bone fractures, foreign bodies, surgical implants and personal artefacts, particularly when history is limited [2]. In other parts of the world, the roles of dental radiographs and skeletal surveys have been applied in disaster victim identification, anthropometric evaluation and investigations of pediatric non-accidental injuries [3-4]. Limitations of PMXR have also been recognized, ranging from positioning difficulties due to rigor mortis to interpretative challenges caused by decomposition artefacts mimicking antemortem pathologies [5-6]. This case study highlights the roles and limitations of PMXR in a decomposed but complete, identified decedent with reference to autopsy findings and literature review.

CASE PRESENTATION

A 39-year-old male farmer was brought in dead by the police after he was found by a friend in a plantation area. Two weeks prior to his demise, he had been feeling unwell with chills and fever but had not sought medical treatment and continued working. Prior to this, he had no known medical disease, psychosocial or financial issues. The deceased was positively identified by a distant cousin but autopsy was performed under police order to investigate the cause of death. No antemortem radiographs were available for comparison at our center.

Postmortem Skeletal Survey (PMXR)

Postmortem radiographic skeletal survey requested by the forensic pathology team was performed prior to autopsy by two experienced radiographers using an analogue mobile radiography unit (Shimadzu MobileArt Evolution). Images were acquired with the decedent in supine position, collimated during acquisition and taken at 66-69 kVp, 3.6 mA and 50 cm source to image distance. Postmortem radiographs of the skull, cervical spine, chest, pelvis, bilateral upper and lower limbs were suboptimally positioned due to rigor mortis (Figure 1 & 2). Digital images were then transferred into computed radiography (CR) workstations and interpreted by a general radiologist.

Figure 1 Portable radiographs in a mature adult skeleton; (a, b) Skull radiographs (lateral and frontal views) demonstrated intracranial air but no skull or mandibular fractures; (c) Pelvic radiograph (frontal view) and (d, e) visualised cervical vertebrae (lateral & frontal views) showed normal alignment and no fractures. (f) Chest radiograph (anterior-posterior view) showed intrathoracic, upper abdominal visceral and generalized subcutaneous air, in keeping with decomposition changes.

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Masculine features were identified with the skull radiographs revealing a projecting glabella, a prominent mental protuberance and enlarged mastoid processes whilst the pelvic radiograph demonstrated a narrow sub-pubic angle of 86°, narrow deep pelvic inlet and cavity. Complete fusion of the iliac crests and all long bone epiphyses, bilateral femora lengths of 48 cm and bilateral humeri lengths of 38 cm correlated with that of an adult decedent.

A radioopaque belt buckle, zipper and buttons from the deceased clothing were identified on pelvic radiograph. No other suspicious weapons or foreign bodies such as bullet, pellets or radioopaque body packs were identified in the rest of the skeletal survey to suspect foul play. No surgical or medical devices that may have provided clues to any underlying comorbidities were found.

Figure 2 No fractures, callus formation, periosteal reaction, osteomyelitic or other bone lesions were seen in bilateral (a-b) femora; (c-d) tibiae and fibulae; (e-f) humeri; (g-h) radii and ulnae bones. No opaque foreign bodies were seen in all radiographs.

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No fixed flexion deformity artefact of rigor mortis was seen in this study. There were no bone fractures, joint dislocations or radiographic signs of violent or traumatic death in the imaged bones (Figure 1 & 2). No callus formation or subperiosteal new bone formations typically seen in antemortem or old fractures were observed. There were no pre-existing bone pathologic lesions such as bone tumors, metastases or chronic osteomyelitic changes.

Diffuse subcutaneous and visceral organ air was observed within the skull, thorax and imaged abdominal cavities. The skull radiographs showed air filling the anterior calvarium and partial settling of the brain silhouette at posterior (dependent) calvarium. Chest radiograph demonstrated intrathoracic, mediastinal and intracardiac air. Cardiothoracic ratio was increased (CTR 0.57) but subject to magnification on anterior-posterior projection of the radiograph, still requiring correlation with autopsy findings. There was relative increased non-specific alveolar density in the left upper and mid- zone but otherwise no obvious lobar pneumonic consolidation, mass, cavities or intrathoracic fluid. Air was also seen within the superficial and deep neck spaces, descending thoracic aorta, peritoneal cavity, liver and spleen. An abdominal radiograph was not performed, but pelvic radiograph demonstrated dilated air-filled bowel loops. There was diffuse symmetric, extensive subcutaneous emphysema extending from skull base, neck, thorax, visualized upper abdominal subcutaneous tissue as well as mixed linear and vesicular patterns of gas accumulation in the brain, liver and spleen and heart.

Autopsy

Postmortem external examination revealed an intact but decomposed body in bloated to decay stage with external and internal maggot infestation. No external signs of antemortem or perimortem injury were identified. As a result of decomposition, multiple postmortem abrasions, peeling of skin, greenish discoloration at the abdomen and skin marbling at the torso were seen (Figure 3). There were no other external or internal injuries that indicated violent traumatic death. From internal examination, all visceral organs were in decomposed states. The heart was marginally enlarged and weighed 400g but all coronary arteries were patent. There was no myocardial fibrosis or haemorrhage typically found in ischaemic heart disease or myocardial infarction respectively. The spleen was also mildly enlarged weighing 200g but with no morphologic abnormality. The other internal organs were also grossly unremarkable.

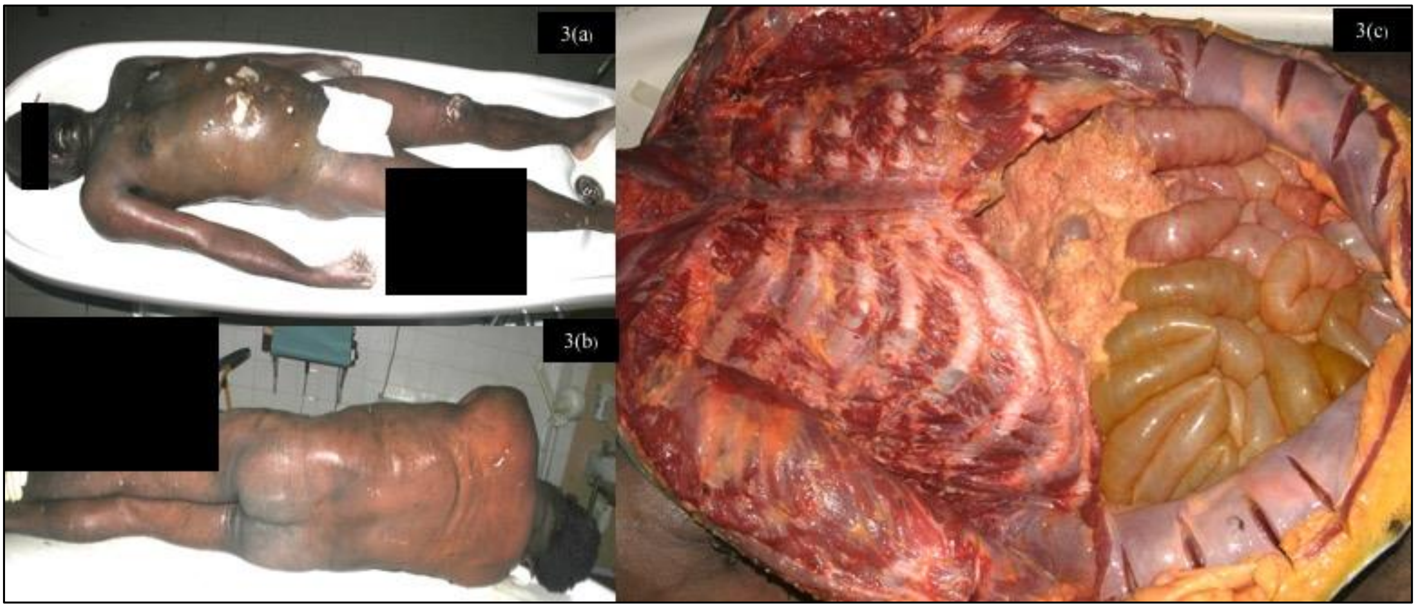

Figure 3 (a, b) External examination revealed an intact, decomposed body with green discoloration and peeling of skin. There were no other external injuries. (c) No intrathoracic or intraabdominal injury was found during internal examination

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Based on forensic entomology findings, the estimated postmortem interval (time period since death) was at least five days. The blood was hemolysed and insufficient for further investigation. As the man was a foreigner, his family claimed his body for proper burial and no further investigations were pursued to determine the exact cause of death. Follow up on histopathology results of the heart, spleen and other organ samples yielded only degenerated, non-viable tissue. Final postmortem diagnosis was thus, classified as "unascertained" in view of the decomposed state of the deceased.

DISCUSSION

The main advantage of postmortem radiographic skeletal survey is to give a general overview of bone, which is relatively resilient to the effects of decomposition. In this case, the main role of PMXR was to exclude violent traumatic death or presence of suspicious foreign bodies such as bullets, concurring with autopsy findings and limited history. Additionally, there were also no radiographic signs of congenital or acquired bone abnormalities like fracture calluses nor medical devices such as bone prostheses, pacemakers, or dental amalgams that may have provided clues to the antemortem state of the decedent before death. As the decedent was positively identified, morphometric analysis combining commonly accepted non-metric pelvic, cranial dimorphic characteristics, complete epiphyseal fusion and measurements of long bone lengths played only minor roles as secondary identification tools for sex, age and stature estimation [7] compared to that of pediatric cases, unknown, incomplete or skeletonized remains.

The disadvantage of PMXR is its inability to assess internal organs and soft tissue directly. Additionally, for this case, decomposition artefacts yielded no contributory findings to the actual cause of death. Putrefaction produces a pattern of air that begins with intravascular gas and proceeds to gaseous distension of all anatomic spaces, organs, soft tissues; air distributions that are symmetrical as seen in this case, can be considered putrefactive rather than pathologic [8]. Generalized linear air patterns within the visceral organs silhouettes conform to air within vascular structures whilst vesicular patterns likely represent gas leakage from vessels into parenchyma secondary to solid organ autolysis and putrefaction [9]. Understanding these postmortem radiographic artefacts are essential to avoid mistaking them as antemortem pathology such as pneumothorax or pneumoperitoneum due to viscus perforation.

Another limitation of PMXR interpretation is estimating the time of death and stage of decomposition. Decomposition is divided into five stages: Fresh, Bloated, Decay, Post Decay, and Skeletal [10]. In this case, the stage of decomposition was classified between bloated to decay stage based on autopsy findings. The decomposition had caused physical alterations and loss of viable soft tissue at both macroscopic and microscopic levels, hindering both autopsy and histopathologic diagnoses [11]. There was also lack of information on confounders that would have affected the rate of decomposition such as interval between exact time of death and examination, external factors such as temperature, humidity, lack of physical barrier, and internal factors such as antemortem disease e.g. sepsis, drugs or toxins [12]. Levy et al. classified decomposition based on PMCT observations into (i) Early (cerebral autolysis, intestinal distension, intestinal mural gas and intravascular gas), (ii) Moderate (cerebral settling, cavity fluid, cavity gas, small amounts of subcutaneous and visceral gas) and (iii) Advanced (cerebral liquefaction, diffuse subcutaneous gas, diffuse visceral organ gas and organ collapse, evidence of insect or animal predation, skeletonization, adipocere formation, mummification) [8]. By no means can this be applied into every PMXR interpretations due its limitation in direct visceral visualization. However, because there was symmetrical diffuse subcutaneous and substantial visceral air in this particular case, it was possible to postulate that moderate to advanced decomposition had set in based on the PMCT classification descriptors. One more challenge of PMXR interpretation is lung assessment and differentiatiation between antemortem lung disease and post mortem lung changes. A study by Hock Gan Heng et. al reported that postmortem mixed alveolar-interstitial lung changes begin immediately to eight hours after death in canine subjects, with variable progression to lung collapse and pneumothoraces by 24 hours after death [13]. Cross referencing PMCT and

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autopsy on humans have found that changes build up with greater delay from death to scan and the best radiologic interpretation of pathology, especially that of the lung, is shown to be within 2 hours of death [14-15].

In view of the low case load of decomposed bodies in our center, the main limitation of this single case report is that while the PMXR findings may provide a general overview, it does not represent the wide spectrum radiographic decomposition changes that vary with time of death to imaging interval, internal and external factors affecting rate of decay. A statistically significant larger sample size with comparison to PMCT and autopsy as standard references, under controlled environment will be needed for this purpose. Additionally, there is no standardized protocol on the interpretation and documentation of postmortem radiographs. For this, intra- and interobserver variability tests are recommended as a scientific means to assess diagnostic validity and and to guide formulation of evidence-based protocols, standardized reporting and training programs for image interpretation.

CONCLUSION

In the absence of advanced imaging facilities, postmortem radiographs play an adjunctive role to autopsy in excluding violent and traumatic deaths i.e. identifying bone fractures, suspicious foreign bodies, medical devices and contribute to identification by means of anthropometric estimation. Limitations include lack of direct visualization of soft tissue and presence of postmortem artefacts, more so in decomposed bodies, that obscure natural causes of death and can be misinterpreted as antemortem pathology. All in all, the diagnostic validity of PMXRs need to be tested when considering them as supplementary evidence and medicolegal documents in legal court proceedings.

Conflict of Interests

Authors declare none.

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Ethics approval and consent to participate

No consent to participate was required as only decedent's secondary data and images were retrospectively utilized without clinical intervention. The manuscript has been sufficiently anonymized and will not cause harm to the patient or their next of kin.

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