Radiological findings at a South African forensic pathology laboratory in cases of sudden unexpected death in infants

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Abstract

Objectives. The work serves as a preliminary evaluation of the utility of full-body radiography in examining cases of sudden unexpected death in infants (SUDI).

Setting. This paper reviews findings from full-body digital radiography in cases of SUDI in 2008 at the Salt River Forensic Pathology Laboratory in Cape Town.

Subjects. One hundred and ninety-two cases of SUDI referred to the mortuary and undergoing full-body digital radiography were reviewed.

Design. Imaging reports were cross-referenced with death registry data. Manner of death, cause of death, whether an autopsy had taken place, and radiological findings, were recorded and analysed.

Results. The absence of bone fractures was recorded as an imaging finding in 40% of cases. The most common type of imaging pathology was lung disease. In cases where autopsies were performed and pathology was found on imaging, the findings of the two methods of examination were consistent.

Conclusions. Imaging might have served to assist cause-of-death determination based on case history, and therefore full-body radiography could improve the workflow in busy forensic pathology laboratories. More detailed and consistent recording of imaging findings is required before stronger conclusions may be drawn regarding the utility of full-body digital imaging of paediatric cases in forensic pathology laboratories.

Introduction

Radiographs have been used in forensic examinations since the discovery of X-rays,[1] and have contributed to forensic autopsy by providing a permanent, but incomplete, record of the anatomy and pathology of the deceased prior to autopsy, particularly documenting fractures and the localisation of foreign material such as bullet fragments.[2] The significance of radiographic soft-tissue findings in forensic pathology has been the subject of only a few studies.[3]

Full-body digital radiography has been shown to be useful for the rapid detection of unsuspected fractures[4] and multiple injuries[5] in a trauma unit; the same benefits would apply to forensic pathology investigation. Forensic radiography is currently not a regular feature of the management of sudden unexpected death in infants (SUDI) in South Africa. A retrospective audit of 512 cases comparing the investigation of SUDI at two large medico-legal mortuaries in South Africa found that no radiological investigations were done as part of the post mortem examination.[6] The absence of additional investigations such as radiology was attributed to probable financial and resource constraints.

A full-body low-dose digital X-ray system has, however, been used in medico-legal autopsies in South Africa for a number of reasons.[7] It allows rapid localisation of foreign bodies with the aid of multiple views, which has benefits where fast burial is dictated by religious practice and in criminal investigation. It is easily operated by trained staff. Its low radiation dose does not pose a major risk to staff.

This paper reviews the findings from full-body radiography in SUDI, with reference to autopsy results and causes of death, over a one-year period at the Salt River Forensic Pathology Laboratory in Cape Town. The incidence of SUDI and the circumstances surrounding it have received little research attention in South Africa. No nationally accepted protocol exists for the investigation of SUDI; and in instances where an infant had an underlying medical condition/disease, the opinion of the treating clinician often determines whether or not a sudden/unexplained infant death is referred to a medico-legal facility.[6] This paper serves as a preliminary evaluation of the utility of full-body radiography in examining cases of SUDI.

Methods

A Lodox Statscan full-body digital radiography system[8] was installed at the Salt River Forensic Pathology Laboratory in 2007. Cases that had undergone imaging between 1 January and 31 December 2008 were cross-referenced with data from the death registry at the Division of Forensic Medicine and Toxicology at the University of Cape Town. The following were recorded: manner of death – of interest in this study was SUDI; age – only cases two years or younger were included; cause of death (CoD); whether an autopsy had taken place; and the radiological findings. Data had been entered by 4 consultant pathologists, 6 registrars and a medical officer. Not all cases seen at the laboratory

undergo imaging; the pathologist determines whether or not imaging is required. No protocol exists for the recording of radiological findings.

The study was approved by the Human Research Ethics Committee of the Faculty of Health Sciences of the University of Cape Town.

Results

An antero-posterior (AP) radiograph was taken in all cases, while additional views were taken in some cases. No information was recorded on the reason for imaging. A total of 1 033 recorded cases were imaged in 2008, among them 197 cases of SUDI. Two of the SUDI cases had no associated notes or death registry information, and the files for 3 cases were unavailable because of criminal investigation; these were excluded. Therefore 192 cases were included in the study.

CoD, determined with or without autopsy, is shown in Fig. 1. The majority of pathology involved the lungs. The imaging notes referred to bone fractures in 77 (40%) cases; no bone fractures were recorded.

Autopsies were performed on 121 SUDI cases. For the 71 cases that were not autopsied, the reported death was due to natural causes (in some cases the natural CoD was specified, and in others not – cf. Fig. 1). In cases where pathology was found on imaging, the notes did not indicate whether or not the imaging findings contributed to CoD determination. However, a larger percentage of autopsied cases showed no pathology on imaging, while a larger percentage of non-autopsied cases showed pathology on imaging (Fig. 2), which suggests that imaging might have assisted in the determination of natural causes based on case history, without autopsy. Twenty-two autopsied cases for which CoD was specified had corresponding imaging findings; a comparison of imaging and autopsy findings is shown in Table 1. Imaging findings for cases without autopsy are shown in Table 2. Fig. 3 shows an example of a full-body image of one of the cases. The findings revealed right upper lobe opacification of the lung. Fig. 4 shows a chest image extracted from a full-body scan; lung disease is evident and the findings were reported as bilateral pulmonary infiltrates.

Discussion

The absence of bone fractures was frequently recorded as an imaging finding. Skeletal surveys by X-ray imaging are part of the SUDI protocol in some centres to rule out the possibility of non-accidental injury or to detect rib fractures associated with resuscitation.[9] Such surveys typically require several images to cover the entire skeleton. Full-body imaging facilitates a complete skeletal survey from one orientation in one image,

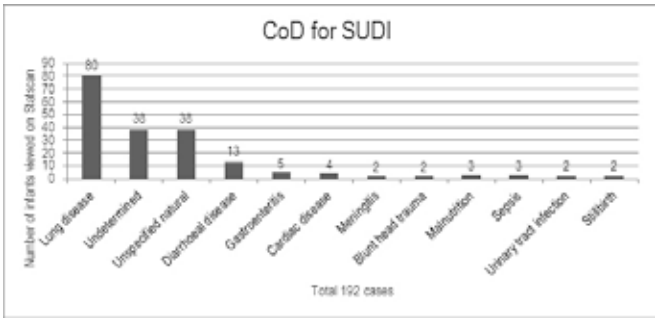

Fig. 1. Cause of death in 192 infant cases designated as SUDI on entering the forensics laboratory.

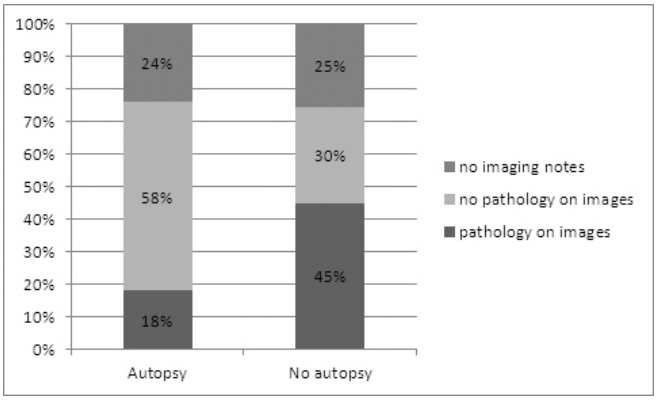

Fig. 2. Imaging findings for autopsied and non-autopsied cases; autopsies were performed on 121 cases; 71 cases were not autopsied.

regardless of subject size, as the imaging field of view on the Lodox Statscan is adjustable from 100 mm x 100 mm to 1800 x 680 mm. While additional views may be required, the full-body AP image replaces a number of smaller AP views, and therefore would reduce the time taken for a skeletal survey.

For the majority of SUDI cases, the CoD was lung disease. The majority of imaging pathology findings reflected lung disease. This is consistent with the results of other studies[3] and with the limitations of radiographs in showing soft tissue pathology.

In cases where autopsies were performed and pathology was found on imaging, the findings of the two methods of examination were consistent. In contrast, De Lange *et al.*[3] found poor agreement between autopsy and radiological findings owing to the presence of post mortem

Table 1. Comparison of imaging findings and autopsy results for 22 cases for which pathology was found on imaging

No. of cases	Imaging findings	Cause of death (CoD)
7	Opacification in lung fields	Pneumonia/lung pathology/aspiration
7	Consolidated lung fields	Lower respiratory tract infection/bronchopneumonia/sepsis
2	Air bronchograms	Pneumonia
2	Obscured heart margins	Congenital cardiac disease
1	Bilateral pleural effusions	Pneumonia
1	Hyperinflation of lungs	Bronchiolitis
1	Lymphadenopathy	Disseminated tuberculosis
1	Infiltrates	Pneumonia

Fig. 3. Full body image with opacification in the right upper lobe of the lung.

Fig. 4. Cropped chest image with bilateral pulmonary infiltrates.

artefacts, which could not readily be differentiated from true pathology and were more likely to occur with long time intervals between death and imaging. Our study did not show radiological findings that were unaccounted for on autopsy, and did not record the time interval between death and imaging. Future work should include a prospective comparison of autopsy and radiological findings, with recording of time intervals between the two types of study, to ascertain the extent and time dependence of post mortem artefacts.

Table 2. Imaging findings for 32 non-autopsied cases where pathology was found on imaging

No. of cases	Imaging findings
	Lung disease
14	Opacification
4	Pneumonia/bronchopneumonia
4	Pulmonary pathology
2	Infiltrates
2	Air bronchograms
1	Lower respiratory tract infection
1	Pleural effusion
	Other
4	Distended bowel
1	Enlarged liver

Although individual case reports contained no indication of the extent to which imaging contributed to CoD determination, findings on imaging without autopsy in cases of death owing to natural causes suggest that imaging might have served to assist CoD determination based on case history.

Full-body radiography may improve the workflow in a busy forensic pathology laboratory, such as the one in Salt River, which receives more than 3 500 cases annually and has to maintain a large daily turnover to prevent overflow, given limited storage capacity,[10] However, more detailed and consistent recoding of imaging findings is required before stronger conclusions may be drawn regarding the utility of full-body digital imaging in cases of SUDI.

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