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ORIGINAL ARTICLE

Diagnosis of lung infection in sudden adult death: Comparison of postmortem computed tomography and histopathology

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Abstract

This study aimed at comparing two main existing diagnostic methods for the detection of lung infection in post-mortem cases of sudden adult death. Post-mortem computed tomography (PMCT) imaging of lungs and histopathology examination (HPE) of lung tissue were selected to compare their sensitivity and specificity. This retrospective case control study was conducted in a tertiary referral centre on 220 deceased individuals who underwent PMCT imaging prior to autopsy and had histology sampling during autopsy in the years 2016 – 2019. The bodies were examined with PMCT prior to conventional autopsy. Histology sampling were taken in those selected cases as part of medicolegal investigations. The reports and images of PMCT, and HPE reports with slides were retrieved and re-evaluated. Findings of PMCT and HPE were divided into pneumonia and non-pneumonia groups. Only PMCT images of chest and histology slides of lungs were accessed and evaluated. The result showed that the sensitivity and specificity of PMCT in the diagnosis of lung infection was 98.2% and 36.4%, whereas HPE showed a sensitivity and specificity of 97.3% and 100%. The accuracy of PMCT and HPE were 67.2 % and 98.6 % respectively. In conclusion, HPE had better accuracy compared to PMCT with almost similar sensitivity but higher specificity. PMCT may act as a good screening tool for pneumonia but is insufficient to substitute conventional autopsy in the diagnosis of pneumonia. Routine histology sampling during autopsy should be practised whenever dealing with sudden death.

Keywords: lung infection, pneumonia, pulmonary tuberculosis, PMCT, histopathology examination, autopsy

INTRODUCTION

World Health Organization (WHO) has defined sudden death as death occurring within 24 hours from the onset of symptoms. The cause of sudden death can be due to various diseases of any body systems with that of the respiratory system contributing to around 25% of causes. In Malaysia, lung infection is one of the principal causes of death (11.8%), second only to ischemic heart disease (15.6%).[1]

The human lungs are vital and complex organs in the human body, constituted by airways, interstitial, and vascular systems, with occasional congenital anatomical variants such as agenesis, aplasia or hypoplasia, accessory lobes, and fusion of lobes. Common infectious aetiology agents are community acquired bacteria (e.g. Streptococcus pneumoniae, Klebsiella pneumoniae, Community-acquired methicillin resistant Staphylococcus aureus), viruses (influenza viruses, Respiratory syncytial virus), mycobacteria (Mycobacterium tuberculosis complex), and opportunistic organisms (e.g. Aspergillosis, Pneumocystis carinii).[2]

Pneumonia can be generally defined as any inflammation of the lung parenchyma and conventional autopsy diagnosis is made by gross findings. Both bacterial and viral pneumonia can give rise to bronchopneumonia and lobar pneumonia. In the gross findings, patchy consolidation of the lung is the dominant characteristic of bronchopneumonia, while consolidation of a large portion of a lobe defines lobar pneumonia. Occasionally these classical anatomical categorisations are difficult to apply as the patterns may overlap each other.

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In lobar pneumonia, there are four stages of inflammatory response which are congestion, red hepatisation, grey hepatisation, and resolution. The lung is heavy, boggy, and red during the congestion stage with microscopic findings of intra-alveolar fluid with few neutrophils, and vascular engorgement. The red hepatisation stage is characterised the by red and airless affected lobe exhibiting a liver-like firm consistency, and microscopic findings of massive exudation admixed with neutrophils, fibrin, and red cells in the alveolar and interstitial spaces. The gross appearance of the following grey hepatisation stage is a greyish brown and dry surface with microscopic findings of fibrinosuppurative exudate and disintegration of red cells. In the resolution stage, the consolidated area is resolving with granular cell debris in the alveolar spaces and infiltration of macrophages and fibroblasts. The surface of the lung may show pleuritis in the early stages if the consolidation extends to the surface, and when it undergoes healing and organisation there could be eventual fibrous thickening or adhesion to the pleural wall.[3]

In bronchopneumonia, there are patchy areas of consolidation characterised by slightly elevated, granular, yellow to grey-red, and poorly delimited margins. The consolidation more often involves multiple lobes and are frequently bilateral and basal in location. Histologically, these areas show suppurative exudates filling the bronchi, bronchioles, and adjacent alveolar spaces.[3]

Tuberculosis (TB) remains a major respiratory cause of mortality from a single infectious agent. WHO estimated that, in 2017, in additional to around 1.3 million deaths (range from 1.2-1.4 million) from TB among HIV-negative people, there were 300000 deaths from TB (range from 266000-335000) among HIV-positive people. The TB mortality rate has shown a declining trend of about 3% per year worldwide, however, it has remained stagnant in Malaysia at about 4.5-5.5 per 100000 population.[4]

Tuberculosis can be categorised into primary and secondary infections. Primary TB is contained in most immunocompetent individuals. The diagnosis of progressive primary tuberculosis is difficult as it resembles acute bacterial pneumonia with pulmonary consolidation and caseous necrosis mainly involved the lower and middle lobes, pleural effusion, and perihilar lymphadenopathy. The Ghon complex refers to a combination of the parenchymal lung lesion and lymph node involvement. In contrast, secondary TB classically involves the apex of the upper lobe of lung with cavitations characterised by circumscribed, grey-white to yellow, central caseation, and peripheral fibrosis. Microscopy of pulmonary tuberculosis classically shows multiple granuloma formation with central caseation and multinucleated Langhan's-type giant cells, and further special staining with Ziehl-Neelsen will reveal the acid-fast bacilli.

The autopsy detection of aetiological agents can be valuable in determining gaps in, or confirming, the diagnosis and management of clinically significant lung infections, but also has an important contribution to disease prevention and epidemiology. Hence, in the autopsy examination, an effort should be made to determine the causative agents. Many approaches have been used. Blood culture and gram staining of tissue sections have been contributory in some cases, but sensitivity is often low. Culture of the lung tissue is considered the gold standard but imposes a significant challenge of ensuring good sterility in taking samples during the autopsy procedure. Polymerase chain reaction (PCR) as a method to identify the DNA or RNA of specific (targeted) infectious agents has also been applied to samples obtained at autopsy.

Post-mortem computed tomography (PMCT) is a more recent modality available to the forensic pathologist as an adjunct to the conventional autopsy to aid in death investigation. PMCT investigation of the deceased prior to the autopsy would be able to pre-empt the presence of certain disease pathologies and as well as traumatic injuries.

In pneumonia, PMCT mainly show abnormalities related to increased lung opacity. The abnormalities are categorised to the nodular pattern, linear pattern, reticular pattern, ground-glass opacity, and consolidation. The nodular pattern of opacity with centrilobular distribution is characterised by the presence of a tree-in-bud morphology that is almost always seen in infection. The linear pattern is characterised by interlobular thickening, parenchymal bands, subpleural lines, or irregular linear opacities. Apart from the evaluation of lung opacity, the PMCT scan is also able to detect pleura effusion in relation to lung infections.

This study was performed in a setting where the available post-mortem diagnostic methods for lung infection were PMCT imaging and routine histopathology examination (HPE) with Haematoxylin and Eosin stain, and special

stains in applicable cases. The detection of lung infection by PMCT imaging was compared with HPE in terms of sensitivity, specificity, and positive and negative predictive value.

MATERIALS AND METHOD

Of a total of 2653 autopsies performed at the Department of Forensic Medicine, Kuala Lumpur Hospital from January 2016 to December 2020, total of 220 post-mortem cases were selected for this retrospective case control study. 110 of subjects for each of the case group and control group were selected based on the cause of death from the autopsy report which the case group (pneumonia) comprised of lung infection, pneumonia, or pulmonary TB, and the control group (non-pneumonia) comprised of other natural causes of death but with no record of pneumonia. Other inclusion criteria included (1) had PMCT imaging of the lung prior to autopsy, (2) had routine histopathology examination, including stains if appropriate, on post-mortem lung samples, and (3) completed police investigations. Cases with traumatic death, decomposed, and age below 18 years were excluded. The cause of death of the subjects were compared with the findings of PMCT and HPE.

Each selected post-mortem case (case-group and control) had undergone non-contrast PMCT imaging by trained radiographers using a Toshiba Aquillon 64 multi-slice CT machine prior to autopsy. The cadavers were placed in supine position and a full body scan from head to toe were performed. The CT machine able to produce 256 slices in one rotation with 0.5-millimetre slice thickness. PMCT was performed as soon as possible after death upon the body arrival at the mortuary. If it was not possible for scanning to be done immediately, the cadaver was stored in the body freezer at 4° Celsius prior to scanning. The PMCT findings were evaluated by the forensic radiologist prior to the conventional autopsy.

In this study, the PMCT images and original PMCT imaging reports were retrieved and reviewed. Cases with discrepancy findings between the PMCT images and original PMCT imaging report were excluded. We divided the findings of the PMCT imaging based on the diagnosis of original imaging report into two groups which were (1) pneumonia or (2) non-pneumonia.

Evaluation of histopathology findings was based on previous Haematoxylin and Eosin staining done on fixed lung tissues as part of the autopsy standard procedure. The HPE reports of the selected cases were reviewed and the findings and diagnosis as reported by the forensic pathologist were recorded. HPE slides were retrieved and re-examined under light microscope. Cases with discrepancy findings between the HPE slides and HPE reports were excluded. HPE evaluations was divided based on the diagnosis of HPE report into two groups which were (1) pneumonia or (2) non-pneumonia.

Ethical review:

This study involved retrospective data retrieved for analysis without any clinical intervention. Informed consent from the next-of-kin was not required for PMCT as it was part of the standard operating procedure (SOP) of the autopsy. The specimens and data retrieved for the research study were subsequently kept within the department as per official usage. The privacy and confidentiality of the subjects were protected throughout the study through the use of non-unique subject IDs. This study proposal was reviewed and approved by the Medical Research Ethics Committees of the Ministry of Health and the University Malaya Medical Centre and entered into the National Medical Research Register.

RESULTS

121 autopsy cases met this study criteria for case group subjects and 110 were randomly selected. Out of the 110 case group subjects, the cause of death recorded were lung infection, chest infection, bronchopneumonia, lobar pneumonia, pneumonia, and pulmonary tuberculosis. Pulmonary tuberculosis as a cause of death accounted for approximately one-third of the case group. In the control group, the cause of death of the 110 subjects mainly comprised of cardiac and central nervous system related deaths. From the selected subjects, the median age for both case and control groups were almost similar at the age of 43 and 49 years old respectively. Both groups had the gender distribution of predominantly male (79% in case group, and 88% in control group).

PMCT findings:

The study revealed that the sensitivity of PMCT findings in relation to cause of death was high at 98.2%, however, the specificity was low at 36.4%. Out of 110 cases in the case group, only 2 cases failed to be diagnosed by PMCT. 70 cases

Table 1: Association of PMCT findings to cause of death.

			COD			
			Pneumonia	**Non-pneumonia**	**Total**	**% within PMCT findings**
PMCT findings	Pneumonia	Number	108	70	178	60.7% (PPV)
		% within COD	98.2%	63.6%	80.9%	
	Non-pneumonia	Number	2	40	42	95.2% (NPV)
		% within COD	1.8%	36.4%	19.1%	
Total		Number	110	110	220	

in the control group were falsely diagnosed by PMCT as pneumonia. The positive predictive value was 60.7% and negative predictive value was 95.2% (Table 1). The association of PMCT findings to cause of death was significant with a p value < 0.05. Figures 1 – 4 showed examples of PMCT images with features suggestive of pneumonia, pulmonary TB, and pulmonary oedema.

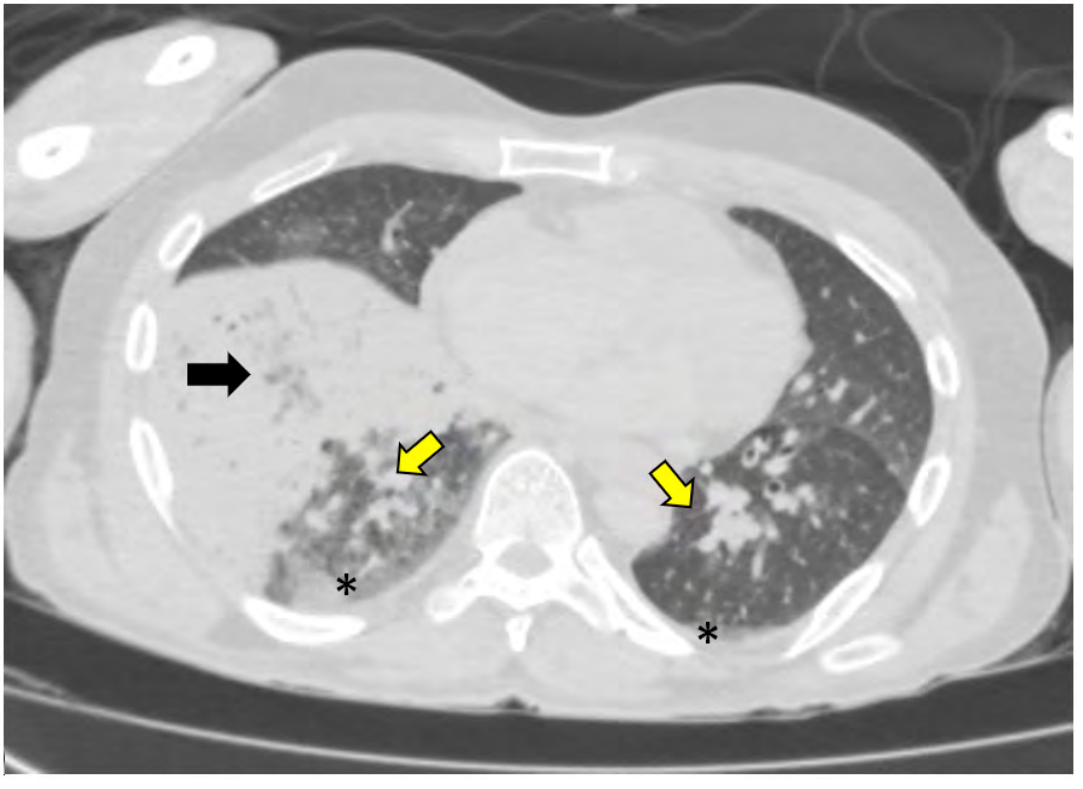

FIG. 1: PMCT of the thorax in this case showed prominent signs suggestive of lobar pneumonia characterized by consolidative changes over the lower lobe of the right lung with inconspicuous air bronchograms (black arrow). Multiple scattered calcifications were seen over both lower lobes (yellow arrows). Ground glass opacities were predominantly seen at the posterior aspect of the right lung and minimally at the left lung (*).

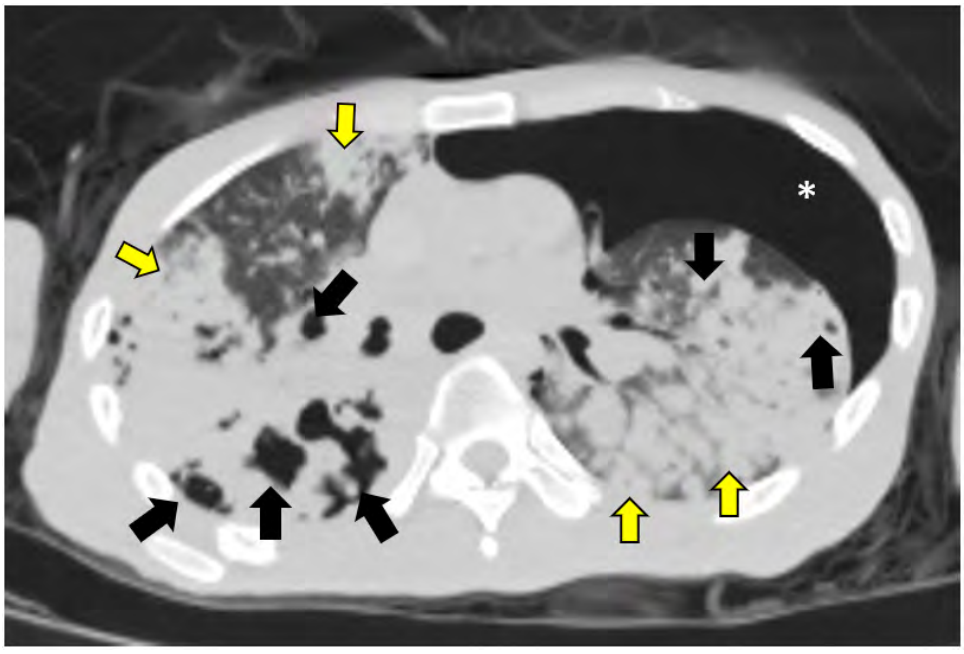

FIG. 2: PMCT of the thorax showed multiple cavitating lesions over both lungs, predominantly in the upper lobes and right lung (black arrows) suggestive of pulmonary TB. Multiple consolidations were also seen in both lungs (yellow arrows). The left lung was collapsed with pneumothorax (*).

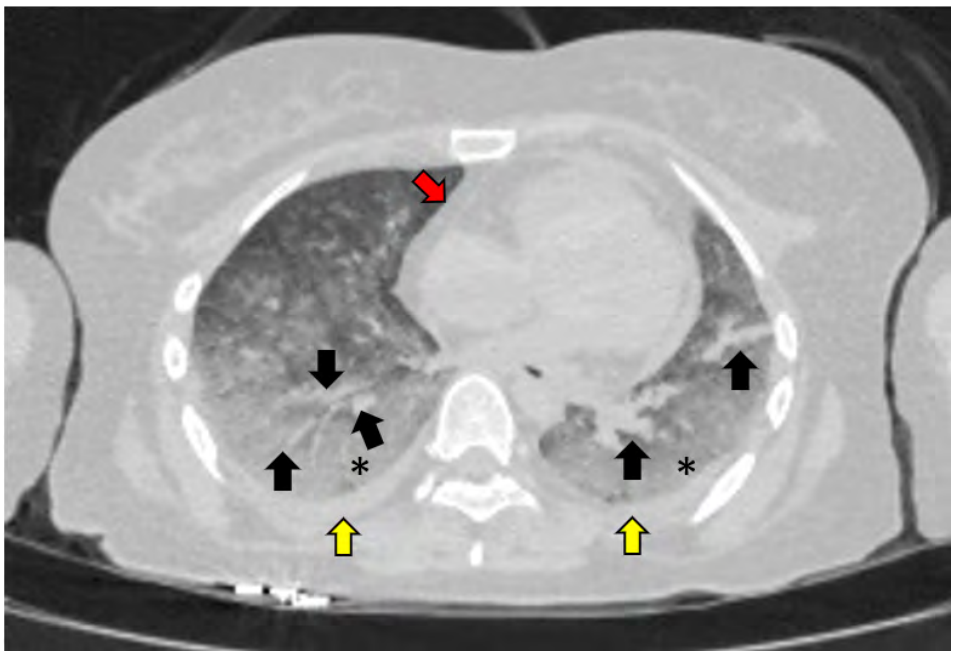

FIG. 3: Bilateral ground glass opacities were seen symmetrical at the dependent areas of all lobes (*) associated with air space opacities (black arrows). No obvious consolidation seen. Bilateral mild pleural effusion (yellow arrows) and mild pericardial effusion (red arrow) were noted. The findings in this case were equivocal for the diagnosis of pneumonia by PMCT. Further investigation by HPE concluded pneumonic changes.

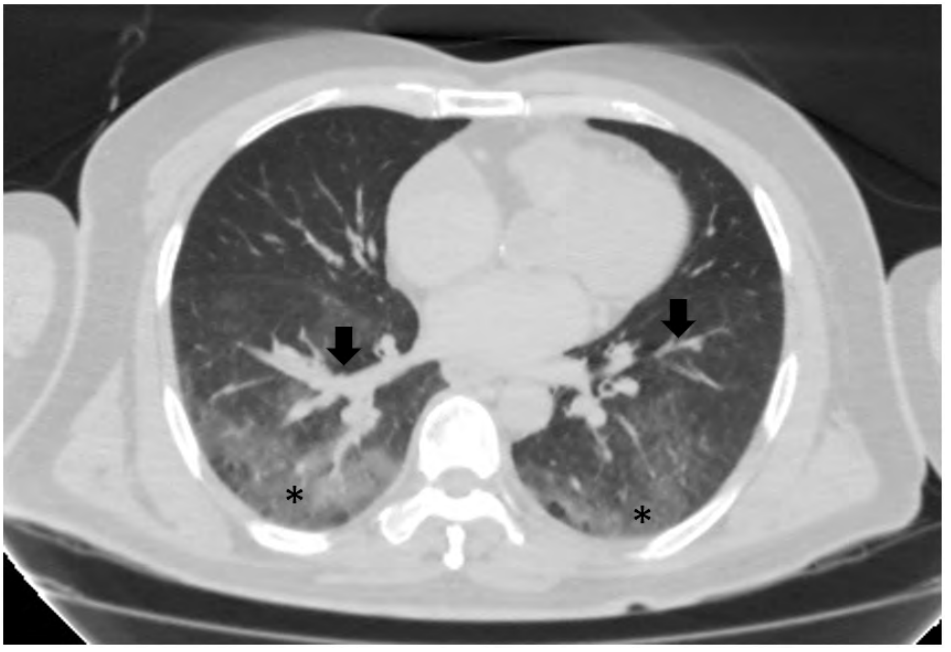

FIG. 4: Bilateral diffuse air space opacities (black arrows) with mild ground glass opacities (*) were seen involving the posterior aspect (dependent areas) of all lobes. The anterior aspects of both lungs were aerated and unremarkable. The findings were consistent with pulmonary oedema and non-pneumonia.

HPE findings:

The analysis of HPE findings showed both sensitivity and specificity were high. Sensitivity was 97.3% reflecting those 107 cases in case group was diagnosed as pneumonia by HPE. All the 110 cases in control group were consistent with the findings of non-pneumonia which result in 100% specificity. The positive predictive value was 100% and negative predictive value was 97.3% (Table 2). The association of HPE findings to cause of death was significant with a p value < 0.05. Figures 5 – 7 showed examples of HPE findings in the diagnosis of pneumonia, pulmonary tuberculosis, and pulmonary oedema.

This study revealed that the sensitivity of PMCT was slightly higher than HPE. However, generally the specificity, positive and negative predictive value of HPE were higher than PMCT (Table 3). The Cohen kappa (K) is 0.329. Based on guidelines from Altman (1999), and Landis & Koch (1977), a kappa (K) of 0.329 represent a fair strength of agreement. Furthermore, considering that the P value was less than 0.05, our kappa (K) coefficient is statistically significant.

Table 2: Association of HPE findings to cause of death.

			COD			
			Pneumonia	**Non-pneumonia**	**Total**	**% within HPE findings**
HPE findings	Pneumonia	Number	107	0	107	100.0% (PPV)
		% within COD	97.3%	0.0%	48.6%	
	Non-pneumonia	Number	3	110	113	97.3% (NPV)
		% within COD	2.7%	100.0%	51.4%	
Total		Number	110	110	220	

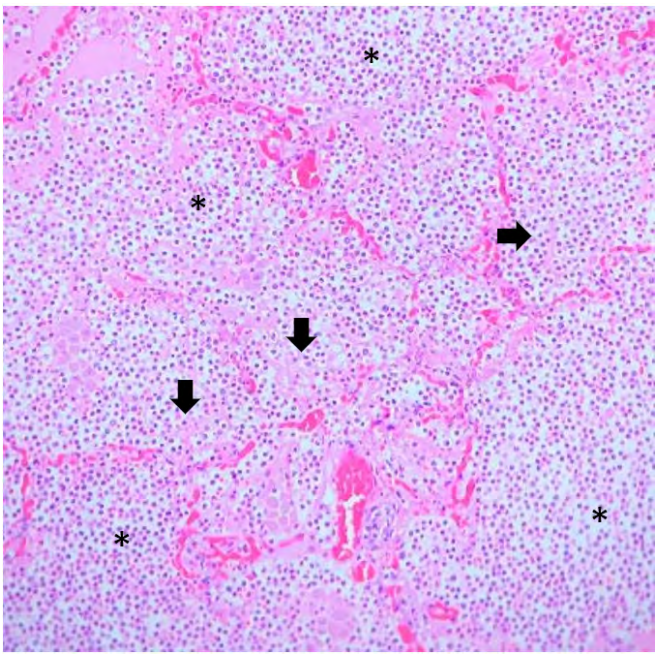

FIG. 5: Haematoxylin and Eosin stain (x 400 magnification). Abundant inflammatory cells predominantly neutrophils admixed with fibrin (black arrows) fill the alveolar spaces (*). Alveolar septa were disrupted. Congestion of blood vessels were noted. The features were consistent with lobar pneumonia in the red hepatisation phase.

DISCUSSION

The analyses of this study showed the sensitivity of PMCT and HPE were almost similar with both being more than 95%. Both methods were able to detect the pneumonic changes in most of the cases. PMCT failed to detect 2 cases out of 110 cases, and the findings of these cases were reported in favour to pulmonary oedema. A study was done by Roberts *et al.* in United Kingdom where they compared the findings of post-mortem imaging with traditional autopsy in

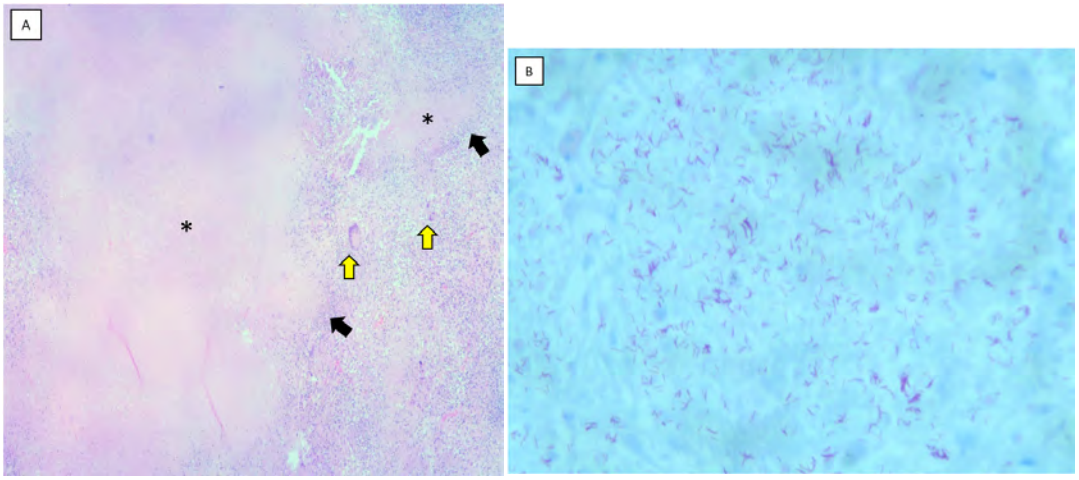

FIG. 6: A) Haematoxylin and Eosin stain (x 40 magnification). Caseating granulomas characterised by lymphocytes and epithelioid histiocytes at the periphery (black arrows) with central caseation necrosis (*). Langhan giant cells were noted (yellow arrows). The differential diagnoses at this stage were pulmonary TB or fungal infection. B) Ziehl-Neelsen stain (x 400 magnification). Abundant acid-fast bacilli (red bacilli) in the necrotic tissue of the lung lesion indicative of Mycobacteria. A diagnosis of pulmonary TB was made in this case.

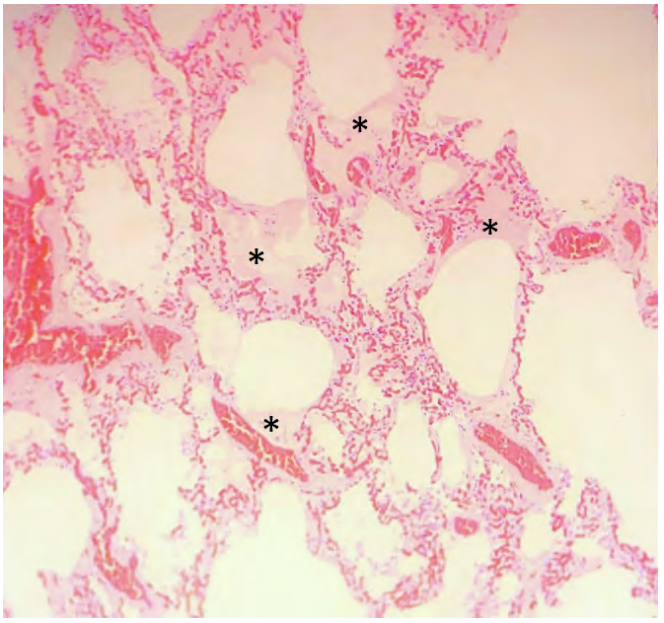

FIG. 7: Haematoxylin and Eosin stain (x 200 magnification). Alveoli were filled with floccular pink material (*) characteristic of pulmonary oedema. The capillaries in the alveoli walls were congested with red blood cells. There was no evidence of infiltration by acute inflammatory cells to suggest pneumonia.

adult deaths. The major discrepancy was found to be around 30% between autopsy and imaging cause of death. Pneumonia was one of the major diagnostic discrepancies apart from pulmonary embolism, coronary artery disease, and intestinal infarction.[5] They also reported that pneumonic consolidation was frequently interpretated as pulmonary oedema. Another study was done in Japan by comparing the accuracy of PMCT with hospital autopsy and clinical diagnosis for identifying the immediate cause of death. This study revealed that respiratory failure was the most frequently diagnosed immediate cause of death by PMCT and all the pneumonia cases were concordant with autopsy diagnosis.[6] They had concluded the accuracy of immediate cause of death diagnosed by PMCT was statistically significantly higher than established by clinical diagnosis.

Ampanozi *et al.* had conducted a study to determine the accuracy of PMCT for determining cause of death. Generally, the sensitivity and specificity of post-imaging cause of death categorisation by non-contrast PMCT in comparison to final cause of death were 82% and 97%.[7] However, in regard to cause of death due to the respiratory system, the study showed sensitivity and specificity of 50% and 98% which was inversely proportionate to our findings. The sensitivity and specificity in our study was 98.2% and 36.4%. Apart from that, the existing literature regarding the diagnostic accuracy of PMCT ranged from 6% to 70%.[5,8–14] The discrepancy between the current study and the published literature is likely caused by a few factors: (1) Our study focused on pneumonia/ lung infection as compared to other studies where

Table 3: Summarised comparison of PMCT and HPE

Test	PMCT	HPE
Sensitivity	98.2%	97.3%
Specificity	36.4%	100%
Positive predictive value	60.7%	100%
Negative predictive value	95.2%	97.3%
Accuracy	67.2 %	98.6 %

wider categories of cause of death were included; (2) A large variance in number of subjects were included in previous studies. A larger number of subjects were analysed in the current study than previous studies; (3) Varying experience of radiologists in interpretating the PMCT findings and formulating the cause of death. Radiologist experience in interpretating PMCT imaging is a crucial factor for high diagnostic accuracy. Not all the cited studies had disclosed their radiologist experience. Although the radiologists in our centre were experienced in the sub-speciality of forensic radiology, and had been exposed to PMCT findings and reporting on a daily basis for at least 5 years, the specificity of PMCT in our study was low, indicating a true challenge of false positive reporting.

The false positive interpretation of pneumonia in non-pneumonic cases is mainly due to difficulty in diagnosing lung disease using PMCT as there were no clear features that will distinguish pathological and non-pathological lungs. Microscopic examination of the lung tissues from those false positive cases showed pulmonary oedema and congestion with no features of pneumonia. In our study, the features of PMCT that led to the conclusion of pneumonic changes were consolidative changes, airspace opacity, air bronchogram or ground glass opacity with non-dependent area distribution. In addition, PMCT findings of lung nodules with cavitation and location at the upper lobe of lung were highly suggestive of pulmonary tuberculosis. Although there is no established criteria to differentiate normal and abnormal lungs, studies had been done to suggest features that were specific for pneumonia: presence of centrilobular opacities without horizontal plane formation, asymmetrical and segmental increase in lung density, multiple areas of consolidation, randomly distributed nodules, and absence of diffuse bronchovascular bundle thickening.[15,16] On the contrary, the following features were found to be useful for the diagnosis of pulmonary oedema: presence of opacities with horizontal plane formation, diffuse opacities, and interlobular septal thickening.[16]

As similar to the other internal organs, lungs will undergo post-mortem changes, and these changes will affect the PMCT images. The most common post-mortem changes of the lungs are represented by attenuation gradient with areas of opacities mainly of ground glass type localised in dependent areas.[17] This appearance of changes seen in lungs after death was due to effect of regional differences in blood and air volume distribution caused by: (1) hypostasis formation, (2) cessation of tension forces by respiratory muscles, and (3) the pushing action of the diaphragm into the thoracic cavity.[18] The distribution and attenuation of post-mortem changes in the lungs are dependent on post-mortem interval or time since death and position of the body after death similar to hypostasis changes seen on skin and other internal organs.[19] Hypostasis will be seen over the anterior aspect of lungs if the deceased was found in a prone position for a significant period of time. Without the knowledge of the position of the body found at the death scene, the radiologist may misinterpret hypostatic changes as suspicious pathological changes. Ground glass opacity is not a specific feature for pulmonary pathology and can be seen with multiple conditions such as diffuse alveolar damage, pneumonia, pulmonary oedema of various causes, pulmonary haemorrhage, hypersensitivity pneumonitis, etc.[20] Hence, Filograna had suggested from her study that in the presence of posteriorly distributed ground glass opacities in PMCT finding, the other pathologies should be considered apart from the diagnosis of "normal" post-mortem changes.[18] This trend of practice was seen in our centre where the forensic radiologist will tend to diagnose pneumonia or lung infection if the radiology imaging shown non-specific changes such as ground glass opacity. Furthermore, the negative and positive predictive value will be affected. In the current study, the positive predictive value was 60.7% and negative predictive value was 95.2%. PMCT may act as a screening tool apart from diagnostic utility. A high negative predictive value implies a higher likelihood of a true negative result and this is important in helping the pathologist to select appropriate personal protective equipment when dealing with suspected infectious respiratory diseases such as pulmonary TB.

With regards to pulmonary TB, PMCT findings can be different in primary and secondary or post-primary TB disease. For primary TB disease, PMCT examination is able to evaluate for enlargement of lymph nodes and involvement of tracheobronchial tree with irregular luminal narrowing and circumferential wall thickening.[21] PMCT scan of post-primary TB disease is helpful in evaluating parenchymal involvement, satellite lesions, bronchogenic spread, and military disease. The cavitation is best demonstrated by PMCT scan with thick outer wall and smooth inner wall of the cavity. Besides

that, a tuberculoma can be detected as rounded lesions with surrounding satellite lesions. There will be presence of peri-bronchial distribution of acinar shadows and different sizes of nodules in bronchogenic spread of disease. In miliary disease, multiple randomly distributed tiny nodules can be observed. Certain complications of TB such as pulmonary haemorrhage might be detected by PMCT scan.

In comparison to PMCT, both the sensitivity and specificity of HPE were high at 97.3% and 100% respectively. Microscopic findings of three cases in the case group showed congestion and no features of pneumonia, however PMCT was able to detect the pneumonic changes in those cases. This would be due to errors in the histopathology examination and generally can be categorised into four types: (1) defective interpretation, (2) defective identification of patient, tissue, or laterality, (3) specimen defects, (4) defective reporting.[22] The histology slides in this study had been retrieved for re-examine and comparison to the reported findings, thus the likelihood of defective interpretation was minimised. Inadequate and error of sampling site was the more likely reason to result in negative HPE findings in the pneumonia cases. Although all the histology slides of the control group showed no evidence of pneumonia, inadequate sampling or error of sampling sites might still occur that can lead to a negative result.

Microscopic investigations in forensic practice serve several purposes[23]:

- To confirm the gross autopsy diagnosis.
- To establish cause of death.
- To detect and exclude pathological findings.
- To detect cells or biological material for further investigation.

The diagnosis of gross lung pathology during autopsy can be challenging especially when the macroscopic appearances of the lungs are trivial. At gross examination, trivial changes of the lungs may render difficulty in diagnosis and the appearance could be similar such as bronchopneumonia and diffuse alveolar damage. A few studies have shown that there are significant discrepancies between macroscopic and microscopic findings in autopsy cases. Bernardi *et al.* found that the lung was the organ with the most frequent discrepancies (38.7%), between the gross and histology findings, from his series of 371 hospital necropsies.[24] Such findings were consistent with the study by Hunt *et al.* who showed bronchopneumonia can be diagnosed on microscopy independently in 69.2% of 279 autopsy cases.[25] Although routine histological sampling during autopsy would definitely increase costs and turnaround times, the Royal College of Pathologists has recommend histological sampling of all major organs to: (1) confirm macroscopic examination, (2) refine cause of death, (3) assist in clinical audit, and (4) aid in training of pathologists.[26]

The histologic features of pulmonary TB are characterised by necrotising granulomatous inflammation in which the granulomas are composed of aggregated epithelioid histiocytes with peripheral rim of lymphoplasmacytic cells and central necrosis. Depending on the immune status of the patient, TB may show non-necrotising granulomas in immunodeficiency or immunocompetent group of patients. Fungi infections and autoimmune diseases also may result in necrotising granulomas. Infections remain the common cause of pulmonary granuloma and special histochemical stains can be useful to distinguish the infective organisms. Grocott methenamine silver (GMS) and periodic acid-Schiff (PAS) are stains frequently used for staining of fungi. The PAS stain can detect the cell walls of living fungi, whereas GMS stain can identify the cells of both living and dead organisms.[27] The Ziehl-Neelsen stain is customarily used for detection of mycobacterium. Some centres also used Auramine-rhodamine fluorescence (Auramine O) as a screening method to detect mycobacterium due to its greater sensitivity than Ziehl-Neelsen staining despite lower specificity (Auramine O: sensitivity 80% and specificity 84%; Ziehl–Neelsen stain: sensitivity 60% and specificity 98%).[28] In view of the high prevalence of TB disease in our country, TB should be highly suspected in the list of differential diagnoses when necrotising granulomatous inflammation are detected in HPE.

Several limitations of this study deserve discussion. First, the forensic pathologists who performed the autopsy were not blinded to imaging findings. This may create bias for the diagnostic accuracy and determination of the cause of death. Pathologists would take extra precaution in sampling tissue for microscopic findings if they were aware of the presence of PMCT findings such as subtle changes suggestive of pneumonia. Second, different forensic radiologists were involved in the interpretation of the PMCT findings. Variance of experience with

post-mortem imaging may affect the conclusion of cause of death. Third, time since death or post-mortem interval was not taken into account as factors affecting the PMCT findings. Finally, inconsistency of method in sampling lung tissues for microscopic examination may affect its pick-up of positive findings. This may result in false negative findings in the control group.

CONCLUSION

The HPE generally had higher accuracy compared to PMCT in detection of lung infection. The routine and correct method in sampling of lung tissues for HPE would provide significant information and aid in determining the cause of death particularly lung infection. PMCT is useful as a screening tool to rule out pneumonia in autopsy cases, however, it is insufficient to substitute conventional autopsy. HPE and PMCT play important roles as ancillary investigations to supplement conventional post-mortem examination in forensic death investigation, although these scientific methods are only part of various considerations that lead to the final conclusion in a medico-legal investigation.

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