Role of Postmortem Multislice Computed Tomography Scan in Close Blunt Head Injury

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BACKGROUND: Conventional autopsy in Indonesia is not well accepted as it is contrary to religion and culture. New radiological imaging method such as multislice computed tomography (MSCT) scan has potential to be a diagnostic tool in forensic pathology. The purpose of this study is to determine the ability of MSCT scan in finding abnormalities in close blunt head injury compared with autopsy.

METHODS: This study used descriptive qualitative method. Postmortem cases in Department of Forensic Medicine and Radiology of Dr. Cipto Mangunkusumo Hospital were selected based on inclusion criteria. Then MSCT scan and autopsy were conducted. MSCT scan and autopsy results were compared and analyzed.

RESULTS: There were 491 postmortem cases of blunt head injury. However, only 10 cases fulfilled inclusion criteria. Subarachnoid haemorrhages were identified 100% with MSCT scan and 80% with autopsy. Cerebral oedemas were identified 100% either with MSCT scan and autopsy. Subdural haemorrhages were identified 100% with MSCT scan, while 50% with autopsy. Multiple fractures were identified 80% with MSCT scan, while 40% with autopsy.

CONCLUSION: MSCT scan showed a sensitive detection in finding abnormalities in close blunt head injury. Therefore it could be as an alternative choice of examination in close blunt head injury cases.
The importance of autopsy procedure has been widely recognized. Autopsy is the current gold standard for determining cause of death.(1-3) Evolution of medical science was heavily influenced by examination of corpses, a key method for description, characterization and understanding the function of human body and the effects of diseases on the target organs. From 1950 until now, several studies have contributed to the understanding of more than 80 pathologies (4) and considered to be a prerequisite for medical education and professional development.(5)

However, in recent years, the rate of autopsy decreased dramatically worldwide, from approximately 60% in 1960 to 10% or less in 2005, both in the United States and Europe (6), with a minimum of 3.7% in France in 1997 (7). Decreasing in autopsy rate is due to several factors, included: progress in diagnosis of diseases, particularly the development of advanced medical imaging methods such as computer tomography and nuclear magnetic resonance (8); the attitude of the deceased’s family, which often opposes to autopsy (9). Some authors (10-13) suggest the reluctance of the forensic experts and pathologists to perform the autopsy, possibly due to infectious risk and time consumption.

The other limitation of autopsy is “subjective and observer-dependent”, and cannot be used to provide a second opinion in court due to the fact that the body tissue are dissected and cannot be stored for a longer time except for selected parts or small specimens for histological examination.(14)

Lawrence and his Forensic-Medicolegal team of Faculty of Medicine, Hasanuddin University, in March 12, 2009, are the first in Indonesia to report the application of virtual autopsy as an alternative choice of the conventional autopsy. This method was selected as an acceptable method to conduct the scientific forensic investigation of the death of a servant with unknown cause. However, the CT scan used in 2009 was a conventional CT scan that could only provide 4 slices.(15)

We, in collaboration with the Forensic-Medicolegal team of Hasanuddin University, have also showed the virtual autopsy method as one of modalities to be used in scientific forensic investigation, in National Congress of Forensic Medicine-Medicolegal.(16)

The acceptance of virtual autopsy as the substitution of conventional autopsy is not easy to be accepted. For the eastern culture, virtual autopsy is still like a fresh air to solve the refusal conventional autopsy problem. The cost and benefit of virtual autopsy should be considered. There is another advantage of virtual autopsy, it is effective in determining kind of injury such as gunshot wounds, because it can be evaluated without breaking the structure of the body. The corpse can not be stored for a long time and dissected like usual.

Considering several limitations of autopsy, some studies were performed to overcome, such as evaluating some modalities which can help autopsy processing in determining cause of death. New radiological imaging method such as multislice computed tomography (MSCT) scan has potential to be a main diagnostic tools in forensic pathology. It is a kind of virtual autopsy, that can generate large, high quality data sets, 3 dimensions (3D), with sub-millimeter precision. Interactive visualization of these 3D data sets can provide valuable insight and enables non-invasive diagnostic procedures.(16)

There are many other reasons for increasing interest in virtual autopsy, for instance, they are time saving and more systematic. With virtual autopsy, the body remains intact, avoiding objections by family members or religious communities, and permitting additional analysis by other forensic pathologists on the same body, in effect, second or third diagnoses or opinions. Images and results of virtual autopsy are understandable for jurors in criminal cases. Furthermore infections that pose serious health risks for coroners, pathologists, and medical examination could be avoided. And finally virtual autopsy such as MSCT scan can be stored easily, conveniently and indefinitely.(17)

Postmortem MSCT scan of bodies prior to medicolegal autopsy has become a powerful tool in several forensic intitutes throughout the world. Indeed, there may be a number of advantages to perform a MSCT scan before a medicolegal autopsy. In forensic pathology as well as in clinical settings the investigation of head trauma is based
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Methods

Descriptive qualitative research design was used in this study. This study was conducted in Department of Forensic Medicine and Radiology of Dr. Cipto Mangunkusumo Hospital from February 2013 to February 2014. The inclusion criteria were *visum et repertum* to perform autopsy and close blunt head trauma as cause of death. This study has been approved by Ethical Committe of Faculty of Medicine, Hasanuddin University (No. UH 11110321).

Inclusion criteria-fulfilled postmortem cases were examined by using both MSCT scan and conventional autopsy in finding abnormalities. All abnormalities which were found from both MSCT scan and conventional autopsy were compared and analyzed.

MSCT scan was obtained by spiral (helical) scan Somatom Definition (Siemens, Forchheim, Germany), with thickness of 1 and 5 mm, increment 0.75 and 4, pitch factor 1, kernel B31f, B50f, B70f, 120 kV, 200mAs, range: cranium scan and dual energy scan. Spiral /helical scanning is characterized by continuous gantry rotation and continuous data acquisition while the corpse’s table is moving at constant speed.

### Results

During the period, there were 491 postmortem cases of blunt head injury. However, many deceased's families rejected autopsy examination, therefore only 10 cases were obtained. Subjects were MSCT scan without contrast. MSCT scan results were read by 2 radiologists. Meanwhile the autopsy was performed by a forensic specialist. Common abnormalities including subdural haemorrhage, subarachnoid haemorrhage, intraparenchymal haemorrhage, subgaleal hematome, cerebral oedema, cerebellar oedema, brainstem oedema, pneumocephalus, uncal herniation, brainstem herniation, skull base fracture and multiple fractures were found with MSCT scan and autopsy (Table 1).

**Comparison of MSCT Scan and Autopsy Results**

Eight common abnormalities in traumatic brain injury obtained with MSCT scan and autopsy were compared and analyzed. The 8 abnormalities were subdural haemorrhage, subarachnoid haemorrhage, skull base fracture, multiple fractures, cerebral oedema, brainstem oedema, brainstem herniation, and pneumocephalus.

Table 2 shows that in comparison to autopsy, MSCT scans could sensitively identify abnormalities in these 10 postmortem cases.

### Discussion

Subarachnoid haemorrhage and cerebral oedema in postmortem blunt head injury, are usually found in autopsy, could also be found with MSCT scan with similar results. Additionally, a report shows that sensitivity of MSCT scan for subarachnoid haemorrhage was 92.2%, specificity was 100%, negative predictive value was 99.4% and positive predictive value was 100%.(21) Thus, for the cause of death...
Table 1. MSCT Scan and Autopsy Results. Ten cases of postmortem in blunt head injury were MSCT scanned and autopsied.

<table>
<thead>
<tr>
<th>Case</th>
<th>MSCT Scan</th>
<th>Autopsy</th>
</tr>
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<tbody>
<tr>
<td>Case 1</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, site of brainstem haemorrhage, cerebral oedema, cerebellar oedema, pneumocephalus, skull base fracture, uncal herniation.</td>
<td>Subdural haemorrhage (at posterior fossa), subarachnoid haemorrhage, cerebral oedema, site of brainstem haemorrhage.</td>
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<tr>
<td>Case 2</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, intraparenchymal haemorrhage, site of brainstem haemorrhage, cerebral oedema, pneumocephalus, brainstem herniation, fracture of the right and left petrous bone, cerebellar oedema, posterior fossa fracture, fracture of the right and left temporal bone.</td>
<td>Subdural haemorrhage (at posterior fossa), subarachnoid haemorrhage, cerebral oedema, fractures of the (right and left) petrous bone, the burst of a partial lobe at cerebral, cerebellar, and brainstem.</td>
</tr>
<tr>
<td>Case 3</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, site of brainstem haemorrhage, cerebral oedema, cerebellar oedema, brainstem oedema, pneumocephalus, skull base fracture, posterior fossa fracture.</td>
<td>Subdural haemorrhage (at posterior fossa), subarachnoid haemorrhage, cerebral oedema, site of brainstem haemorrhage, skull base fracture.</td>
</tr>
<tr>
<td>Case 4</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, extensive intracerebellar haemorrhage, cerebellar intraparenchymal haemorrhage, cerebral oedema, cerebellar oedema, brainstem oedema, brainstem herniation, pneumocephalus, posterior fossa (occipitale bone) fracture, skull base fracture.</td>
<td>Subarachnoid haemorrhage, cerebral oedema, cerebellar oedema, brainstem oedema.</td>
</tr>
<tr>
<td>Case 5</td>
<td>Subdural haemorrhage at posterior fossa and the right frontal region, subarachnoid haemorrhage, site of brainstem haemorrhage, cerebral oedema, cerebellar oedema, brainstem oedema, pneumocephalus.</td>
<td>Subdural haemorrhage (at posterior fossa), subarachnoid haemorrhage, cerebral oedema, brainsetem oedema, cerebellar oedema.</td>
</tr>
<tr>
<td>Case 6</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, brainstem haemorrhage, brainstem oedema, cerebellar oedema, cerebral oedema, pneumocephalus, multiple fractures: fractures of the right and left frontal bone, fractures of the right and left posterior fossa, skull base fracture, fracture of the left mastoid bone.</td>
<td>Subarachnoid haemorrhage, cerebral oedema, cerebellar oedema, brainstem haemorrhage, cerebellar contusion, brainstem haemorrhage.</td>
</tr>
<tr>
<td>Case 7</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, site of brainstem haemorrhage, cerebral oedema, cerebellar oedema, brainstem oedema to the posterior fossa extensive pneumocephalus broad, multiple fractures: skull base fracture, bilateral fractures of the orbital base and the left frontal bone.</td>
<td>Subarachnoid haemorrhage, cerebral oedema, brain setem oedema, cerebellar oedema, bilateral fractures of the orbital base and the left frontal bone.</td>
</tr>
<tr>
<td>Case 8</td>
<td>Subdural haemorrhage at posterior fossa, the right intracerebellar haemorrhage, cerebral oedema with widespread narrowing systema especially systerna preoptin system in the brainstem. Multiple fractures: skull base fracture, fracture of the right and left posterior fossa, linear fracture at the right and left of sphenoid bone with pneumocephalus in the left temporal region, pneumocephalus in the posterior fossa.</td>
<td>Subarachnoid haemorrhage, fractures of occipitoparietal bone, temporal bone, sphenoid bone, and zygomaticum bone, cerebral oedema.</td>
</tr>
<tr>
<td>Case 9</td>
<td>Subdural haemorrhage at posterior fossa, subarachnoid haemorrhage, site of brainstem oedema, cerebellar haemorrhage, cerebral oedema with widespread narrowing sisterna especially sisterna preoptin system in the brainstem, linear fracture at the right and left of sphenoid bone with pneumocephalus in the left temporal region.</td>
<td>Linear fracture at the right and left of sphenoid bone. Extensive cerebral oedema</td>
</tr>
<tr>
<td>Case 10</td>
<td>Subdural hematome in the fronto-temporo-parietal (causing midline shift), subarachnoid haemorrhage, site of brainstem haemorrhage, cerebral oedema, cerebellar oedema, subgaleal hematome in the left of temporoparietal region, cranium bone fracture.</td>
<td>Cerebral oedema, cranium bone fracture.</td>
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</tbody>
</table>

related to subarachnoid haemorrhage and cerebral oedema in blunt head injury, MSCT scan could be considered as an option for finding these complications.

Bleeding is fatal, especially if it is accompanied by subarachnoid and subdural haemorrhages. A report shows that combination of subdural and subarachnoid haemorrhage is the leading cause of death for craniocerebral blunt head injury, which found more than half the cases.(22,23) From our current study, all 10 postmortem cases of blunt head injury subdural haemorrhage were found with MSCT scan, while 5 cases found with autopsy. So, this suggested that MSCT scan is sensitive enough in finding subdural haemorrhage.

Skull base and multiple fractures in blunt head injury were accompanied with tissue damages, which usually depend on the magnitude of fracture caused mechanical strength. Multiple fractures are usually caused by a large mechanical strength compared to the linear fracture. Skull
base fracture is usually fatal due to the location adjacent to brainstem as a vital organ in the brain. Skull base and multiple fractures are usually highly correlated with the incidence of intracranial haemorrhage, including subarachnoid haemorrhage. alvaria were involved in 69.3% cases while comminuted fracture of the skull was common among the fatal cases. Skull base fracture was noted only in the fatal cases and a combination of subdural and subarachnoid haemorrhage was found in the majority of the fatal cases (20,24). Identification of skull base and multiple fractures in this study were also found with MSCT scan. In addition, the radiology was reported superior to autopsy in assessing fracture.(14) In our current research, MSCT scan is superior to autopsy to visualize fracture. MSCT scan could be useful in assessing fracture, especially skull base fracture, which is difficult to be identified by conventional autopsy.

Abnormalities in blunt head injury detected with autopsy can also be detected with MSCT scan. MSCT scan has advantages which help autopsy to identify fracture, fatal haemorrhage, brainstem oedema and pneumocephalus. In addition, MSCT scan as a diagnostic modality, can perform faster and avoid contamination to the operator. Therefore, when autopsy could not be performed for some reasons, such as deceased's family refusal to act of the autopsy, priceywise, transmission of blood-borne pathogens at the time of autopsy on the corpse, MSCT scan will be taken into consideration in determining the cause of death.(8-13) Both MSCT scan and conventional autopsy have their own respective advantages. Thus, in this study, MSCT scan capabilities in finding the abnormalities found with autopsy were analyzed. Results suggest that MSCT scan with some of the highlights can be used as a complement or alternative to help autopsy in finding abnormalities.

### Table 2. Comparison of MSCT Scan dan Autopsy in finding Abnormalities.

<table>
<thead>
<tr>
<th>Abnormality</th>
<th>MSCT Scan Detected</th>
<th>Detected N(%)</th>
<th>MSCT Scan Undetected</th>
<th>Undetected N(%)</th>
<th>Autopsy Detected</th>
<th>Detected N(%)</th>
<th>Autopsy Undetected</th>
<th>Undetected N(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skull Base Fracture</td>
<td>7 (70%)</td>
<td>!&quot;#%&amp;</td>
<td>1!&quot;#%&amp;</td>
<td>4 (57%)</td>
<td>6 (60%)</td>
<td></td>
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<tr>
<td>Multiple Fractures</td>
<td>8 (80%)</td>
<td>2 (20%)</td>
<td>4 (40%)</td>
<td>4 (40%)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Subarachnoid Haemorrhage</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
<td>8 (80%)</td>
<td>2 (20%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subdural Haemorrhage</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
<td>5 (50%)</td>
<td>5 (50%)</td>
<td></td>
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<tr>
<td>Cerebral Oedema</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
<td>10 (100%)</td>
<td>0 (0%)</td>
<td></td>
<td></td>
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<tr>
<td>Brainstem oedema</td>
<td>6 (60%)</td>
<td>4 (40%)</td>
<td>2 (20%)</td>
<td>8 (80%)</td>
<td></td>
<td></td>
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<tr>
<td>Brainstem Herniation</td>
<td>1 (10%)</td>
<td>9 (90%)</td>
<td>0 (0%)</td>
<td>10 (100%)</td>
<td></td>
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<tr>
<td>Pneumocephalus</td>
<td>9 (90%)</td>
<td>1 (10%)</td>
<td>0 (0%)</td>
<td>10 (100%)</td>
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</table>

### Conclusion

In summary, our study has shown that MSCT scan has many advantages in assessing fractures, type of fatal haemorrhage, brainstem oedema and pneumocephalus. So that, If MSCT scan could be an alternative choice to help autopsy examination to identify cause of death in blunt head injury cases.

### Acknowledgement

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