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Case Report

Forensic Determination of Wet Drowning in a River Utilizing *Pennales* Diatom Analysis: A Forensic Autopsy Report

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ABSTRACT

Background: Drowning remains a significant cause of unintentional mortality, requiring comprehensive forensic investigation to determine the mechanism and circumstances of death.

Case Presentation: This case report is about a 30-year-old person whose name is not known and who was found in a freshwater river. After that, they were examined on the outside, inside and in other ways. The external findings included fine, frothy fluid coming from the airways, livor mortis that made the skin look pale, rigor mortis of the upper extremities, signs of hypoxia, and maceration of the hands. An internal examination found the Nile sign, no structural problems with the major organs, and stomach contents that were consistent with recent eating. Ancillary tests showed a positive diatom test with *Pennales* diatoms found in over 10 fields, which supports the idea of freshwater drowning.

Conclusion: However, the lung fluid study had a chance of false positives because the body had been preserved for a long time. This case underscores the persistent necessity for comprehensive forensic evaluation encompassing diatom analysis, organ examination and contextual interpretation to ascertain drowning as the cause of death.

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Introduction

Drowning is still a major cause of unintentional and unexplained deaths around the world, especially in areas with a lot of rivers and coastlines (1). Even though it happens a lot, it is still hard for forensic experts to say for sure that someone drowned because many of the usual indications, like pulmonary edema, froth formation, and soggy lungs (2), are not always present. Because of this, more tests are often needed to help understand what the autopsy found.

One of the most common extra tests done in cases of suspected drowning is diatom analysis. Diatom can get into the blood while a person is breathing in water and then they can be sent to organs that are far away like the liver, bone marrow, and kidneys (3). Their presence in these interior tissues can provide supporting evidence of antemortem aspiration (4, 5). The application of diatom testing for diagnostic purposes is contentious, stemming from apprehensions about contamination, environmental variability, and disparties in species distribution across aquatic environments (5).

Rivers and other freshwater systems usually have a lot of diatoms from the order *Penales* (6). Their ecological characteristics, morphology, and relative abundance may provide additional contextual information when evaluating water related fatalities. However, there are not enough reports right now that show how important certain diatom species are in cases of tropical river drowning (7, 8).

This case study aims to clarify the forensic findings, encompassing diatomological analysis, in a purported freshwater drowning incident. The report emphasizes the importance and interpretative dimensions of identifying *Penales* diatoms in internal organs and explores their ramifications within the broader context of forensic drowning diagnosis.

Case Presentation

A man whose name is not known but is thought to be around 30 years old was last seen alive on Thursday, August 29, 2024, at about 23.00 WIB in the Kalimas River in Surabaya, Indonesia. Witnesses say they saw the man in the river asking for help and waving his hands to get it. There was not enough light, and the wittness could not swim, so they did not try to help directly. After the event, the leader of the local community was told about it and went to see the spot right away but the victim was no longer there.

The police were officially told about the case on Friday, August 30, 2024, at about 08.00 WIB. The body was found floating near where the victim was first seen around 11.00 WIB that morning. Forensic Medicine Installation at Dr. Soetomo General Hospital looked at the remains for legal reasons.

The dead person had a one of a kind tattoo on their chest that was about 20 by 4 cm and done in black ink. On August 30, 2024 a full examination of the outside of the body was done, followed by a full autopsy a month later. To help figure out how and why the person died more tests were done like a lung exudate assessment and a diatom analysis.

External Examination

The dead person had a fine frothy fluid leaking from their airways. The back had postmortem lividity that was reddish-purple and turned white when pressed. Rigor mortis was evident in the upper extremities and could be readily countered (Figure 1). There was a 6 cm long, unevenly shaped, reddish laceration on the right forehead, just above the medial canthus. The cut was about 2.5 cm long in a straight line (Figure 2). It was believed that there were 6 to 8 hours between the time of death and the autopsy. Signs of hypoxia included conjunctival petechiae and cyanosis of the distal fingernail beds, as well as maceration of the hands (washerwoman's hands) (Figure 3).

Internal Examination and Ancillary Investigations

A midline incision was made, and the Ghon method was used to take out the organs (Figure 4). Additional tests involved examining the pulmonary fluid and conducting diatom tests. The Nile sign was visible

Figure 1. Postmortem lividity observed on the dorsal surface, presenting as reddish-purple discoloration that blanched upon pressure. Rigor mortis was present and involved the upper extremities, although it could be overcome with moderate force.

Figure 2. Irregular laceration located on the right forehead above the medial canthus, measuring approximately 6 cm in total length with reddish margins. When approximated, the wound edges form a linear configuration measuring approximately 2.5 cm.

Figure 3. (A) Asphyxial signs including conjunctival petechiae (a); (B) cyanosis of the distal fingernail beds, and hand maceration consistent with "washerwoman's hands.".

(Figure 5). The brain (Figure 6), thoracic cavity and heart (Figure 7), trachea and lungs (Figure 8), urine bladder and testes (Figure 9), and kidneys (Figure 10) all worked fine. There was something in the stomach (Figure 11).

There is a chance that the results of the lung fluid investigation are wrong because the body was kept for more than 30 days before the autopsy (Figure 12). The diatom test came back positive, which means that there were more than 10 fields with diatoms of the order Pennales that had a rod-shaped structure (Figure 13). The lungs were wet and full of fluid, and there was no smell of alcohol in them. The event occurred in a freshwater river without cold water conditions, and the postmortem interval was less than 24 hours.

Based on these results, the case was first called a wet drowning and then a normal drowning, which happened in a river with fresh water.

Figure 4. Midline incision and evisceration performed using the Ghon technique during internal examination

Figure 5. (a) Dorsal view of the calvarium after removal, showing intact external bone surface without detectable abnormalities; (b) Inner surface of the calvarium demonstrating normal dural impressions with no evidence of hemorrhage or structural pathology; (c) Cranial base following evisceration, demonstrating the *Nile sign* (arrows) without associated intracranial lesions; (d) Superior view of the brain after removal, showing preserved cortical gyri and vasculature with no macroscopic abnormalities observed.

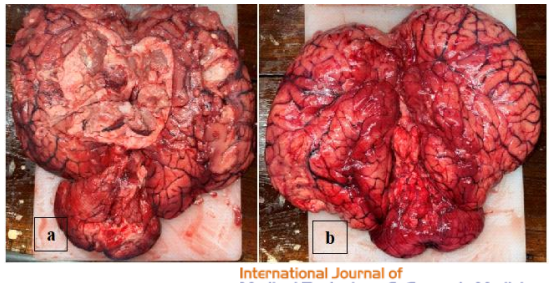

Figure 6. (a) Superior view of the brain showing intact cerebral hemispheres without focal lesions; (b) Inferior view demonstrating preserved brain structures with no evidence of hemorrhage or edema.

Figure 7. (a) Thoracic organs in situ demonstrating no gross abnormalities; (b) Heart after dissection showing intact chambers and valves without pathological changes; (c) Posterior view of the heart demonstrating normal myocardial coloration and absence of structural abnormalities.

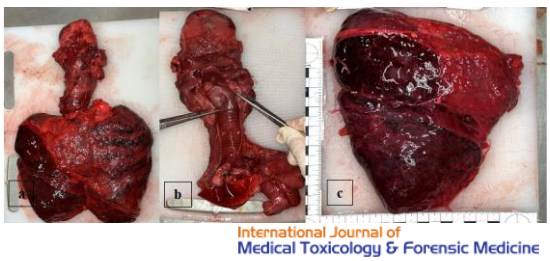

Figure 8. (a) Trachea and main bronchi showing patent lumens without obstruction; (b) Right lung displaying uniform parenchymal coloration without consolidation; (c) Left lung showing preserved architecture with no macroscopic evidence of pathology.

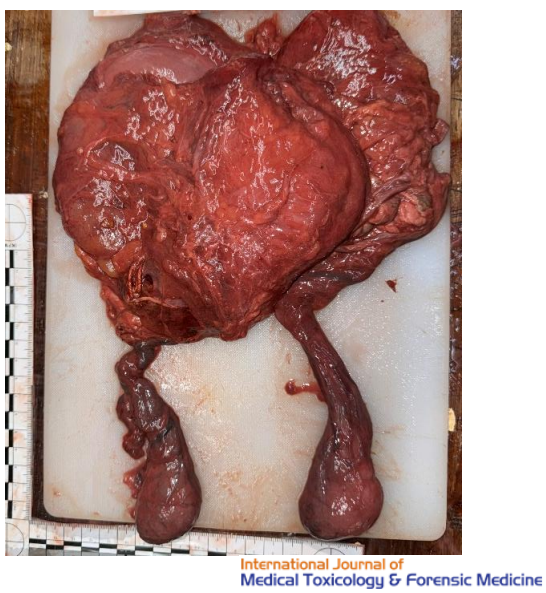

Figure 9. Genitourinary organs showing no gross abnormalities.

Discussion

The World Health Organization says that when you are in water and can't breathe, you are drowning. It is a leading cause of accidental death globally and remains a significant focus of forensic investigation due to the challenges in achieving a definitive diagnosis (9). In forensic practice, drowning is not seen as a single,

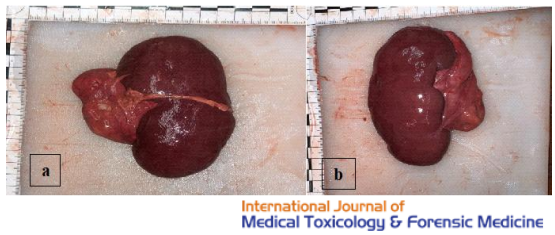

Figure 10. Gross appearance of the kidneys, with no abnormalities noted: (a) Right kidney; (b) Left kidney.

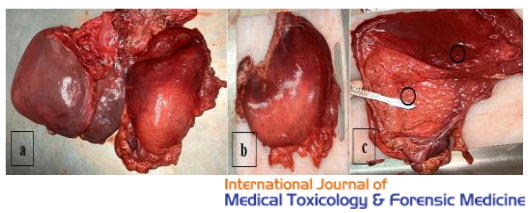

Figure 11. Stomach examination showing the presence of corpal material: (a) Stomach before opening; (b) Internal gastric mucosa after incision; (c) Corpal material identified within the gastric lumen.

uniform mechanism. Instead, it is seen as a range of physiological processes that depend on the environment, the medium used, the time between the autopsy, and the victim's unique traits (1, 9).

Wet drowning, dry drowning, secondary drowning, near drowning, and immersion syndrome are all different types of drowning (10). Most of these cases are wet drownings, which happen when water gets into the lungs and airways. There are different kinds of wet drowning, such as drowning in dirty water, seawater, or freshwater. These classifications are important because different types of water have different effects on the lungs, circulation, and balance of electrolytes (8, 11).

When someone drowns in freshwater, they usually breathe in hypotonic water, which quickly passes through the alveolar-capillary membrane. This leads to hemodilution, hemolysis, and pulmonary edema (11). Common forensic findings may include frothy fluid in the airways, lung congestion and edema, washerwoman's changes, conjunctival petechiae, and positive diatom tests. None of these traits are pathognomonic by themselves, but they do make the diagnosis stronger when taken together (1, 10).

In this case, a lot of different things strongly support the idea that it was a wet freshwater drowning. Externally, the emergence of fine white froth from the airways, lividity corresponding to the body's position, early rigor mortis, conjunctival petechiae, peripheral cyanosis, and "washerwoman's hands" are prevalent indicators of hypoxia associated with drowning (10, 11). The uneven cut on the forehead shows that there

was blunt force trauma before or after death, but it doesn't go against the idea that the person drowned. Instead, these kinds of minor injuries might happen when you first get into the water or when you move around in it later (10, 12, 13).

An internal examination further substantiates the diagnosis. The lungs were very wet and full of fluid, which is a sign of wet drowning. The absence of anomalies in the brain, thoracic organs, trachea, and abdominal organs signifies the lack of concurrent fatal pathology. The stomach notably contained corporeal material, possibly signifying agonal ingestion during drowning.

Diatom analysis, despite the possibility of false-positive lung fluid results due to prolonged body storage, provided additional evidentiary support. Finding rod-shaped diatoms of the order Pennales in more than ten small fields is in line with the Kalimas River's freshwater setting. When ambient diatoms and internal discoveries match, like they do in this case, positive diatom results are very important. The diatom profile enhances the overall diagnostic significance (7, 14), despite lacking definitive status independently.

The external features, pulmonary findings, freshwater habitat, and diatom examination collectively support the diagnosis of standard wet drowning in freshwater. The estimated postmortem interval of less than 24 hours at the time of discovery further supports the morphological findings, even though the body was stored in a refrigerator for a long time before the autopsy.

Conclusion

In conclusion, integrating our understanding of drowning mechanisms with the specific autopsy findings in this case establishes a definitive connection to wet freshwater drowning, a recognized form of typical drowning. The presence of external signs of asphyxia, changes in the lungs, a positive diatom test, and the investigation's history all support this conclusion. There have been no other major causes of death found.

Conflicts of Interest

The authors report there are no competing interests to declare.

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