Medico-legal Significance of Diatoms Detection in Different Organs of Drowning Victims

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Abstract

Background: Drowning is a main universal community health problem & In Medico- Legal Aspect the autopsy diagnosis of drowning presents one of the major problems especially when there is delay in recovering the victim from water.This study concentrates on the significance of diatoms detection in different organs to reach more accurate diagnosis of drowning.

Objective: To determine the diagnostic features of drowning depending on detection of diatoms in deep tissues of drowning victims.

Methods: This study was performed at Medico-legal Directorate (M.L.D.) in Baghdad for (12) month[s] within the period from 1/1/2018- 31/12/2018. Full proper autopsy including external and internal examination of the body for all cases was performed, after obtaining complete medico-legal history, in addition to diatoms detection in different organs of drowning victims to determine the cause of the death as due to drowning.

Results: The study included (60) cases, (52) male and (8) female with their ages ranged between (15-44 years old) for male , while ages ranged between (1-44 years old) for females . Drowning was the cause of death in all cases. Among the most important results of this study is the presence of diatoms in the different organs of the drowning cases. The diatoms were found in the lung in all drowning cases (100%), and found in other organs in a percentage that increased with the duration of immersion.

Conclusion: Drowning is the 10th cause of violent deaths in Baghdad. And important point in the diagnosis of drowning by detection of diatoms in different organs of drowning cases and pennate diatoms was common type in Iraqi waters and also study showed Aulacasiera granulata sp. common in Iraq.

Keywords: *Medico-legal, diatoms detection, Drowning.*

Introduction and Literature Review

Drowning is the process of experiencing respiratory impairment from submersion / immersion in liquid as stated by WHO. (Van, et al,2005; Joost, et al, 2016) In Medico-legal view drowning is a type of asphyxia due to aspiration of fluid either water, milk, oil ...etc instead of air following immersion of whole body or nose and \ or mouth under the level of fluid. (Hussein, 1999; Hassan, 1980 ; Ali, 1976 ; Al-Jabri, 2000).In drowning there is relation between liquid and air junction at the entrance of the airway prevents breathing air . (Idris, et al, 2003) Drowning could be considered as a mixture of mechanical presence of water within the respiratory system (mechanical asphyxia)with liquid and electrolyte changes depending on the medium (either sea or fresh water) in which immersion has occurred. (Simpson , 2011)

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Autopsy Signs include those of immersion and drowning signs. Immersion signs are Maceration of the skin ,becomes wrinkled, pale and wet so-called 'washerwoman's skin'. Cutis anserina is a common sign in immersed bodies but is connected to cold rather than warm water and cause a generalized pimpling of the skin. (Knight,2004)

The hypostasis of bodies is frequently pink, this color is caused by the presence of unreduced oxyhemoglobin in the superficial blood vessels, but has no diagnostic value.(Joost, et al, 2016; Knight,2004)

Mud, coal-slurry, oil, silt or sand present on the body, in addition to other artefacts such as seaweed, waterweed, algae. Mud may be adherent to the whole-body surface and clothing. Sand may be found deep in the respiratory passages and stomach, especially if the body has been rolled by the waves on a beach. But deep penetration is not sign of live aspiration. (Knight,2004) Other features include contraction of scrotum, and algae growth on the skin.(Knight,2004 ; Roll, 2004 ; Nandy, 1996)

Drowning signs include froth in the air passages as a positive sign in fresh bodies. Froth is also seen around mouth and nostrils. (Knight,2004)

Froth also observed in epilepsy, electrical shock, drug intoxication and cardiogenic pulmonary edema. (Simpson , 2011; Forens , et al, 1998)

The most important organ to observed the cause of death in drowning are lungs. They are distended brick red in color, with signs of emphysema. (Knight,2004; Hallery, 2003)

Miscellaneous signs in drowning include bloody or watery fluid in the intracranial sinuses, engorgement of solid organs, reduced weight of the spleen, Tardieu spot on organ and muscular hemorrhages in the neck. (Simpson , 2011)

Cadaveric spasm is a positive sign and may be see in one or both hands. There may be grass, herbs, or gravel in the fist of the victim . (Simpson , 2011; Knight,2004)

Diatom in the diagnosis of drowning:

In Medico-legal practice, the environment of water is more complex than that of the land, Recently, forensic diatomology plays an important role in diagnosis of drowning cases. (Hallery, 2003)

Diatoms are unicellular algae, eukaryotic microorganism measuring from 5 micron -3 mm (Bate, 2004) , belong to the class of Bacillariophyceae which includes in excess of (15 000) species living in sea &fresh water. The skeleton of these algae is called a frustule which is constituted by two valves fitting together to enclose the cytoplasm (Ludes, et al , 2003) , and made of hard silica .Due to this hard smilacaceous skeleton, diatoms can be recovered from putrefied or injuried tissues due to enzymatic or acid digestion.(Ludes, et al, 1999)

Diatoms are non-motile .(Crawford, et al ,1990) Diatoms are responsible for about 20–25% of global oxygen production.(Smolt, et al , 2010) Not all diatoms are able to penetrate the body organs through the lung cavity. The diatoms which can penetrate through this capillary network are called Drowning Associated Diatoms (DAD). (Modell, et al, 1999) A medicolegal & algological collaboration in lasting several years aimed at developing methods for dealing with cases found in water where the circumstances are not clear.(Lunetta, 2005) The specimens for diatom detection are taken from bone marrow, sphenoidal sinus aspirate, lung , liver , both kidneys , and brain. About 25gm of specimens to be taken without any contamination and collected in a clean glass bottle . (Pollanen, 1998) The acid resistant extracted material is isolated from specimens with some water from the drowning medium and would be examined microscopically to detect diatoms. .(Lunetta, 2005)

Diatom test is used for diagnosis of drowning is based on the present diatoms in the medium where drowning had taken place. The inhaled water enters the alveolar spaces of lungs and penetrates from the alveoli into the blood circulation, thus diatoms will be transported to different organs of body. The diatoms found inside the organs of drowned victim is a conclusive evidence to support the diagnosis of death by drowning. Diatoms are classified as Class Bacillariophyceae that is divided into two Orders. The Centric (Biddulphiales) which have valve striae arranged basically in relation to a point, an annulus or a central areola and tend to appear radially symmetrical as in figure (1). The Pennates (Bacillariales), which have valve striae arranged in relation to a line and tend to appear bilaterally symmetrical as in figure (2), their silica-based skeletons do not readily decay, and they can sometimes be detected even in heavily decomposed bodies.(Kaushik, 2017)

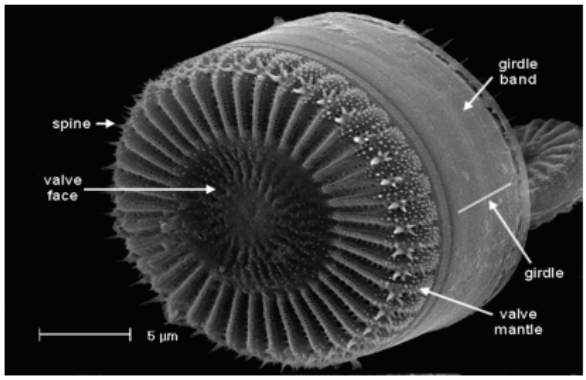

Figure 1: Centric diatom

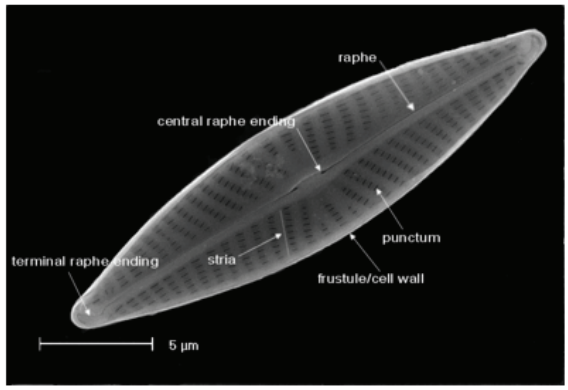

Figure 2: Pennate diatom

This study is aimed to determine the diagnostic significance of diatoms detection in different internal organs of victims in drowning cases.

Subjects and Methods:

Site and Duration: Medico-legal Directorate (M.L.D.) of Baghdad for one year duration from 1\1\2018 till 31\12\2018.

Subjects: sixty victims of drowning. Inclusion criteria: Cases with circumstantial evidence favoring drowning death. Exclusion criteria: Decomposition.

Method

Full forensic autopsy consisting of external examination including that of the clothes and external signs followed by internal examination after taking history of the incident from the autopsy request form written by the police authority and from the relatives of the victims. Tissue samples were taken from different organs for detection of diatoms type and species , and this includes:

1. Taking specimens (about 1 gram) from lungs ,heart ,liver ,kidneys and brain.

2.Putting them in a mixture of ethanol alcohol (20%) and(80%) distilled water.

3. Taking bone pieces from sternum or femurs and washing them in distilled water. Longitudinal sections to be made using a clean band saw, then taking sample of (1 g) to be placed into a mixture of ethanol alcohol(20%) and(80%) distilled water.

4.keeping samples in a cool atmosphere (refrigerator).

5. Sending samples to the toxicology lab. to investigate them for diatoms.

Laboratory investigation for Diatoms:

one gram from each organs are taken and placed in glass bake. Sulphuric acid diluted with distilled water (30%,70%) is added until the volume is twice that of the original sample. The sample then will be placed at room temperature over night to dissolve the organic matter. Sulphuric acid removes resistant dirts In this method no foaming will be produced . After that centrifugation will be done in test tube with (4000) rpm for (10) min. The supernatant will be discarded and sediment washed several times by distilled water. The previous process are repeated (3 – 4) times.From each sample (100) microliter is taken, spread on a surface of slide and dried in oven at (70 - 90°C). The slides are examined under light microscope (Novel type) . The diatoms were identified according to morphology & species. Diatoms resist putrefaction, so diatom test is valuable even if the decomposition is advanced . Diatom test is negative in dead bodies thrown in water and in dry drowning .In diatom examination, the control water samples must be used for comparison purpose . Standard diatom samples can be preserved on slides and can be used as standards for comparison purpose. The test is positive if minimum of (20) diatoms are identified in each (100 µl) of sediment extracted from lung sample and if more than (5) diatoms in each(100 µl) of sediment extracted from a tissue samples .

Results

The study included (60) cases, (52) male and (8) female with their ages ranged between (15-44years old) for males , while ages ranged between (1-44years old) for females . Drowning was the cause of death in all cases.

This study showed the presence of diatoms in different organs of the drowning victims . The diatoms were found in the lung in (100%=60) of cases, in the liver in (41.7%=25) of cases, in the kidny in (40%=15) of cases, and there were no diatoms in bone marrow and brain (if the duration of immersion is about 30 minutes).Other results were obtained in other durations of immersion as shown in figure (3).

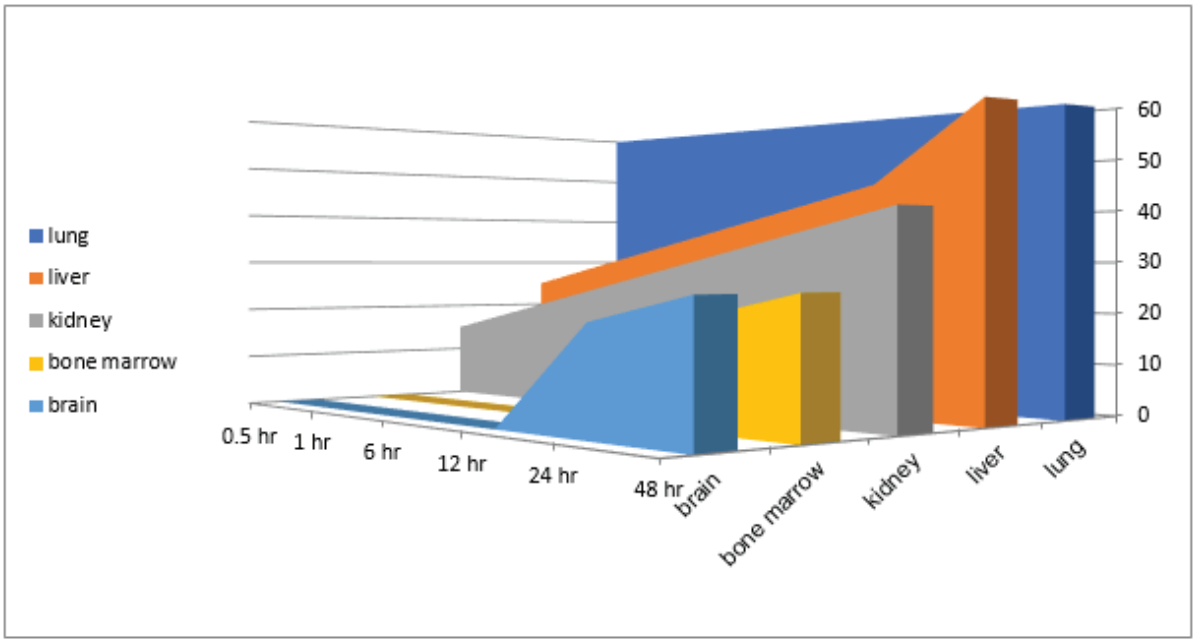

Figure 3 :- Presence of diatoms in samples of different organs according to the duration of immersion in water.

This study showed that there are two types of diatom in fresh water, the first is pennate diatom in a percent of about (75%) or in (45) cases. The second type is centric diatoms in a percent of (25%) or in (15) cases as in figure(4).

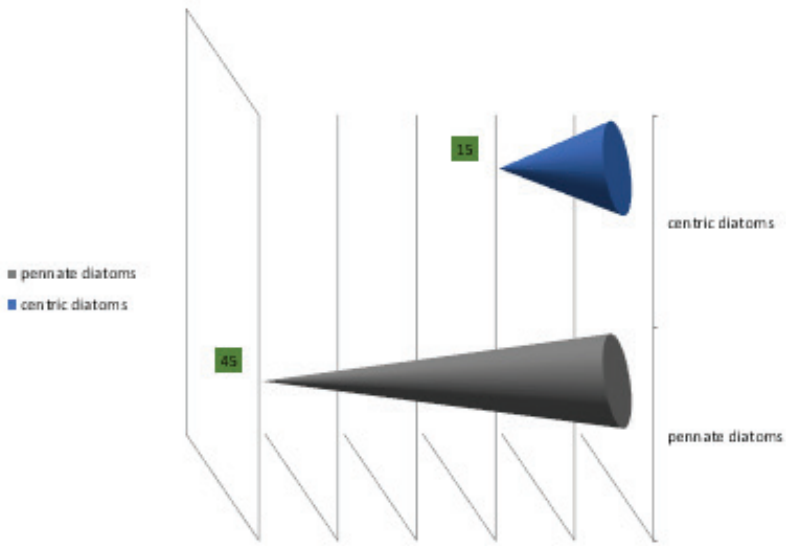

Figure 4 :- Diatoms type in drowning cases.

The Aulacasiera granulate sp. Was the most common in fresh water in this study (in about 43.3% of cases =26). While Amoeba sp. Was discovered in about (3.3%) or (2) cases as in Table (1) . See also figure (5) & (6).

Table 1: Diatoms species in drowning cases.

Diatoms species in drowning cases	Frequency	%
Aulacasiera granulata sp.	26	43
Cyclotella sp.	12	20
Nitzschin filiforms sp.	10	17
Gurosigma sp.	10	17
Amoeba sp.	2	3
Total	60	100

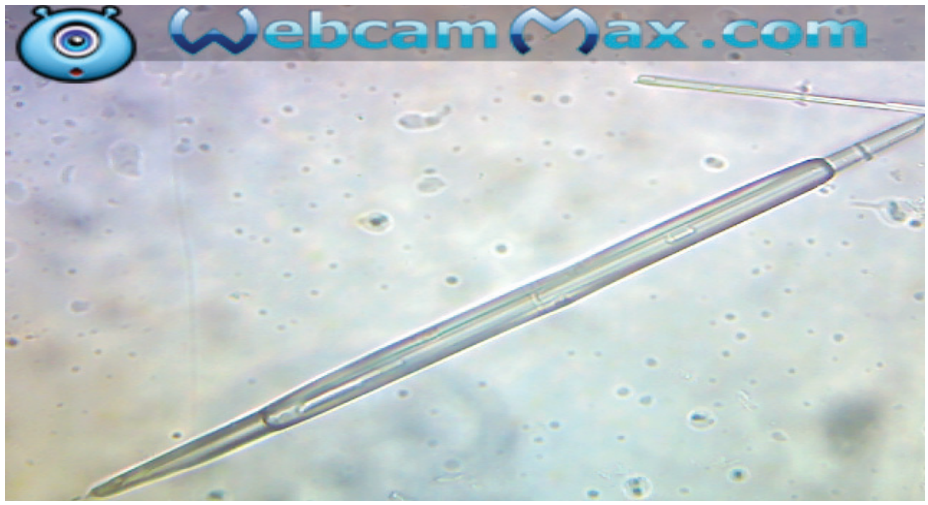

Figure 5 : - Pennate diatom , shows the filamentous diatom *Aulacosiera granulate.* x 400

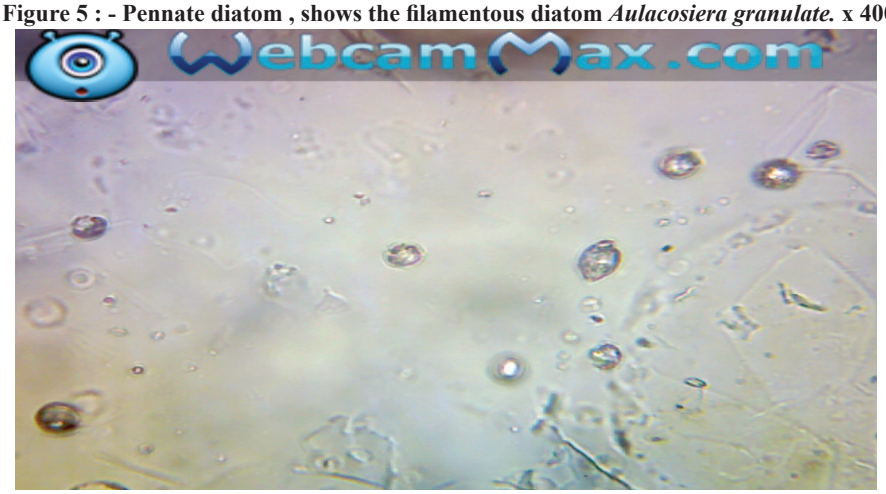

Figure 6 : - Centric diatom , Cyclotella sp. x 400

Discussion

In this study the diatoms were found in the lungs in all drowning's victims if the period of immersion is about 30 minutes as in Figure(3) because the lungs are the first invaded by water in drowning. While in other organs, such as the liver, kidneys, brain and bone marrow the presence and percentage of diatoms varies according to the duration of immersion in water. Those results agrees with an Indian study. (Kaushik,2017)

The study also showed the presence of diatoms in the body organs of the drowning victims in all cases due to the fact that the person was alive during drowning and he inhaled water containing diatoms that moved to various organs of the body, so diatoms detection in samples taken from differnt organs of victims specially those other than lung and stomach are very helpful in diagnosis of drowning as it is a challenge in forensic practice. (Robert; Stemberg, 2009)

The Pennate type of diatoms was commoner than the centric in this study. The commonest species respectively were Aulacasiera granulata sp., Cyclotella sp. , Nitzschin filiforms sp., Gurosigma sp., Amoeba sp., were found to be frequent respectively in Iraqi water Table(1) in agreement with the above mentioned Indian study.(Kaushik,2017)

The detection of diatoms in the lungs alone (Found in all cases in this study) is also helpful in the diagnosis of drowning . The result that was also found in a study from srilanka.(Gunatilake,2010)

Conclusion

Diatoms detection in samples from lung and different other internal organs of drowning victims are very helpful in the diagnosis of drowning cases in addition to the traditional external and internal findings. Diatoms were present in the lung in all cases of drowning, while diatoms detection in other organs was in relation with the period of immersion of the victim.

Diatoms of Pennate type specially that of Aulacasiera granulata sp. was the most common in Iraq.

References

1. Van, F., et., al., A new definition of drowning: towards documentation and prevention of a global public health problem, vol. 83, p. 853–856, Bull. World Health Organ, 2005.
2. Joost, J., et., al., Physiology of Drowning: A Review, physiology journal, Volume 31, p. 147–166, American Physiological Society, 2016.
3. Hussein, Osman Salem, Forensics, First Edition, Chapter 4, p. 121-136, Tihama Typical Presses, New, 1999.
4. Hassan, Zia Nouri, Asphyxiation, Judicial Medicine and Medical Practice, Chapter 1, p. 181-203, Directorate of Dar al-Books For Printing and Publishing - Mosul University.1980
5. Ali, Wasfi Mohammed, Suffocation, Forensic Medicine, Science and Application, Fifth Edition, Part 1, Chapter 5, P. 334-406, Knowledge Press, Baghdad, 1976.
6. Al-Jabri, Jalal, Asphyxia, Judicial Forensics, First Edition, p. 215-219, Dar al-Culture, Publishing and Distribution Library, Jordan, 2000 .
7. Idris, AH., et., al., Recommended guidelines for uniform reporting of data from drowning: the "Utstein Style". Resuscitation, vol. 59, p.45-57, 2565–74, 2003.
8. Simpson C., immersion and drowning , Simpsons Forensic Medicine , 13th Ed., Chap. 16, p.163 -167 , MPS Ltd ., a Macmillan Company, India 2011 .
9. Knight, B., Immersion death, Forensic Pathology, third edition, Chapter 16, p. 395- 407, A Garamond by Charon Tec Ltd., A Macmillan Company, India, 2004.
10. Roll, H., Drowning: still difficult autopsy diagnosis, Forensic sci. int., vol. 163, p. 1-9, Elsevier Ireland Ltd. 2004.
11. Nandy, Apura, Violent Asphyxia Death, principle of Forensic Medicine, chap.16,p. 142- 336, New central book Agency (p.) LTD., India , 1996 .
12. Forens , P., et., al., Diagnosis of drowning by combined Computer assisted histomorphometry of lung with blood Strontium determination ,J. Forensic Sci., Vol. 43, p. 772- 779 , 1998 .
13. Hallery, J., A., Organ weight effects of drowning and asphyxiation on lung, liver, brain , heart, kidney, spleen , J., Forensic Int., Vol. 137 , p. 239- 246 , 2003.
14. Bate, G.,C., Benthic diatoms in the rivers and estuaries of South Africa, Water Research Commission. Pretoria,2004.
15. Ludes, B., Fornes, P., Drowning in, Forensic Medicine, Clinical and Pathological Aspects,

Greenwich Medical Media, p. 247-257, 2003.

16. Ludes, B., , et. ,al., Diatom analysis in victim's tissues as an indicator of the site of drowning, Int., J., Legal Med., Vol. 112,p. 163-166,1999.
17. Crawford, R., M., et., al., The Diatoms: Biology & Morphology of the Genera, Cambridge University Press, 1990.
18. Smolt, J., P., et., al., The Diatoms, Applications for Environmental and Earth Sciences, Second Edition, Cambridge University y Press, p.667, 2010.
19. Modell, J., et., al., Drowning without aspiration: is this an appropriate diagnosis, J. Forensic Sci., Vol.44, p. 1119-1123, 1999.
20. Lunetta, P., Microscopical, microscopical, and laboratory findings in drowning victims – A comprehensive view. Forensic Pathology Reviews – Chapter 1, Volume 3, p. 3–77, Humana Press, 2005.
21. Pollanen, M., Forensic Diatom- ology and drowning, 1st edition, Elsevier pr., p. 83-91, 1998.
22. Kaushik, N., Role of Diatoms in Diagnosis of Death Due to Drowning , Case Studies, International Journal of Medical Toxicology and Forensic Medicine, Vol.7, No.1, p. 59-65, 2017.
23. Gunatilake, P.G.L. et., al., Drowning associated diatoms IN SRI LANKA Department of Forensic Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka, Journal of Forensic Medicine, Science & Law, Vol.1 No.2, p., 23-24, Sri Lanka, 2010 .
24. Robert, N., M., and Bibi ,Sangha, barrister, Diagnostics of Drowning Cases, Networked Knowledge , Medical Issues, webmaster@howstat.com.
25. Stemberg, V., et., al., Immunohistochemical surfactant protein-A expression: fatal drowning vs. postmortem immersion, US National Library of Medicine, National Institute of Medicine, Vol.72, p. 413-5, Croatia, 2009.