International Journal of Research in Medical Sciences
Anand TP et al. Int J Res Med Sci. 2016 May;4(5):1479-1484
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20161214

Research Article

Diatom test: a reliable tool to assess death by drowning?

Anand T. P.[1], Unmesh A. K.[2]*,

[1]Department of Forensic Medicine, Government Medical College, Thrissur, India
[2]Department of Forensic Medicine, Government Medical College, Alappuzha, India

Received: 19 February 2016
Accepted: 22 March 2016

***Correspondence:**
Dr. Unmesh A. K.,
E-mail: drunmeshak@gmail.com

ABSTRACT

Background: Post mortem analysis of drowning is a classical problem especially in decomposed bodies recovered from water. One of the important issues in the study of drowning has been the search for a sensitive, specific and easily applicable test for the cause of death. The aim of the present study was to identify the presence of diatoms in cases of death due to drowning and to compare with non-drowning cases. The seasonal variations in the presence of diatoms in water samples collected from different water sources were also assessed.
Methods: Specimens of bone marrow, nasal sinus aspirate and lung bits were collected from 50 known drowning cases and water samples from the site of recovery of the bodies. The bone marrow, lung bits in 50 non-drowning cases and their house hold drinking water was also analyzed for detecting presence of diatoms.
Results: 50 drowning cases were studied. Only 21 cases showed positive diatom test and the rest showed negative results. Out of the cases the number of drowning was more in the rainy season. It was seen that the diatom population increased in the spring season and decreased in the rainy season. Hence the diatom test showed more negative results during the rainy season. The test was more positive during spring and summer season. In the non-drowning cases, 40 cases showed positive diatom but only 10 showed presences of diatoms in bone marrow.
Conclusions: Diatom test in drowning is significant even though occasional diatoms may be recovered in bone marrow in non-drowning cases. As in the diatom test, we are comparing the identical diatoms in both bone marrow and the putative drowning medium. Just the presence of diatoms in tissues is not sufficient in giving a positive opinion in drowning cases. This diatom test is very valuable in drowning deaths especially in decomposed states as other findings of drowning may be lost or obscured due to decomposition.

Keywords: Drowning, Diatoms, Seasons, Pennate

INTRODUCTION

Hippocrates hypothesized that the menstrual function is diatoms are microscopic unicellular algae with a silicaceous exoskeleton. Diatom test assumes that when a person drowns in diatom containing water these microscopic algae are inhaled, penetrate the alveolar capillaries and circulate by a still beating heart to distant organs such as brain, kidneys, liver and bone marrow.[1] These organs are removed at autopsy, acid digested and examined for presence of diatoms. Therefore the presence of diatoms in the organs and bone marrow is an indication of ante mortem inhalation of water. Diatoms are known to vary in type and population in various water collections in various regions and in different seasons.[2] For this reason, studies of diatom species and blooms of seasonal variation conducted on the region may be applicable in forensic evaluation of death in drowning.[3] Local studies regarding the diatoms are rather lacking in our state. This study attempts to assess the significance of diatom test in various drowning cases, seasonal variation

of diatoms in a year and a search for diatoms in the bone marrow and lungs in non-drowning cases.

METHODS

The study was conducted in department of Forensic Medicine, Medical College, Thrissur, India.

The specimens of bone marrow, nasal sinus aspirate, lung bits are collected from 50 dead bodies in drowning cases and water sample from the site of recovery of bodies, in medico legal autopsies conducted at Medical College, Thrissur. The method internationally accepted as described by Pollanen MS is used in the study. In this study instead of femoral bone marrow, sternal bone marrow is used. The bone marrow, lung bits in 50 non drowning cases and their house hold drinking water is analysed for detecting the presence of diatoms.

Inclusion criteria

Cases of drowning including decomposed bodies.

Exclusion criteria

Cases other than drowning are not included as confirmed by history and police investigation. Bodies with multiple fractures were excluded from the study.

Collection and preparation of specimens

Collection of water sample; Samples of putative drowning medium are collected as soon as possible after the body is discovered. Approximately 1000 ml of water is collected. Water samples are placed in clean containers labelled. A diatom free formalin solution is added to water (1ml 2% formalin in water) to inhibit microbe growth indefinitely so that the same can be stored at room temperature.

Collection of biological samples

After midline incision during autopsy the sternum is carefully removed the 25gm of bone marrow without any contamination is collected in a clean glass bottle.

After removing the sternum and extracting the bone marrow in a clean glass bottle, 25gms of both lungs is removed and collected in another clean bottle.

After opening the cranial cavity nasal sinus (sphenoid sinus) is opened and the fluid present in it is aspirated and collected same as the bone marrow and lungs mentioned above.

Examination of specimens

The acid resistant extracted material isolated from the bone marrow, lungs, nasal sinus aspirate and the water from the drowning medium is examined microscopically to detect identical silica based frustules of the putative diatoms.

RESULTS

50 drowning cases were studied. Only 21 cases showed positive diatom test and the rest showed negative results. Out of the cases the number of drowning was more in the rainy season. It was seen that the diatom population increased in the spring season and decreased in the rainy season. Hence the diatom test showed more negative results during the rainy season. The test was more positive during spring and summer season. In the non-drowning cases, 40 cases showed positive diatom but only 10 showed presences of diatoms in bone marrow. The following values were observed during the study period from April 2011-march 2012.

Table 1: The total drowning cases (5) and their sites in four seasons during the study period in the department of forensic medicine, medical college, Thrissur, India from April 2011 to March 2012.

Drowning sites	Total drowning cases during the 4 seasons			
	Summer (April-June)	Rainy (July-September)	Winter (October-December)	Spring (January-March)
Well	6	8	5	5
Pond	2	2	4	2
River	2	2	1	2
Tank	0	0	1	0
Canal	1	1	0	0
Sea	0	1		0
Stream	0	1	0	1
Paddy field	0	2	0	0
Water Pit	0	1	0	0
Total	11	18	11	10

Table 2: Number of cases of drowning studied (50) and the result of diatom test during the study period and their distribution in the 4 seasons in the department of forensic medicine, medical college, Thrissur, India.

Season	Number of drowning cases	Number of positive tests	Number of negative test
Summer	11	5	6
Rainy	18	7	11
Winter	11	4	7
Spring	10	5	5
Total	50	21	29

Table 3: The diatom test results in various sites in drowning cases in the four seasons.

Drowning sites	Seasons							
	Summer (April-June)		**Rainy (July-September)**		**Winter (October-December)**		**Spring (January-March)**	
	Diatom test		Diatom test		Diatom test		Diatom test	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Well	2	5	3	6	2	4	1	2
Pond	1		1	1	1	1	2	1
River	1		1	1		1	1	1
Tank		1				1		1
Canal	1		1	1				
Sea								
Stream			1	1	1		1	
Paddy field				1				
Water Pit								
Total	5	6	7	11	4	7	5	5

Table 4: The seasonal variation of various diatoms observed in a pond near mosque at Velakkode, Wadakkanchery Thrissur, India during the four seasons from April 2011 to March 2012.

Diatom species	Seasonal variation of diatoms in a pond			
	Summer	**Rainy**	**Winter**	**Spring**
Cocconis	++	+	+++	++
Cuniate	++	+	++	++
centric	+++++++++	+++++++	+++++++++	++++++++++
Naviculoid	++	+	+++	++++
Small pennate	+++++++	+++++	+++++++	+++++++++
Heteropolar	+++	+++	++++	++++
Dorsiventral	+++	++	+++	+++
Nitzschia	+++	++	+++	++++
Elongated	++	+	++	++
Filamentous	++	+	++	+++

DISCUSSION

During the period of study from April 2011 to March 2012 there were 50 drowning cases autopsied in Department of Forensic Medicine medical college, Thrissur (Table 1). Out of these there were 11 cases in summer season, 18 cases in rainy season, 11 cases in winter season and 10 cases in spring season. The drowning cases were more during the rainy seasons and equal and low during the spring and summer. In all seasons the well was the most predominant site of drowning and least were the sea and water. During the study 50 drowning cases were studied. Out the 50 drowning cases 21 cases showed positive diatom test and 29 showed negative diatom test (Table 2). During the rainy season there was increase in the drowning cases compared to the other seasons. Out of the 18 cases studied during the rainy season only 7 cases were positive and 11 cases were negative. In winter seasons 4 out of the 11 cases showed positive diatom test and 7 cases showed negative diatom test. In the spring season out of the 10 cases of drowning 5 cases showed negative test and 5

cases showed positive diatom test (Table 3). The diatom test during the study period showed an increase in the negative test during the rainy season. The test was more positive during the spring and summer seasons. The microscopic examination of bone marrow studied during the diatom test showed pennate and centric types which were the smaller diatoms in the putative drowning medium compared to the vast variety of diatoms in drowning medium. The pennate types were more common than the centric types.

Fifty different sites such as well, pond, river, canal, paddy field, stream and sea were studied during the four seasons for seasonal variation (Table 4). It was found that there was an increase in the diatom population during the spring season and a decrease in the rainy seasons.[4,5] In the winter and summer seasons the diatoms count did not show much change. The variation of diatoms was mostly seen in ponds. The samples from house well did not show much change as that of the ponds and rivers.

Bone marrow and lungs studied in non-drowning cases showed presence of diatoms in the lungs. In 40 cases out of the total 50 cases, only 10 non drowning cases showed diatoms in bone marrow. The diatoms seen in bone marrow were very less in number that only one or two were seen in one full slide. Mostly these were centric or small pinnate types. The diatoms in lungs showed pennate, centric and naviculoid in abundance. The filamentous and elongated forms were absent. While a positive comparison of presence of diatoms in bone marrow and the water sample is helpful, a negative result does not rule out drowning.[6] The diatom test does provide reliable supportive evidence when the tests are made on all enclosed organs, skeletal muscles and femoral bone marrow.[7] The possibility of the presence of diatoms in the tissue of non-drowned people is the root of much of the criticism of the diatom test.[8]

The reliability of diatom test as a predictor of death by drowning has been debated for long. Though from the present study we find the diatoms positive only in 21 of the 50 cases, the fact that, the diatom population is increased during the spring season and the majority of cases taken for the study were during the rainy season should be accounted. Hence the role played by the diatom test as a predictor of drowning cannot be underestimated.

From the findings of the present study we conclude that:

The drowning cases were more during the rainy seasons and equal and low during the spring and summer seasons.

In our study in spite of the increase in the drowning cases in rainy seasons there was a decrease in the number of positive diatom test as compared to the other seasons.

In our study there was a decrease in the diatom population during the rainy seasons and an increase in the spring season which suggests that the diatom bloom at the study area is spring season. The decrease in the diatom during rainy season may be due to the over dilution of water collections due to rain and may be due to the decreased multiplication. The increase in the diatom population noted in spring seasons may be due to the relative less frequent of rains and abundant supply of sunlight and nutrients and conditions which favour their multiplication. The decreased sunlight may be the reason for the relatively decreased number and varieties of diatoms in water tanks and house wells since diatoms are unicellular algae and photosynthetic and require sunlight for their life and metabolism. This relative decrease in the diatom population correlates with the increased frequency of negative diatom test in drowning in water tanks and wells.

The lung samples of non-drowning cases showed diatoms in 80% of cases and may be due to the inhalation of diatoms in the atmosphere. The diatoms seen in the bone marrow was very less that only one or two diatom frustules seen in the entire slide.

This suggest that diatom test is drowning is significant even though occasional diatoms may be recovered in bone marrow in non-drowning cases. As in the diatom test, we are comparing the identical diatoms in both bone marrow and the putative drowning medium not merely detecting the diatoms in tissue the test is significant in drowning.

CONCLUSION

As from the study, it is found the number of identical diatoms detected in drowning test should also be considered in giving the positive result. Diatom test in drowning death especially in a decomposed state, as other findings in drowning may be lost or obscured due to decomposition changes, as a corroborate evidence in medico legal cases.

AKNOLWEDGMENTS

Authors would like to deeply acknowledge the help of Dr. P.C. Ignatius, Professor of Forensic Medicine, Government Medical College, Thrissur, India for his guidance.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Gettler AO. A method for the determination of death by drowning. JAMA. 1921;77:1650-2.
2. Porawski R. Investigation on the occurrence of diatoms in organs in deaths from various causes. Journal of Forensic Medicine. 1966;13(4):134-7.

3. Giri BS, Tripathi CB, Chowdary YB Characterization of drowning by diatom test. Indian J Med Res. 1993;98:40-3.
4. Round FE, Crawford RM, Mann DG. The Diatoms: Biology, and morphology of the genera. Cambridge University Press; 1990.
5. Cox EJ. Identification of freshwater diatoms from live material. New York: Chapman and Hall, 1996.
6. Vincent J. Dimaio, Dominic Dimaio. Forensic Pathology. 2nd edition. USA: CRC Press; 2007: . 413-421.
7. Camps FE, Ann E. Robinson AE, Lucas BGB. Gradwohl's Legal Medicine. 3rd edition. Great Britain: Bristol John Wright & Sons Ltd; 1976: 353-4.
8. Pollanen MS. Forensic Diatomology and drowning. 1st edition. Elsevier, 1998 : 83-91.

Cite this article as: Anand TP, Unmesh AK. Diatom test: a reliable tool to assess death by drowning?? Int J Res Med Sci 2016;4:1479-84.

Proforma for collection of samples of the case group in the study of diatoms in drowning

1) Serial number :
2) Name :
3) Age :
4) Place :
5) Date :
6) Postmortem Number :
7) Crime number and police station :
8) Location of body recovered:
   a) Pond ☐ b) River or stream ☐ c) Well ☐ d) Canal ☐
   e) Others
9) Type of water: a) Running water ☐ b) Stagnant Water ☐ ☐
10) Date and time of death as per the police records:
11) Date and time of Postmortem examination:
12) Postmortem Interval in hrs:
   Within 24hrs between24 and 48hrs between 48 and 72 hrs ☐ ☐
13) General Examination Height**:** .....cms. Weight**:** …….Kgs
14) Autopsy findings
   a) Fine Tenacious froth: Present Absent ☐
   b) Presence of Foreign body: Present Absent ☐
   c) Typical lung Findings : Present Absent ☐
15) Samples Collected

Bone marrow Sample (B)	Lung sample (L)	Sphenoid sinus aspirate (S)	Water sample (W)

PROFORMA FOR COLLECTION OF WATER SAMPLES DURING FOUR SEASONS FROM APRIL 2011 TO MARCH 2012

1) Serial Number :
2) Location :
3) Panchayath /taluk :
4) Date and Month of collection :
5) Season of collecting water :
   a) Season 1 (April, May, June)
   b) Season 2 (July, August, September)
   c) Season 3 (October, November, December)
   d) Season 4 (January, February, March)
6) Source of water

River Stream Pond Canal
Dam Paddy field Sea Others

7) Name of the source of water:

PROFORMA FOR THE COLLECTION OF SAMPLES OF NON DROWNING CASES IN THE STUDY OF DIATOMS IN DROWNING

1) Serial number :
2) Name :
3) Age :
4) Place :
5) Date :
6) Postmortem Number :
7) Crime number and police station :
8) Date and time of death as per police records :
9) Date of Post Mortem examination :
10) Cause of death :
11) General Examination
12) Height**:** .....cms. Weight**:** ……..Kgs
13) Samples Collected

Bone Marrow Sample (S)	Lung Sample (L)	House hold drinking water sample (W)