

## Diatoms - Significant evidence in drowning cases

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### Abstract

Drowning is a form of asphyxia due to submersion or immersion in liquid, which are mostly accidental. Death by drowning is difficult to determine and often done by eliminating other causes of death. One of the most important criteria in the study of drowning is the search for a sensitive and specific test. The diatoms are major group of eukaryotic algae and stand as the strongest biological forensic evidence. In the present study hundred cases of drowning from two different states viz (Andhra Pradesh and Telangana) were examined by using acid digestion test method for the detection of diatoms in sternum, clavicle, and femur bone and lung tissue. Various parameters like Age group of deceased, Gender, and Causes of drowning were studied. In the cases analyzed, 94% were reported to be positive for diatoms. Death due to drowning was more prevalent in men in the age group of 40 to 50 years, and 46% were found to be accidental in nature. Diatoms prove to be helpful in successful case resolution.

**Keywords:** Drowning, Forensic, Acid digestion method, Diatom

### Introduction

The Indian subcontinent is a rich source of water bodies with a number of rivers, ponds, lakes, wells and a wide seacoast. Under such situations extensive chances of drowning will be a repeated event, and the bodies recovered from water will be at different stages of decomposition.

In highly decomposed and skeletonized bodies the only method of identifying the ante mortem drowning is detection of the diatoms from the bone marrow and comparing them with the diatoms in the water (1-6)

Forensic limnology is a measure of significant means to conclude and confirm the death due to drowning (7).The diatom

test remains highly specific in its application. The presence of diatoms in bone marrow, lungs, liver, spleen, kidney, and brain tissue is a direct screening test for drowning. Diatoms have complex cell wall which is impregnated with silica (hydrated silicon dioxide).Silica based skeletons of diatoms being chemically inert and almost indestructible is a boon for their identification in highly decomposed bodies. Timperman (1969) made very thorough studies of the diatoms test and concluded that it provides most reliable confirmation of drowning (8).

A correlation between the number and type diatoms extracted from tissue /bone samples and the samples collected from putative

drowning medium, establish successfully the suspected drowning site and cause of death. The presence of nominal count of diatoms in the bone marrow is evidence that the individual was alive when he /she entered water (9).

This study is attempted to highlight the presence of diatoms in bone marrow, lung and liver in cases where the bodies were recovered from water bodies of the two states viz Andhra Pradesh and Telangana regions. The present study is about drawing a correlation between Gender, Age and Causes of drowning by statistical analysis and comparative study of the water diatoms with those found in bone marrow/tissue (10), their by ascertaining the strength of diatom test (11).

All the dead bodies recovered from water medium do not conclude "Death due to drowning". The death could be either due to natural disease or of a shock before entering into the water, or while inside the water (12) medium. In highly decomposed bodies, all the important post mortem findings of ante-Tissue (lung, liver, kidney) / bone (sternum, femur, clavicle) preserved medico legally by the department of forensic medicine of both Andhra Pradesh and Telangana state and water by the investigating officers from the probable place of drowning are forwarded through either magistrate or ACP to TSFSL, Biology section, Hyderabad, Telangana state for the detection of diatoms. Hundred cases were randomly selected for the present study that was received during the year 2015. All cases where the body is recovered from water, irrespective of age group, gender, socio-economic status, unidentified bodies, fresh or decomposed organs and even skeletonized organs were accepted and examined for the presence of diatoms. There were no criterion / or such circumstance for elimination of the case. All the cases randomly selected were found to be recovered from fresh water bodies. The general information like gender, age, and

mortem drowning disappear. Post-mortem injuries, caused by flowing water to the dead body, or, by aquatic animals will only surplus the difficulty to analyze, if drowning? In such situations, conclusive evidence is Diatom test which raises a hope to confirm the cause of death.

The diatom test in drowning is based on fact that diatoms are Present in the medium where the possible drowning took place. (13, 14,15) . The number and type of diatoms found in the water is directly proportional to the number and type of diatoms found in the bone marrow. Diatoms and algal communities of no two water sources is similar. Presence of diatoms in the bone marrow confirms the death to be true drowning as inhalation of water is required to transport the diatoms. Deposition of diatoms are detected in the sternum bone, femur bone, brain, kidneys and other organs (16-22).

## **Materials and methods**

### **Source of cases / material**

history about the crime scene, probable causes of drowning was collected from the police panchanamas / inquests that were filed in proper format.

Acid Digestion Method (Thomas et al. (1961) and Timperman (1962)) with slight modification to identify and enumerate diatoms accurately, it is necessary to remove both extracellular and intracellular organic matter from the siliceous frustules of diatoms and other material in the sample. Removing the organic matter is necessary to have clear visibility of diatom structures. The bone (sternum, femur) / the tissue (lung, liver kidney) are initially washed with distilled water to remove any debris adhered to it. With a clean knife the marrow is curetted out from the bone and in the case of soft tissue the inner part is cut and taken into clean beaker concentrated. Nitric acid of analytical grade is added to the contents in beaker in the ratio of 1:5 by volume and left

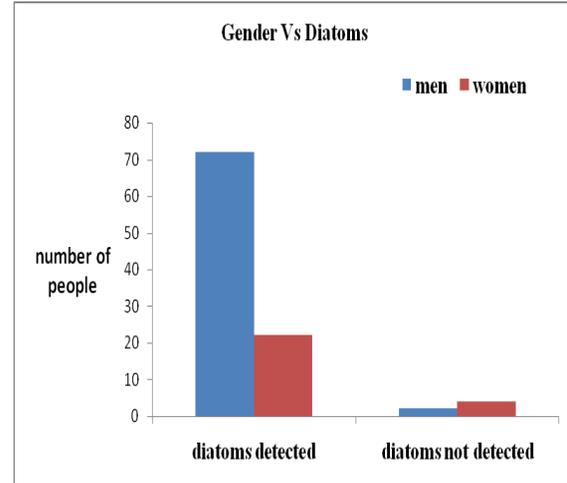
**Results and discussion**

**Table 1: Type of organ preserved medico legally.**

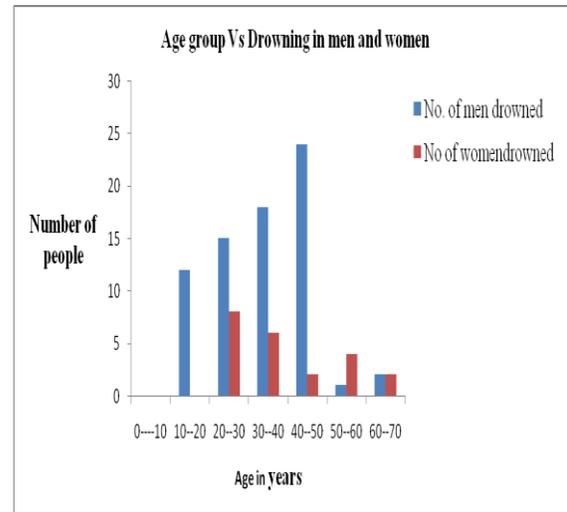
S. No	Type of organ received	no. of cases	Positive diatoms
1	sternum bone	80	79
2	lung tissue	11	9
3	Femur bone	9	6

undisturbed for 24 hours. Clear yellow color solution is obtained with fat floating on top. The solution in the beaker is transferred into a clean separating funnel to discard the fat layer. The two layers i.e. a less dense fat layer on the top and a denser clear yellow color solution at the bottom is formed. The denser yellow color solution is collected into a clean conical flask leaving behind the fat layer. The contents in the conical flask are taken into a clean 20ml centrifuge tubes and centrifuged (remi centrifuge) at 3500 rpm for 10 minutes. The supernatant is discarded and the residue is retained. The process of centrifugation is repeated 3 to 4 times till the solution in the conical flask is completely utilized. The residue is further washed with distilled water. This process is repeated three times. Finally supernatant is discarded, and residue taken. The residue is spread on a clean microscopic slide into a thin layer and dried. The microscopic slide is treated with meta-cresol or directly viewed under microscope for the detection of diatoms. first under low magnification (10 folds) then under high magnification (45 folds) and finally under oil immersion (100 folds). Diatoms were also isolated from water bodies by acid digestion process and microscopic slide of the water sample where the probable drowning occurred is also prepared.

Comparative study of the diatoms detected in the water sample and organ sample is done and results accordingly are correlated. Diatom examination was considered positive only when number of diatoms is greater than a nominal established count. And, further correlation of diatoms from bone marrow and drowning site, reinforced this supportive proof and a positive conclusion was arrived at to ascertain if drowning was anti mortem or post mortem in nature.



**Figure 1: Occurrence and absence of diatoms in each of the gender.**



**Figure 2: Number of drowning cases of different age groups in both men and women.**

Men Three Times As Likely To Drown As Women? Sep 1, 2013 05:57 PM By John Ericson)

Diatoms were not detected in 6% of the cases, 2% were men and 4% were women. Men to women ratio where diatoms were not detected was found to be 1:2, the absence of diatoms does not instantly exclude drowning. Non detection of diatoms in the bodies recovered from water means either atypical dry drowning or death before drowning. (modi's jurisprudence);

Figure 2 shows that Maximum number of men who died of drowning was found to fall in the age group of 40-50 years accounting to 33.33%. Maximum number of women who died of drowning was found to fall in the age group of 20-30 years accounting to 36.36%. Among women, 63.63% of the suicides occurred in 20—40 years old. The ratio of men to women was found to be greatest in the age group of 40-50 years. In the extreme age groups that is 60—70 years the ratio was equal to 1.

Figure 3 shows that maximum No. of drowning cases were found to be accidental in nature which accounts to about 49% of the total drowning cases. Most men in coastal areas, where the only source of livelihood is fishing, accidentally get trapped in the net and drown. Drowning in such areas to some extent is even due to bad weather, accidental drowning also included cases of alcoholics (Review of the role of alcohol in drowning associated with recreational aquatic activity T R Driscoll, J A Harrison, M Steenkamp Injury Prevention 2004; 10:107–113. doi: 10.1136/ip.2003.004390); slipping into water while having a bath or attending to calls of nature. Medical problems like epilepsy (D, A. Gaitatzis, MD, C. L. Bell, A. L. Johnson, PhD and J. W. Sander, PhD, FRCP) is again a hurdle for people interested in swimming, the study revealed that 9.5% of the people died of drowning due to epilepsy problem. The study also revealed that People committed

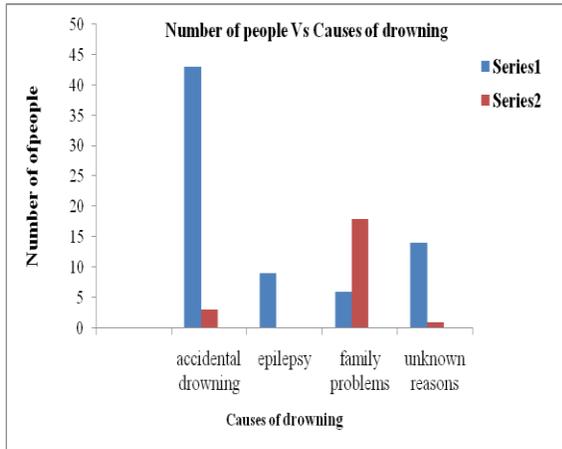


Figure 3: Cause of drowning in each of the gender.

**Discussions**

The most frequent use of diatoms in forensic discipline is the diagnosis of “if drowning” cases. Diatoms have a number of uniqueness, including their widespread occurrence, sensitivity to environmental water quality, superior preservation, easy detection and prevalence in high numbers.

Table 1 shows that Diatoms were detected in 98.75% of the sternum bone 81.8% of lung tissue and 66.66% of the femur bone Medico legally sternum bone is the most preserved and preferred for detection of diatoms. Lung being a soft tissue gets liquefied fast there by making the detection of diatoms difficult, in skeletonized bodies femur bone is received for diatom testing.

Figure 1 depicts that 74% of the cases pertained to men whose bodies were recovered from water and 26% were those of women. Diatoms were detected in 94% of the cases 72% were of men (ROYAL LIFE SAVING National Drowning Report 2015 R) and 22% were those of women, indicating that death was due to drowning. The ratio of men to women who died of drowning were found to be 3.27:1, representing drowning cases were more among men than women. Quite a lot of factors add to relatively high drowning toll among men, including overestimation of abilities and intense alcohol use. (Why Are

suicide by drowning due to their low socio economic status; or unable to bear ill health and even difficulty in repaying of debts taken.

### Conclusion

The study revealed that drowning deaths were more among men than women it is also observed that accidental drowning death were due to open defecation near the water bodies or entering into water bodies after consuming alcohol. These can be controlled to a maximum extent by formulating strict rules and implementing them unbiased.

The diatom test, while exceptionally specific, is of enormous significance allowing for the restricted point tests accessible for drowning diagnoses. And, with the advent of newer technologies, the Diatom test is on its way to pinpoint the fact.

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