A Demographic Study on Cases of Drowning with Special Reference to Histopathological Changes of Lung and Other Tissues in a Tertiary Centre

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Abstract

Introduction: Drowning is the 3rd leading cause of unintentional injury deaths.As drowning is a preventable cause of mortality, our aims for the benefit of society at large is to minimize the events as far as possible. **Objective:**A clear knowledge about factors which play a major role behind such incidences is important.It has equal forensic importance as determination of cause and manner of death require thorough investigation. **Methodology:** We conducted one-year study of demographic variables and the histopathological changes in relation to lung and splenic tissues in cases of drowning deaths, in the hot and humid climatic region of Eastern India.**Results:** The demographic findings were presented in graphs and charts. However, none of the commonly known autopsy findings (histopathological) are found to be individually confirmatory of drowning. **Conclusion:**Several factors inclusive of autopsy findings, biochemical examination, radiological and molecular technique,are needed to be taken together as complementary methods to conclude drowning as the cause of death when bodies are recovered from water.

Keywords: *Drowning, Forensic, Demography, Histopathology*

Introduction

Mortality due to drowning is a major global public health concern.[1] A study on Global Burden of Disease (GBD) revealed that drowning constitutes 7% of all injury-related deaths (WHO, 2010). It is the 3rd leading cause of unintentional injury deaths. In 2012, an estimated 372,000 people died from drowning, making drowning a major public health problem worldwide. The WHO *Global report on drowning: preventing a leading killer*, published in 2014, highlights that 372,000 people drown worldwide each year. Drowning is among the ten leading causes of death for children and young people in every region of the world.[2]Approximately 90% of drowning take place in freshwater (rivers, lakes and swimming pools) and 10% in seawater.[2]As with other south East Asian countries, fatalities due to drowning are common in India. Drowning as a method of choice in suicides is also responsible for a substantial proportion of unnatural deaths. According to the National Crime Records Bureau, MHA Govt. of India NCRB (2014), 29,903 deaths (6.6% of total accidental deaths) were reported due to drowning in 2014.[3]In developing country like India formulation of health care planning is very muchdependent on incidence, prevalence, frequency and distribution of a particular disease or accident.[4] As drowning is a preventable cause of mortality, our aims for the benefit of society at large is to minimize the events as far as possible.A clear knowledge about factors which play a major role behind such incidences is important. Modell et al.[5] 'stated that to ascribe drowning as a cause of death to a body found in water without some evidence of the effect of having aspirated water is risky' and concluded that 'in this situation, it

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may be more accurate to list a differential diagnosis rather than a specific cause of death'. In this study we attempted to analyze the demographic variables and the histopathological changes in relation to lung and splenic tissues in cases of drowning deaths, in the hot and humid climatic region of Eastern India.

Materials and Method

A cross sectional study was conducted at the R.G.Kar Medical College & Hospital Police Morgue attached to the Department of Forensic Medicine and Toxicology and Department of Pathology, R.G.Kar Medical College. It was conducted on the dead bodies on which medico legal autopsy performed in the morgue for a one-year period i.e., 1st April, 2012 to 31st March, 2013.

Cases of unnatural deaths (on whom Medico legal Autopsy was performed during the stipulated period) where cause of death was clearly identified as drowning were included in the study.

Cases presenting as drowning but actual cause of death found after autopsy to be something else e.g. head injury, any natural disease etc. were excluded.

Results & Analysis

16 cases of drowning were found in age group 11 to 20 years, 13 cases among 31 to 40 years, 10 cases among first 10 years whereas only 2 cases found in 61 to 70 years but no cases in 61 to 70 years age group. Eighty percent of study population was male while twenty percent were female.Maximum cases (46) were found to be accidental in nature, 6 cases were suicidal, only 2 cases were homicidal and 6 were unknown or undetermined.21 cases of drowning were found in pond, 17 in river, 13 in lake, 6 in canal whereas 2 cases from well and only 1 in sewage pipeline water.Most of the cases (10) found in the month of June whereas least cases (3) in July and December (Fig 1).

Scatter diagram shows age distribution in cases with known manner of death (Fig 2).70% of all cases were happened during bathing among people with no swimming lesson; different disease conditions including depression comprised 5% of all cases as risk factor; in 3% cases alcohol intake was possible risk factor whereas in 15% cases no significant risk factor was found (Fig 3).78% of all cases showed dilatation of alveoli and thinning of alveolar septa as microscopic changes in lungs whereas in 14% cases alveolar oedema was found and only 8% cases showed interstitial oedema.

All of the cases showed reactive changes as microscopic feature of spleen.Histopathological examination was performed on all the organs of non-putrefied bodies with the aim to differentiate between death due to drowning and other causes of death. Hematoxylin and eosin (H & E) staining often gives excellent results to determine the cause of death in bodies recovered from water. Pulmonary changes in drowning are distributed heterogeneously in the lung parenchyma (Fig.4,5). In this study, other organs like spleen showed nonspecific changes like generalized congestion and swelling of the capillary endothelia (Fig.6).

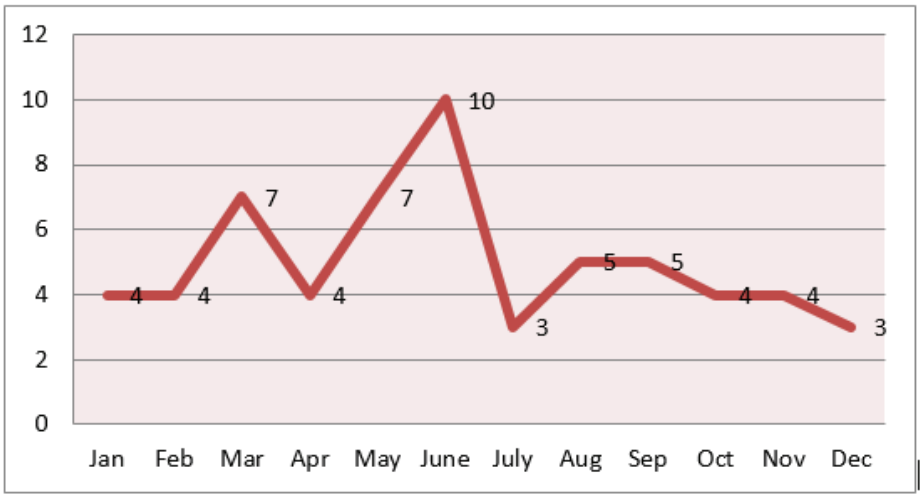

Fig. 1: Showing distribution of cases in different months

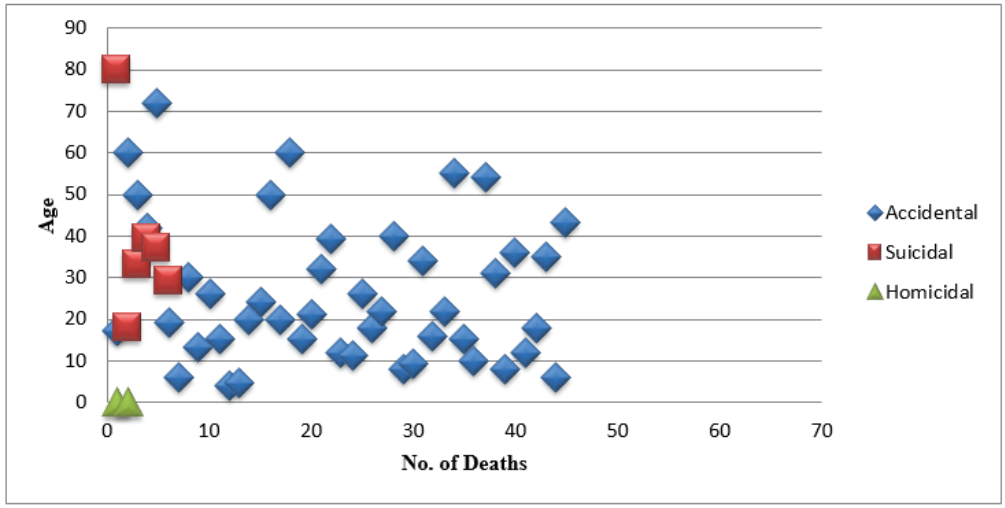

Fig. 2: Scatter diagram showing age distribution in cases with known manner of death

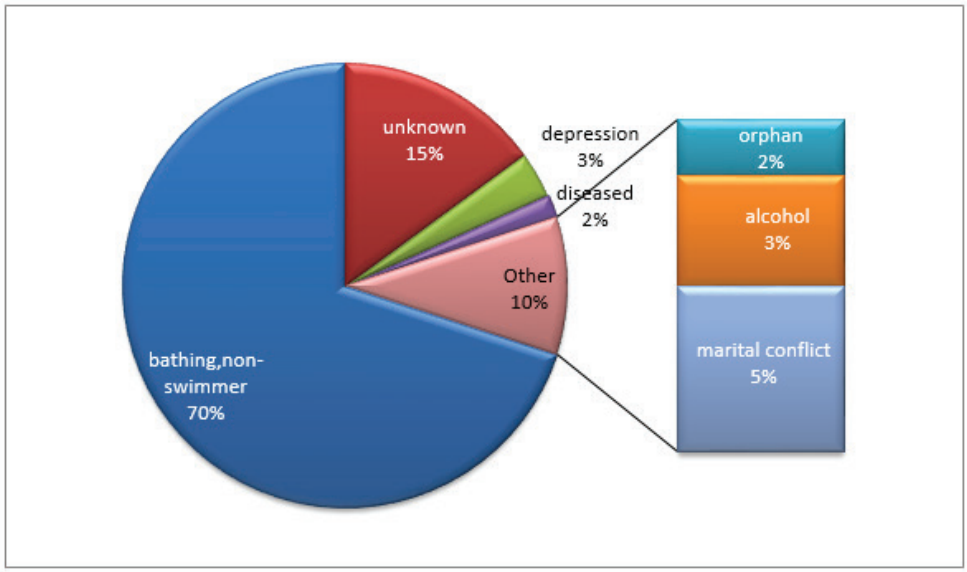

Fig. 3: Pie diagram showing possible risk factors among all cases

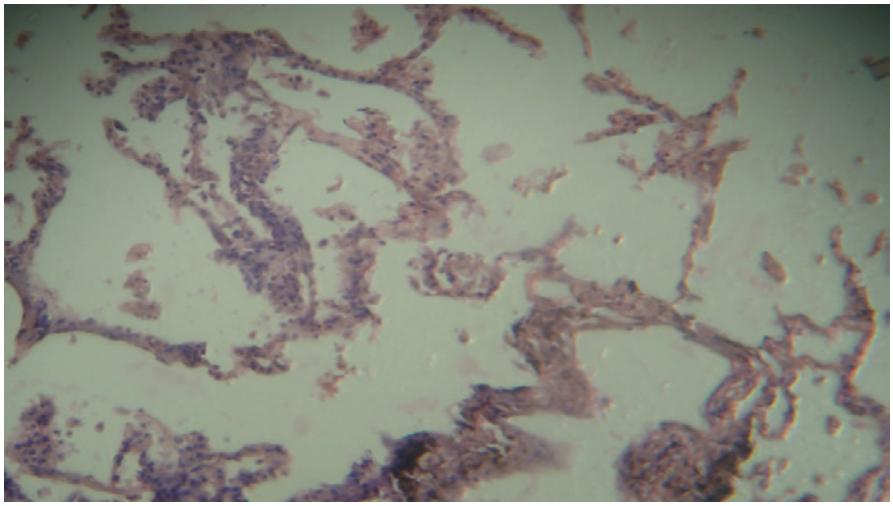

Fig. 4: Microscopic picture showing bronchopneumonia of lung indicating interstitial oedema (H& E, 100X) in a case of Secondary drowning (Near-drowning).

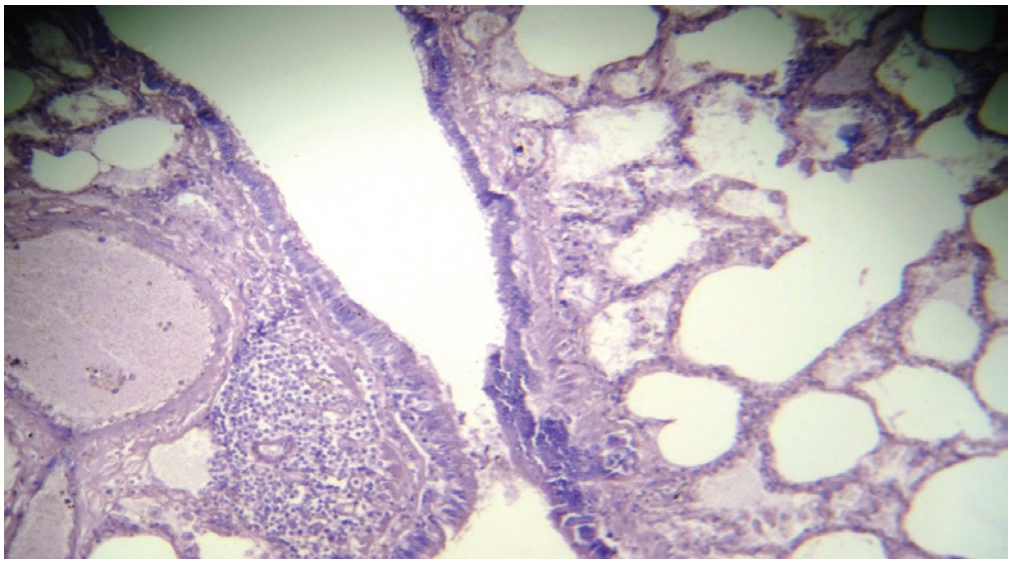

Fig.5: Microscopic picture showing bronchopneumonia indicating alveolar oedema(H&E,100X) in another case of Secondary drowning (Near-drowning).

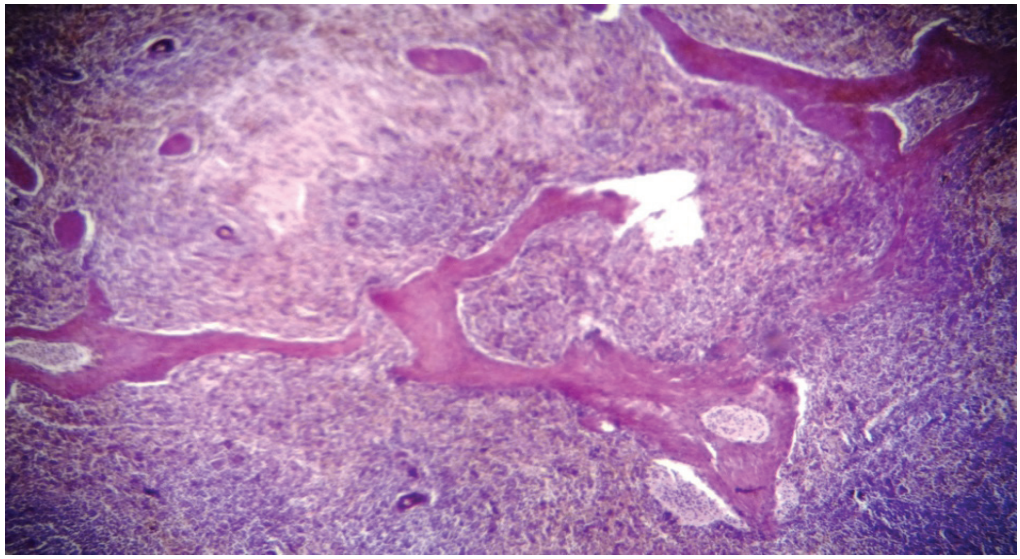

Fig. 6:Microscopic picture showingreactive change of spleen in above case (H&E, 100X).

Discussion

The results of observations have been analyzed in form of graphs & charts and compared with available studies to bring out similarities and dissimilarity in different aspects.

Our study population were distributed from newborn to 80 years of age and it is seen that most of the cases(16) of drowning was in the age group 11 to 20 years. Palimar V, Manjunath S (2010)in their study[6] in Manipal, found that age group commonly involved in drowning was 11-20 years. Davoudi- Kiakalayeh A et al (2008) in their study[7] in Northern Iran also found that more than one-third of all victims of drowning were under the age of 20. Results of both the study corroborated with the findings of our study. On the other hand, Singh A, Gorea R K, Dalal J S, Thind A S, Walia D (2003)[8] showed that most commonly involved age group was 31-40 years. Shetty M conducted a study[9] regarding the profile of drowning deaths in coastal Karnataka (1999-2004) and found that maximum number of drowning victims were of age group 31 – 40 years. Therefore, findings of both the study were nearly similar to findings of our study as second highest no. of cases were found in age group 31-40 years in our study.

Incidence of drowning deaths were much higher in male with a male: female ratio 4:1, as found in our study. Male predominance in drowning deaths was shown in

many other studies done by Kanchan T et al[10], Chaudhary B L et al[11], Byard R W et al [12], Davoudi- Kiakalayeh A et al[7] and many more. ArdeshirSheikhazadi et al (2009)[13] found in their study in Iran thatmale: female ratio was 6.5:1 among drowning deaths whereas Somers GR et al (2005)[14] found male:female ratio as 2.5 in paediatric drowning cases.

Accidental submersion is the most common manner of deaths by drowning and we found the same result. According to our study, accidental drowning cases comprised of 77% of all cases. Gomiak J M et al (2005) in a 10-years long study[17] in Ohio, USA found that the majority (78%) of drowning deaths were accidents. This finding was consistent with our findings. Palimar V, Manjunath S (2010) in a 12-year long study[6] in Manipal,also found that accidental drowning was most common form of drowning. ArdeshirSheikhazadi, Mohammad Hasan Ghadyani (2009) studied about epidemiology of drowning in a province of Iran and found somewhat higher rate of accidental drowning (85.1%)[13].

Data analyses showed that 10% of all cases were suicidal submersion, i.e. 6 out of 60 cases. According to Gomiak J M et al (2005)[17] 14% cases were suicidal which is close to our findings. On the other hand, Stemberga V et al (2010) studied[18] about suicidal drowning in Croatia and found that it accounted for 31% of all drowning deaths. A study done by Avis SP (1993)[19] in Canada also found higher rate (25%) of suicidal drowning.

It is stated that homicidal submersion is really rare because of difficulties it involves when the victim is adult, unless the victim is first weakened by something like alcohol or drugs. Only 2 homicidal cases of drowning were found in our study, both were unknown cases and newborn, one was male and other female, found in lake and sewage pipeline water respectively. It represented 3% of all deaths due to submersion [Table 5, Fig.6&7] which was consistent with findings of Gomiak J.M. et al[17]. Although ArdeshirSheikhazadi et al[13] found only 0.3% homicidal cases in Iran. On the other hand, Auer A[20] found 2.3% homicidal cases in Finland.

When the manner of death could not be recognized, the case is considered undetermined or unknown which comprised 10%, i.e. 6 cases of total deaths caused due to drowning in our study.

Natural freshwater settings were the sites of all drownings except a newborn which was found in sewage pipeline water. It highlights the risk of going in such water whether deliberately or not. The absence ofsalt-water drowning case in our area is not surprising, because of geography of the region and jurisdiction of our area.

In our study pond was the location with highest number of drowning victims. Patetta M J, Biddinger P W in a study[21] in North Carolina, USA showed that most death occurred in freshwater settings, notably lakes and ponds, 39 percent, and rivers and creeks, 29 percent. Chaudhary B L, Singh D et al in their study[11] in Sevagram, Wardha found that most of drowning deaths were seen as a result of fall in well which was inconsistent to our study and may be due to geographical variation. On the other hand, Stemberga V et al[18] found 57% incidents occurred in the sea, 34% in water wells, 6% in rivers, and 3% in bathtubs in a study done in Croatia.

We tried to highlight over some risk factors which possibly contributed to the fatal outcome. In our study 70% cases of death occurred during bathing among people with no swimming lesson. Chaudhary B L et al in their study[11] found that maximum cases of suicidal drowning were seen in person with history of some kind of mental illness or some chronic disease. Byard R W et al in a study[12] in South Australia showed that alcohol use was not usual and there was often a significant history of mental illness. Copeland AR in a study[22] in Florida found that the reason for the act was depression concerning poor health, death of a loved one, financial problems, chronic pain, or being “tired of life”.

The increase or decrease of drowning death in a year is closely related to seasons, climatic factors and geographic zone. Our study showed that the majority of deaths took place during the summer followed by the end of the spring, when the weather is warm. This correlates to the results of studies done by ArdeshirSheikhazadi et al in Iran[13] and also in some western countries. Shetty M.[9] and Palimar V et al [6]in their study found different result and concluded that incidence of drowning death increased during rainy season.

We have studied macroscopic and microscopic changes of lung of the drowning victims. In our study 78% cases showed dilatation of alveoli and thinning of alveolar septa as microscopic changes in lungs whereas in 14% cases alveolar oedema was found and only 8% cases showed interstitial oedema. These findings were

consistent with the opinion of Farrugia A and Ludes B[23]. Somers GR et al[15,16] highlighted the need for thorough clinicopathologic correlation in cases of drowning to accurately interpret the pathologic findings like frothy exudate, pleural effusion and increased lung weight.

We have studied microscopic changes of spleen of the drowning cases during our study period. In all of the cases no specific finding characteristic of drowning was found; only some reactive changes were found. Kotani H et al[24] found a significant relationship between red splenic arteriolar hyaline and drowning deaths; moreover, the presence of the red pattern had high specificity for the detection of rapidly fatal cases. These findings were inconsistent with our study findings.

Conclusion

Death due to drowning has forensic importance as determination of cause and manner of death require thorough investigation. The forensic pathologists often confront cases wherein the findings are not definite enough to clinch the diagnosis as death due to drowning though the body might have been recovered from water. Moreover, in the majority of the cases, autolytic and putrefactive changes would preclude a scientifically sounded diagnosis of drowning. None of the commonly known autopsy findings are individually confirmatory of drowning. Several factors inclusive of autopsy, biochemical examination, radiological and molecular technique are taken together as complementary methods to conclude drowning as the cause of death when bodies are recovered from water. Unfortunately, the cost–benefit analysis in current practice could be hard to defend. The roles of chloride, magnesium, strontium, silicon is promising. Molecular tools like expression of aquaporins are useful for differentiating salt water from freshwater drowning. This mandates ongoing research to further fine-tune the various modalities of confirming drowning and applying them in real forensic casework.

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Conflict of Interest - Nil

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