

STUDY OF INCIDENCE OF MIDDLE EAR HEMORRHAGE IN DROWNING

Chidanand C¹, Satish K. V²

HOW TO CITE THIS ARTICLE:

Chidanand C, Satish K. V. "Study of Incidence of Middle Ear Hemorrhage in Drowning". Journal of Evidence based Medicine and Healthcare; Volume 2, Issue 6, February 09, 2015; Page: 621-628.

ABSTRACT: OBJECTIVES: An autopsy study of deaths due to drowning with special reference to middle ear hemorrhage and spleen findings was done. **METHODS:** Data were collected from the police, relatives, and photographic evidences from the scene, postmortem findings and chemical analysis /histopathological examinations representative control groups. 101 cases of drowning deaths were studied. **RESULTS:** The presence of froth, wrinkling, bleaching, soddening, overlapping of anterior margin of lungs, antemortem ingestion of water and postmortem aquatic bite marks were seen in 58%, 83%, 59%, 23%, 52%, 45% and 8% of cases respectively. Middle ear hemorrhage was seen in 72.27% of cases with an odd's ratio of 23.73 and it increased with increase in duration and depth of submersion. The mean organ weights observed in the drowning group were 1112.54±295.01, 1208.84±264.60, 121.68±53.28, 361.96±99.59gms for the combined lung, liver, spleen and combined kidney respectively; the increase in lung and kidney weight were statically significant and a 16% drop in the spleen weight seen after a postmortem interval of >24 hours was statistically insignificant. **CONCLUSION:** Males and the young population constituted the bulk and more than half of the deaths were unintentional and a significant number died in drainages. A good number of drowning deaths are preventable.

KEYWORDS: Drowning, middle ear hemorrhage, swimming ability.

INTRODUCTION: The autopsy study of cases of deaths due to drowning was conducted to know age, sex and seasonal distribution of deaths due to drowning. To know the incidence of middle ear hemorrhage in deaths due to I drowning in comparison to other studies in this country as well as western countries. To determine the manner of death. To know the importance of spleen weight, spleen liver weight ratio and other organ weights in drowning. To suggest preventive measures.

METHODS: The present study has been carried out in the Department of Forensic medicine, Victoria hospital, Bangalore Medical College and Research Institute, Bangalore during the period November 2005 to April 2007. All the cases brought to the department for medico-legal autopsy with alleged history of body being submerged in the water were selected and there were 101 such cases during the 18 month period.

Control group were taken from the bodies which are not recovered from water.

Demographic information regarding the deceased including age, gender, religion, occupation, literacy, and per capita income, time of incident, place of incidence, cause for submersion and the circumstances of death was collected from the police and relatives.

ORIGINAL ARTICLE

Entire dissection of the body was carried out as per the procedure mentioned in "Autopsy Diagnosis and Technic" by Otto Saphir¹ and the middle ear was opened by knocking off the roof of the each middle ear just lateral to arcuate eminence by a horizontal cut with a Gresham² and due importance was given for recording of depth and duration of submersion.

All organs were weighed prior to dissection except the heart, which was weighed after washing out the clots.

INCLUSION CRITERIA: All cases of drowning deaths. For comparing organ weights, all the cases between 18-65 years of age other than decomposed cases were taken and their submersion time was considered.

EXCLUSION CRITERIA: For comparing organ weights, the decomposed cases were not considered

SAMPLE SIZE: Percentage of middle ear hemorrhage in previous study of Niles was considered for determination of sample size. In that study prevalence of middle ear hemorrhage was 83.67%. The sample size is estimated based on the precision consisting of significant level and permissible error (P.E)³. If P.E. for 95% confidence level is 10%, then the

$$P.E. = \frac{\text{prevalence} \times 10}{100} = \frac{83.67 \times 10}{100} = 8.37$$

Where P = prevalence, q = P – 100

At 95% confidence level P.E. = 2 S.E.P (Standard Error of Proportion).

$$S.E.P = \sqrt{\frac{P \times Q}{n}}$$

n = 74.04

Hence the number of cases to be studied = 74. However, the total number of cases in the study =101.

In the study for comparing middle ear hemorrhage and organ weight effects, 1:1 representative control was selected.

Statistical analysis for testing significance of middle ear hemorrhage in drowning was done by odds ratio and for testing significance of effects of organ weights, Standard error of difference between two means was used.⁴

DISCUSSION: In the present study few salient and interesting observations were recorded and these have been analysed, discussed and compared with findings of other workers in similar studies.

ORIGINAL ARTICLE

The first objective was to see at the demographic trends. There was a clear predominance of males 68% in contrast with the females 32%. These values are in conformance with other studies where Dery Azmak⁵ reported 90% males, Suresh Kumar⁶ reported 78% males; Gino R Somers^{7,8} stated it as 71%, Li yang⁹ as 61%, and Jan M. Gorniak¹⁰ as 63%. The probable reason for a higher rate among males may be due to a high rate of exposure to water, riskier behavior and the habit of drinking alcohol.

The age group of the victims in the study ranged from newborn to 85 year old. The maximum number of death occurred in the age group of 20-29 years (22.8%) followed by 10-19 and 0-9 years (18.8 & 17.8%). And the rate is in accordance with B. Suresh Kumar Shetty⁶ who also reported maximum number between 21-30 years (25.8%), M Kohn¹¹ reported it between 25-35 years and Jan M. Gorniak¹⁰ reported it between 19-29 years (21%) followed by 0-5 years (15%) and in contrast Jonathan reported it between 1-14 years. This high rate among young adults could be because of lack of maturity, higher rate of exposure, learning and exploring ideas. The maximum number of drowning took place in the lower middle and upper lower class of the people and the same has been reported to WHO by many countries.¹² This could be because of lack of supervision of the children, higher exposure to unprotected water sources and a lower chance to learn swimming. This can also be seen in our study, where 64% of deaths occurred among non-swimmers and the similar high rate of death (93.2%) was reported by Li Yang;⁹ and few drowned while defecating and bathing in the water and even most of the incidents took place in the morning hours suggesting lack of proper facilities and adherence to stringent taboos of defecating outside and away from the houses.

The commonest place of submersion was lake (37.6%) followed by well (17.8%) and the maximum number of submersion were seen in summer months (44%) followed by spring (29.33%) and results are in accordance with the study of Jan M.Gorniak¹⁰, where he reported the commonest place as Erie lake and most deaths in the months of June, July and August (summer-43.85%) and; this in contrast to the study of Suresh Kumar Shetty who reported it in the well (44%) and in spring 52.38 % followed by summer 42.86% and Gino R Somers⁸ also reported it in the spring and summer (87%). This seasonal increase during summer and spring could be due to monsoon rain, which hits India in the late summer and spring, resulting in increased water levels and overflowing dangerous drains and in addition to this encroachment of lake beds and drainage areas for residential purposes results in overflowing of drains; in our study there were significant number (12%) of victims who drowned in drains and all were not under the influence of alcohol/drugs alarming the need for proper maintenance of drains.

Middle ear hemorrhage was found in 73 cases (72.27%) and it was unilateral in 26 (25.74%) cases, bilateral in 47 (46.53%) cases. It was interesting to see that, there was a gradual increase in the rate of middle ear hemorrhage with increase in the depth and duration of submersion i.e., a middle ear hemorrhage rate of 62% at the depth of <4 feet to 83% at a depth of 16-20 feet. An exceptionally reduced rate was seen in the group that was submerged beyond 20 feet. It was also seen in the study that the middle ear hemorrhage was not seen in 3 victims who went into 150 feet deep well and all the three were swimmers.

Middle ear hemorrhage was found in 10 cases (9.9%; 1 Bilateral & 9 Unilateral) in the control group. The odd's ratio observed was 23.73; i.e., there is 24 times increased chance of

ORIGINAL ARTICLE

getting middle ear hemorrhage in the drowning cases as compared to the non-drowning group. The presence of middle ear hemorrhage is in confirmation with Nelson R Niles¹³, who reported it in 80.4% of cases, bilateral in 68.63% of cases and unilateral in 11% of cases. R.D. Robbins¹⁴, reported in 80% of the cases. Contrary to this Ito Y¹⁵ reported occurrence of middle ear hemorrhage in up to 80% of non-drowning groups.

Most of the deaths were accidental and accounted for 55.5 % of drowning deaths and the percentage is in accordance with the studies of Suresh Kumar Shetty⁶ (54.06%), Lunetta¹⁶ (58%), and is in contrast with Derya Azmak, Jan M Gorniak,^{5,10} and M Kohn¹¹ who reported it as 78% and 95%. The rate in male was higher than in the female: and 9 out of 62 males (13%) were intoxicated and only one female was intoxicated. Most of the accidental drowning occurred in children, this is in contrast to that in the west where it was high in middle-aged.^{11,16}

Suicidal drowning constituted 15% (15 cases) of the cases with a male to female rate of 1:2.8 which is in contrast to the study of Suresh Kumar shetty,⁶ who reported it as 42.27% with a reverse male: female ratio of 2.8:1. Our study is in accordance with the results of Derya Azmak, Jan M Gorniak,^{5,10} and Lunetta,¹⁶ who reported it as 17.1%, 14% and 24.5% respectively. The lower rate of suicidal drowning compared to the study at Mangalore⁶ (42.27%) could be due to less access to water in Bangalore city than in Mangalore-a coastal region.

Only 3 cases of homicidal drowning were noted and all were children and in them the mother who was the assailant had committed suicide by dumping the children into the water; and the lower rate of homicidal drowning is very similar to that reported by others.^{6,16,17,10}

In a significant number of cases (27.7%) manner of death remained undetermined and this is very high when compared to the studies of others i.e., Suresh Kumar⁶ and Jan M Gorniak,¹⁰ who reported it as 3.4% and 6% respectively; a rate similar to that seen in our study was observed by Lunetta¹⁷ as 16.6%.

The mean organ weights observed in ,he drowning group were 1151.75 ± 147.12, 242.84 ± 76.49, 560.47 ±147.62, 536 ± 144.05, 1112.54 ± 295.01, 1208.84 ± 264.60, 121.68 ± 53.28, 182.74 ±50.37, 179 ± 50.37, 361.96 ± 99.59gms for the brain, heart, right lung, left lung, combined lung, liver, spleen, right kidney, left kidney and combined kidney respectively and all the organs in drowning group had an expectedly higher organ weights when compared to the control group except for the liver and spleen, where the liver remained almost the same and the order of increase was in the percentage of 69% for mean combined lung weights, 11% for mean heart weight, 42% for combined kidney weight and the spleen showed a drop of 2% at the postmortem interval of < 6 hours to 16% at >24 hours of postmortem interval; the findings are in accordance with J.A. Hadley¹⁶ study, who reported a 47.8% and 14.7% increase in lung and kidney weights.

The greatest drop was observed at >24 hours of postmortem interval; A 20gm (16%) drop was noted for the mean spleen weight between 6 hours and at >24 hours of PMI in the drowning group but in contrast to that, the rate of drop in the control group was 1 gm (0.84%) suggesting an enhanced rate of decomposition in the drowning group.

Despite a corresponding 132gm (11.39%) drop in combined mean lung weights in drowning group, a statistically significant difference prevailed between drowning and the control

ORIGINAL ARTICLE

groups, i.e., the actual difference between two means (384.1) was more than twice the standard error of difference between two means ($95.86 \times 2 = 191.2$).¹⁹

However, the 16% drop in spleen weight after 24 hours was not statistically significant and the presence of difference in the mean spleen weight between the drowning and control group i.e., the spleen weight being 107: 123gm at >24 hrs to 123.5: 123.6 gms at 6 hrs can be attributed to a decompositional drop; and the finding of an 18% reduction in the spleen weight by Haffner²⁰ seems to be an artifact, which could have been masked by the absence of information about the postmortem interval in his study.

Whereas an increase in mean combined kidney weight reached statistically significant levels and it could be due to the early onset of diuretic phase and it needs to be studied with even more number of samples.

The findings of the present study are in accordance with the studies of Lunetta¹⁷ who noted an increase in combined lung weight of 1316 ± 401 gm, Copeland²¹ and De la grand maison²² noted mean right lung weight as 744.9 ± 199.3 gm, 663 ± 29 gm and mean left lung weight as 655.4 ± 184.2 gm, 583 ± 216 gm respectively, Derya Azmak⁵ recorded a combined lung weight of 1.136gm; J.A. Hadley¹⁸ reported mean combined lung weight as 1576 ± 467 gm, mean liver 1893 ± 467 gm, mean spleen 200 ± 101 gm and he also found a 15 % drop of mean spleen weight at 6 hours, and a 33 % drop after 12 hours and a 12 gm (3%) drop in kidney 126 gm (8%) drop in lung weights after 12 hours.

In the study in 21% of the cases combined lungs weighed <1000gm and were considered dry^{16,18} and slightly higher than that seen by Lunetta¹⁷ and Jeffrey A Hadley¹⁸ who had reported it in 15.2% and 16.8% of the cases; this increase could be due to a higher incidence of drowning in filthy, high viscosity fluid in our study; In contrast Lunetta¹⁶ in another study reported only 2% of the cases as dry lungs.

RESULTS: A total number of 5565 autopsies were carried out over a period of 18 months and of which there were 101 cases of deaths due to drowning constituting 2% of all the unnatural deaths at the center. Of the 101 cases, 68% were males and 32% were females with a male to female ratio of 2.2: 1.

An autopsy study of deaths due to drowning with special reference to middle ear hemorrhage and spleen findings was done at Victoria hospital, over a period of 18 months from November 2005 to April 2007.

The presence of froth, wrinkling, bleaching, soddening, overlapping of anterior margin of lungs, antemortem ingestion of water and postmortem aquatic bite marks were seen in 58%, 83%, 59%, 23%, 52%, 45% and 8% of cases respectively.

Middle ear hemorrhage was seen in 72.27% of cases (Unilateral in 25.74% and Bilateral in 46.53%) and the odd's ratio was 23.73 and the rate of occurrence of middle ear hemorrhage increased with increase in duration and depth of submersion.

An assessment of organ weights was done in 57 cases (cases which were not decomposed and belonged to the age group of 18-65 years and in which the submersion time was known) the mean organ weights observed in the drowning group are 1151.75 ± 147.12 gm for brain, 242.84 ± 76.49 gm for heart, 560.47 ± 147.62 gm for right lung, 536.28 ± 144.05 gm for left

ORIGINAL ARTICLE

lung, 1112.54±295.01 gm for combined lung, 1208.84±264.60 gm for liver, 121.68±53.28 gm for spleen, 182.74 ± 50.37 gm for right kidney, 179.23 ± 50.93 gm for left kidney.

The mean organ weights observed in the drowning group were 1151.75±147.12, 242.84±76.49, 560.47±147.62, 536±144.05, 1112.54±295.01, 1208.84±264.60, 121.68±53.28, 182.74±50.37, 179±50.37, 361.96 ± 99.59gms for the brain, heart, right lung, left lung, combined lung, liver, spleen, right kidney, left kidney and combined kidney respectively and the values found in the control group were 1117.46±117.73, 220.4±55.19, 352.33±95.26, 323.12±93.83, 657.46±179.39, 1215.33±320.65, 123.93±47.15, 126.19±33.61, 128.68±32.69 and 254.88±61.40 respectively; the mean increase in combined lung and combined kidney weight were statically significant; there was a 16% drop in the spleen weight after a postmortem interval of >24 hours and this was statistically insignificant.

SUMMARY AND CONCLUSION: A total number of 101 drowning death cases were autopsied in 18 months. Majority of death occurred among males 68 %. Young adults, adolescents and children constituted the bulk. Maximum numbers of cases were seen in summer. Significant number of deaths occurred in underground tanks, construction tanks and drainages, which are preventable.

Accidental submersion was the commonest manner of death, followed by suicidal and the rate of accidental submersion was more in males and the suicidal in females. More than 63% of the victims were Non-swimmers. Presence of froth, wrinkling, bleaching, soddening and overlapping of anterior margin of lungs were seen in 58%, 83%, 59%, 23% and 52% of cases respectively. Postmortem aquatic bite marks and antemortem ingestion of water was found in 8% and 45% of cases respectively.

Middle ear hemorrhage was present in 72% of cases with an odd's ratio of 23.73 and the rate of occurrence increased with increase in duration and depth of submersion. There was a mean increase in organ weights for lungs and kidneys and the difference was statically significant even after 1 or 2 days. >Even though the spleen weight was lower in drowning group it was not significant, as it was found to be an artifact.

Dry lungs were found in 21% of cases. Alcohol intake was found in 7.2% of the cases. 10% of the people had mental illness and only few of them had committed suicide and the rest fell unknowingly or accidentally.

SUGGESTIONS TO PREVENT DEATHS DUE TO DROWNING: Unattended underground tanks should not be kept open. Proper engineering and meshing/closing of the construction tanks and drainages should be made compulsory. Encroachment of lakebeds and drainages for residential purposes should be prohibited and should be regularly scrutinized.

Fencing and meshing of the lakes with prominent warning signals may reduce the rate of accidental submersions. Introduction of resuscitation education and swimming lessons to the curriculum of the children can do better. Good counseling of the epileptics and patients suffering from mental illness can reduce their submersions. Parents and or caregivers should be advised not to leave the children alone/unattended.

ORIGINAL ARTICLE

BIBLIOGRAPHY:

1. Sapphire O: "Autopsy Diagnosis and Technic": 4th ed: Hoeber- Harper books: 1961.
2. Gresham G.A and Turner A.F: Post mortem procedures (An illustrated text book): Wolfe medical publishers: 1979:79.
3. Dr. B. Sridhar Rao: Principles of community Medicine: 4th edition: AITBS Publishers: 2005:105-106.
4. Park K: Park's Text book of preventive and social Medicine: 16th edition: M/s Banarsidas Bhanot Publishers: 2000: 594-599.
5. Azmak D: A retrospective study and review of the literature: AM J FM and pathol: June 2006(27)(2):134-144.
6. Shetty S K, Shetty M: Epidemiology of drowning in Mangalore, a coastal Taluk of South India: B.Journal of Forensic and legal Medicine xxx (2007) xxx-xxx pg 1-6 available at www.sciencedirect.com accessed on 6/7/2007.
7. Gino R. Somers, David A.Chiasson, and Charles R. Smith: Pediatric Drowning A 20-year Review of Autopsied Cases: I. Demographic Features: Am J Forensic Med Pathol: December 2005:26(4):316-320.
8. Gino R.Somers, David A.Chiasson, and Charles R. Smith: Pediatric Drowning A 20-year Review of Autopsied Cases: III. Bathtub Drownings: Am J Forensic Med Pathol; June 2006:27(2):113-116.
9. Li Yang, Quan-Qing Nong, Chun-Ling Li, Qi-Ming Feng, Sing Kai Lo: Risk factors for childhood drowning in rural regions of a developing country: a case control study Injury prevention: 2007: 13:178-182.
10. Jan M.Gorniak, Amanda J.Jenkins, Joseph A.Felo, and Elizabeth Balraj: Drug prevalence in Drowning Deaths in Cuyahoga county, Ohio A Ten-year Retrospective study: Am J Forensic Med and Pathol: September 2005: 26(3):240-243.
11. M Kohn, R Duthu, H Flood, G Hall, J Wiley et al., MMWR weekly: May 2001: 50(20): 431-4
12. Etienne creux, Pretoria: Dept. of injuries & violence prevention annual 2003, WHO: URL: http://whqlibdoc.who.int/hq/2004/WHO_NMH_VIP_04.02.pdf
13. Nelson R Niles: Hemorrhage in the middle ear and mastoid in drowning: American Journal of Clinical Pathology: Sept.1963: 40(3): 281-283.
14. R.D. Robbins, H.K. Sekhar and V.Siverls: Temporal bone histopathologic findings in drowning victims: Arch Otolaryngol Head Neck Surg: September 1988: 114.
15. Ito Y.Kimura H: Histological examination of the temporal bone in medicolegal cases of asphyxia. Forensic Sci Int: 1990: 44: 135-142.
16. Lunetta P, Penttila A, and Sanjatila A."Circumstances and Macropathological findings in 1590 consecutive cases of bodies found in water' Am J Forensic Med and Pathol: 2002: 23(4): 371-376.
17. Lunetta P, Penttila A, and Sanjatila A. 'Circumstances and Macropathological findings in 1950 consecutive cases of bodies found in water' Am J Forensic Med and Pathol:2002: 23(4): 371-376.

ORIGINAL ARTICLE

18. Jeffrey A. Hadley, David R.Fowler: Erratum to "organ weight effects of drowning and asphyxiation on the lungs, liver, brain, heart, kidneys, and spleen": Forensic Science International: 2003: 137: 239-246.
19. Park K: Park's Text book of preventive and social Medicine: 16th ed: M/s Banarsidas Bhanot Publishers: 2000: 594-599.
20. Haffner HT Graw M Erdelkamp J: Spleen findings in drowning: Forensic Sci Int: Nov.2003:26: 137(2-3): 239-46.
21. Arthur R Copeland. 'An assessment of lung weights in drowning cases' Am J Forensic Med and Pathol: 1985: 6(4): 301-304.
22. Tsokos M, Lunetta P and Jerome H. Modell: Forensic Pathology Review, Death from Environmental conditions: Vol.3: Humana Press Inc.: 2005: 5-77.

AUTHORS:

1. Chidanand C.
2. Satish K. V.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Forensic Medicine, Shimoga Institute of Medical Sciences, Shimoga.
2. Associate Professor, Department of Forensic Medicine, Bangalore Medical College & Research Institute.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Satish K. V,
Associate Professor,
Department of Forensic Medicine,
Bangalore Medical College & Research Institute,
Bangalore.
E-mail: drsathishkv@gmail.com

Date of Submission: 15/12/2014.
Date of Peer Review: 16/12/2014.
Date of Acceptance: 13/01/2015.
Date of Publishing: 03/02/2015.