

Unveiling the Significance and Incidence of Middle Ear Hemorrhage in Drowning Cases: an Insight from Autopsy Observations Conducted in a Tertiary Centre of Central India

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Abstract:

Middle ear hemorrhage and drowning are two topics that are often associated with violent asphyxial deaths. Understanding the relationship between these two can provide valuable insights into forensic investigations and medical examinations. When an individual drowns, the process involves the inhalation of water or other fluids, leading to a lack of oxygen supply and subsequent asphyxiation. During this traumatic event, the body undergoes significant physiological changes, including increased pressure on various organs and tissues. One specific consequence of drowning is middle ear hemorrhage. The middle ear is a delicate structure located behind the eardrum, responsible for transmitting sound signals to the brain. When subjected to intense pressure changes during drowning, such as rapid submersion or resurfacing, blood vessels in the middle ear can rupture, resulting in hemorrhage. Middle ear hemorrhage serves as an important indicator in forensic autopsies when investigating cases of violent asphyxial death due to drowning. It can help determine whether drowning was indeed the cause of death or if other factors played a role. Furthermore, studying middle ear hemorrhage in relation to drowning can aid in distinguishing between fresh and postmortem injuries. This differentiation is crucial for accurate evaluating the exact cause and manner of a fatality after forensic examinations. In conclusion, understanding the connection between middle ear hemorrhage and drowning provides valuable insights into violent asphyxial deaths. By examining this specific injury pattern during autopsies and forensic investigations, experts can unravel critical information that aids in determining cause of death accurately.

Keyword: Drowning, Middle Ear Hemorrhage, Data, Autopsy.

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Introduction

Middle ear hemorrhage is a common finding in cases of drowning and asphyxial deaths. This phenomenon occurs due to the rapid changes in barometric pressure that happen during such incidents.[1] Understanding the causes, mechanisms, and significance of middle ear hemorrhage is crucial in forensic investigations to determine the cause of death accurately.

During drowning or asphyxial events, the sudden increase in pressure and oxygen deprivation causes a variety of physiological responses in the body, including middle ear hemorrhage.

The middle ear, situated between the eardrum and the inner ear, contains delicate blood vessels that

can rupture due to the intense pressure changes. [2] Drowning victims develop significant haemorrhages in the petrous and mastoid sections of the temporal bone. Three possible mechanisms have been postulated to explain these:

a) Barotrauma: Pressure increases by 1 atm for every 33 feet below sea level⁵⁷. If the pressure difference between the nasopharynx (external environment) and the middle ear is 90 mmHg or more, the Eustachian tube becomes blocked, causing the tympanic membrane and vascular mucosa to stretch inwards, leading to barotrauma⁵⁸.

b) Penetration of inhaled fluid through the Eustachian tube into the middle ear.

c) Higher pressures in capillaries and veins caused by respiratory action which leads to prevention of closure of glottis.[3]

It is essential to differentiate middle ear hemorrhage from other potential causes. For instance, middle ear infections or trauma unrelated to drowning or asphyxial deaths can also result in hemorrhage. Therefore, a thorough examination of the entire body, including the cardiovascular and respiratory systems is necessary to rule out other possible explanations for the hemorrhage.

Middle ear hemorrhage is a common finding in drowning and asphyxial deaths due to the abrupt changes in pressure and oxygen levels. It serves as a valuable forensic indicator in ascertaining the precise cause of mortality and evaluating the force and duration of the incident.[4] However, it is important to explore various other causes and conduct a comprehensive autopsy to accurately diagnose the origin of the hemorrhage. Advances in understanding middle ear hemorrhage are vital for forensic experts to make well-informed conclusions in criminal investigations involving drowning and asphyxial deaths.

Materials and Methods:

The study has been carried out in the year 2021-22 after approval from ethical committee of Gandhi medical college, Bhopal. 62 cases were taken to study on the significance of middle ear hemorrhage in drowning deaths, excluding bodies which had a history of head injury and the ones presenting in advanced state of decomposition. The process involved the whole dissection of the corpse to be performed along with naked eye examination. To examine for middle ear hemorrhage, the roof of each middle ear was removed meticulously lateral to the arcuate eminence employing an incision

made horizontally with a chisel. The study was carried out over the period of January 2021 to August 2022, with the aim of finding out relevance of middle ear haemorrhage in drowning death as compared to non-drowning asphyxial death. Consent was taken as per the proforma and protocol approved by the ethical clearance committee.

Observations and Results:

A total number of 4590 autopsies were carried out at Gandhi Medical College Bhopal, over a period of 20 months and of which there were 83 cases of deaths due to drowning out of which 62 cases are included and rest excluded due to decomposition and head injuries, constituting 1.35% of all the unnatural deaths at the Department of Gandhi Medical College Bhopal. The study involved exclusively 62 non-decomposed, unmutated deceased individuals retrieved from water bodies with a history of drowning and presented for post-mortem examination.

Data collection is done by MS Excel and appropriate statistical methods are applied. The gender distribution of the 62 examined cases was 26% female and 74% male. Middle ear haemorrhage was seen in 70.97% (44) of cases (Unilateral 3.23%, 2 cases: Bilateral 67.74%, 42 cases) and the same was seen in 4.84% (3 out of 62 cases) of control group.

The incidence of middle ear hemorrhage in drowning group was compared with duration and depth of submersion and is shown in Table. 1 to 4, and It became apparent that the frequency of occurrence for middle ear hemorrhage increased substantially as one prolonged depth as well as duration of submersion. The amount of middle ear bleeding gradually increased with depth and duration of immersion, i.e., the amount of middle ear bleeding ranged from 37.50% at ≤ 5 ft to 83.33% at >15 ft.

Table 1: Middle Ear Haemorrhage Incidence

Middle ear hemorrhage	Male	Percent	Female	Percent	Total	Percent
Present	35	74.47	9	60	44	70.97
Absent	12	25.53	6	40	18	29.03
Total	47	100	15	100	62	100

Table 2: The Incidence of Middle Ear Haemorrhage in Drowning

Middle ear Hemorrhage	Male	Percent	Female	Percent	Total	Percent
Unilateral	1	2.17	1	6.25	2	3.23
Bilateral	33	71.74	9	56.25	42	67.74
Absent	12	26.09	6	37.50	18	29.03
Total	46	100	16	100	62	100

Table 3: The Relation between Middle Ear Hemorrhage and Depth of Water in Drowning

Depth	≤5 feet		5-10 feet		10-15 feet		> 15 feet	
	No.	%	No.	%	No.	%	No.	%
Unilateral	3	37.50	2	4.76	0	0	0	0
Bilateral	0	0	30	71.43	4	66.67	5	83.33
Absent	5	62.50	10	23.81	2	33.33	1	16.67
Total	8	100	42	100	6	100	6	100

Table 4: The Relation between Middle Ear Hemorrhage and Duration of Submersion

Duration	<6 Hours		6-12 Hours		> 12 Hours	
	No.	%	No.	%	No.	%
Unilateral	1	2.56	1	7.14	0	0
Bilateral	23	98.97	11	78.57	8	88.89
Absent	15	38.46	3	21.43	1	11.11
Total	39	100	14	100	9	100

Discussion

The incidence of middle ear bleeding was found in 70.97% (44) of cases (Unilateral 3.23%, 2 cases; Bilateral 67.74%, 42 cases). It was interesting to see that the amount of middle ear bleeding gradually increased with depth and duration of immersion, i.e., the amount of middle ear bleeding ranged from 37.50% at ≤ 5 ft to 83.33% at >15 ft. The reason for the increase in incidence with increasing depth and duration may have been due to long-term exposure to higher pressure and little reduction in middle ear bleeding deeper than 20 feet, and the higher rate observed by Ito remained unexplained may be due to the inclusion of microscopic evidence of bleeding in the study.

Middle ear bleeding was observed in 4.84% (3 out of 62 cases) of control group. The odd's ratio was 48.07; that is, drowning victims are 48 times more likely to develop middle ear bleeding than non-drowning victims. The study conducted by Nelson R Niles validated the occurrence of middle ear hemorrhage by reporting it in 80.4% of patients, bilateral in 68.63% of cases, and unilateral in 11%.[5] R. D. Robbins, reported the same in 80% of cases.

In contrast, Ito Y reported middle ear haemorrhage in up to 80% of non-drowning groups.[6] There was significant association between presence of middle ear haemorrhage and cases studied in drowning, where p value of $p < 0.00001$ which was found significant at $p < 0.05$. The absence of middle ear bleeding does not exclude the diagnosis of drowning; Faneh discovered them in only approximately 60% of instances, but other writers reported a greater rate.[7]

Two variables can influence the severity of haemorrhage: (i) age, which is directly related to the absence of pneumatization of the mastoid air cells in young children; and (ii) scarring from prolonged middle ear ailments. These two factors can therefore reduce the chances of showing this function at autopsy. Interestingly, the water depth

does not play an important role in the occurrence of these hemorrhages.[8]

The most accepted theory of pathogenesis of middle ear haemorrhage is that the increased pressure transmitted to the body by the surrounding water, which tends to be evenly distributed, compresses air in closed cavities more easily than in body tissues.[9] The soft tissue lining these spaces expands because it may absorb fluid from the other parts of the human body. Filling of blood vessels in this tissue is followed by bleeding into the ventricles.

Conclusion

In conclusion, the discovery of middle ear hemorrhage during autopsy in cases of drowning holds significant forensic implications. The presence of such hemorrhage serves as a reliable indicator of drowning, aiding forensic pathologists in establishing the cause of death with greater certainty. This finding is crucial in distinguishing drowning from other potential causes of death, particularly in cases where external evidence may be lacking or inconclusive.

Moreover, middle ear hemorrhage provides valuable insights into the mechanism of drowning, contributing to our understanding of the physiological processes involved in asphyxiation by water. By recognizing the significance of this characteristic post-mortem finding, forensic professionals can enhance the accuracy and reliability of their conclusions, ultimately facilitating justice and closure for the families of the deceased. Therefore, the identification of middle ear hemorrhage during autopsy in drowning cases stands as a pivotal aspect of forensic investigation, underscoring its enduring significance in the field of forensic science.

Ethical Clearance: The study has been carried out in the year 2021-22 after proper approval from ethical committee of Gandhi medical college, Bhopal.

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