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Original Research Article

Fluid in Sphenoidal Sinus In Cases of Drowning

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Abstract

Background: Drowning can be defined as death due to submersion in a liquid. Diagnosis of death by drowning is one of the challenges in the field of Forensic pathology as there is no pathognomonic sign for drowning. As sphenoid sinus is easily accessible during autopsy, fluid aspirated from the sinus could be used to ascertain drowning. The same is extremely useful in drowning cases where foreign body and water does not enter the air passages due to laryngospasm and in decomposed bodies. Therefore, this study was done to illustrate the significance of fluid in the sphenoidal sinus in drowning cases.

Methods: This was a descriptive study done on 168 drowning cases brought for autopsy in the Department of Forensic Medicine, Government Medical College, Kottayam. Study tools included semi structured proforma, needle bearing syringe, Lugol's iodine, concentrated nitric acid, 30% hydrogen peroxide, test tubes, centrifuge, glass slides and microscope. The paranasal sinuses were opened in all cases to look for presence of fluid. Diatom test performed for the fluid and diatoms compared with that of drowning medium.

Data were entered in Microsoft excel and analysed using Statistical Package for Social Sciences (SPSS) software (version 26).

Results: In the present study total 168 drowning cases were taken of which 152 (90.48% of total, with 95% confidence interval 86.05 to 94.91) showed the presence of fluid in sphenoid sinus.

Conclusion: The present study supports previous research that studied on significance of fluid in sphenoid sinus in diagnosing drowning. In the study, a high proportion of drowning cases showed the presence of fluid in sphenoid sinus along with identical diatoms to that of drowning medium which proved that the victim had inhaled fluid from the medium along with the diatoms. Therefore, it can be concluded that that the presence of fluid in the sphenoidal air sinus could point towards drowning as cause of death and so it is suggested to look for the presence of fluid in sphenoid sinus in all cases of drowning.

Keywords: Drowning; Sphenoidal Sinus; Sinus Fluid; Svechnikov's Sign.

Introduction

Drowning is a significant public health issue all over the world and ranked as third leading cause of unintentional injury death.[1] Drowning can be defined as death due to submersion in a liquid. The fluid in sphenoidal sinus becomes significant in drowning cases where foreign body and water does not enter the air passages due to laryngospasm. The presence of fluid in sphenoidal sinus is called Svechnikov's sign as it was first described by Russian pathologist, Svechnikov Vjac Eslav Alexandrovic in 1965.[2] Drowning as a cause of death is a diagnosis based on the exclusion of other potential causes.[3] Without proper history of circumstances which lead to drowning, post-mortem examination becomes more difficult. The external and internal signs of drowning may get altered due to putrefaction and aquatic animal activity with this background, this study is undertaken to illustrate the significance of fluid in sphenoidal sinus (Svechnikov's sign) for diagnosing antemortem drowning.

Methods

The study was conducted on 168 drowning cases brought for autopsy at Government Medical College, Kottayam. The procedure of data collection started on 31/3/2021 and concluded on 30/9/2022

Inclusion Criteria

1. All cases subjected to Medico Legal Autopsy with history of drowning.

Exclusion Criteria

1. Drowning cases with fracture of base of skull.
2. Putrefied bodies recovered from water with history other than drowning.

Sample Size: Sample size was calculated using the statistical formula,

$$n=\frac{4pq}{d^2}$$

Where 'p' is the prevalence in previous study, 'q' is 100-p and 'd' is permissible error.

According to the study conducted by R. Muthumuneeswaran, the prevalence obtained was 88 (Prevalence of fluid in sphenoidal sinus in drowning cases).

Hence calculating sample size with p=88.

Sample size calculated for the study is 168.

Data Collection Procedure

The drowning victims brought for autopsy at Department of Forensic Medicine, Government Medical College, Kottayam were studied. The inquest reports were scrutinized to select the cases. Written consent was obtained from the available relatives. The preliminary details of the person were collected from a reliable near relative of the deceased. The civil police officer in charge and the available person who witnessed the incident or in his absence the person, who had first-hand knowledge regarding the incident were interviewed in detail. The detailed history of incident including the time, duration, place and nature of the water body at the time of occurrence was collected.

Free fluid from sphenoid sinus was aspirated using a needle bearing syringe after piercing the jugum sphenoidale during autopsy using chisel and hammer. The sphenoid sinus could be approached

both intracranially and intranasal. We made intracranial approach because it gives good visibility and jugum sphenoidale can be easily exposed during autopsy. So, with this technique, the study could be done without any cosmetic disfigurement.

Analysis: Data was collected and entered in MS-Excel and analysed using the software SPSS (Statistical Package for Social Sciences) Version 26.

Ethical Considerations: The study is under less than minimal risk category. The study was started after getting approval from Institutional Ethics Committee. Informed written consent taken. No additional incisions were put on the body for the study.

Results

Maximum deaths were seen in the age group 40-49 years (20.83%) followed by 50-59 years (16.07%). Only 4.76% of the victims were aged below 10 years.

Among the victims of drowning, unemployed people (58.33%) were more than the employed (36.90%). There was a male preponderance among victims of drowning with males comprising of 79.17% and females 20.83%.

Table 1: Sociodemographic profile of victims

		n	%
Age	Below 10 yrs	8	4.76
	11-19 yrs	16	9.52
	20-29 yrs	16	9.52
	30-39 yrs	20	11.90
	40-49 yrs	35	20.83
	50-59 yrs	27	16.07
	60-69 yrs	21	12.50
	70 and above	25	14.88
Occupation	Unemployed	98	58.33
	Employed	62	36.90
	NA	8	4.76
Sex	Male	133	79.17
	Female	35	20.83
Total		168	100.00

Table 2: Period of submersion, Season and type of water medium

		n	%
Period of Submersion	<12 Hr	98	58.33
	12 to 24 Hr	32	19.05
	>24 Hr	38	22.62
Season	Monsoon	103	61.31
	Winter	38	22.62
	Summer	27	16.07
Type of Water medium	River	91	54.17
	Stagnant	41	24.40
	Well	35	20.83
	Bucket	1	0.60
Total		168	100.00

Bodies were retrieved within 12 hours in 58.33% of cases. Victims lying in water bodies for more than a day comprised of 22.62%. The table also shows death in different seasons. Drowning was maximum in monsoon season (61.31%). The lowest mishap was in the summer season (16.07%). Among the mediums of drowning, river was the commonest (54.17%). The well water drowning death was seen in 20.83 % which was the lowest.

Death due to drowning was highest during monsoon season (61.31%) and least in summer season (16.07%). Drowning happened maximum in rivers (54.17%) followed by stagnant water (24.40%) and well (20.83%). 0.60 % of victims drowned in a bucket of water.

Table 3: External findings in Victims

External Findings		n	%
Froth	Yes	100	59.52
	No	68	40.48
Cutis Anserina	Yes	76	45.24
	No	92	54.76
Wrinkling	Yes	157	93.45
	No	11	6.55
Bleaching	Yes	117	69.64
	No	51	30.36
Soddening	Yes	55	32.74
	No	113	67.26
Total		168	100.00

Froth at nostrils was present in about 60% of the cases. Cutis anserina was absent in 54.76% of the cases. However, in more than 93% of the cases, wrinkling was present. Bleaching was found in about 70% of the cases and soddening in more than 67% of cases. All these 5 variables are general physical appearances of the drowned bodies. Wrinkling, bleaching and soddening are the yardstick for assessing the time period of immersion in fluid medium.

Table 4: Internal findings in Victims

Internal Findings		n	%
Trachea and Bronchi	FB	79	47.02
	No FB	89	52.98
Appearance of Lungs	PDC	150	89.29
	CO	18	10.71
Weight of right lung	Up to 400	51	30.36
	401-500	55	32.74
	Above 500	62	36.90
Weight of left lung	Up to 400	62	36.90
	401-500	49	29.17
	Above 500	57	33.93
Total		168	100.00

In the study presence of foreign body was seen in more than 47%, which may be taken as a positive sign of antemortem drowning.

Table 5: Proportion of victims with fluid in sphenoid sinus

	n	%
Present	152	90.48 (95% CI: 86.05 to 94.91)
Not present	16	9.52
Total	168	100.00

Fluid was present in sphenoidal sinus in 90.48 % cases of drowning with 95% confidence interval between 86.05 % and 94.9%.

Table 6: Amount of fluid aspirated from sphenoid sinus

Amount of fluid	n	%
<1	9	5.92
1 to 2	30	19.74
2 to 4	63	41.45
>4	50	32.89
Total	152	100.00

Factors associated with fluid in sphenoidal sinus

Age

Independent sample t test was performed to determine the association of age with presence of fluid in sphenoidal sinus as age followed normality assumption. It is observed that the average age is not significantly different between the groups. The t test reveals that there no statistically significant association exist between age and fluid in sphenoidal sinus (p=0.374). More details are given below.

Table 7: Age and fluid in sphenoid sinus

Fluid	n	Mean	SD	t statistic	P value
Present	152	45.49	21.33	0.892	0.374
Absent	16	50.44	18.48		

Sex distribution

Fishers exact test was performed to determine the association of sex distribution with fluid in sphenoidal sinus. The test revealed that there no statistically significant association exist between sex distribution and fluid in sphenoid sinus (p=1.000). More details are given below

Table 8: Sex distribution and fluid in sphenoid sinus

Variable		Fluid in sphenoid sinus		Fisher's exact p value
		Present	Absent	
Sex	Male	120	13	1.000
	Female	32	3	

Period of submersion in fluid medium

Chi square test with continuity correction was done to determine the association between period of submersion and fluid in sphenoidal sinus. The test revealed that a statistically significant association exists between period of submersion and fluid in sphenoid sinus ($p < 0.001$).

Table 9: Period of submersion and fluid in sphenoid sinus

Variable		Fluid in sphenoidal sinus		Chi square test statistic with continuity correction (p value)
		Present	Absent	
Period of submersion	Less than or equal to 24 hours	125	5	18.687 (<0.001)
	More than 24 hours	27	11	

Foreign body in air passages

Chi square test with continuity correction was performed to determine the association of foreign body in air passages and fluid in sphenoidal sinus. The test revealed that no statistically significant association existed between foreign body in air passages and fluid in sphenoidal sinus (p=0.607). More details are given below

Table 10: Foreign body in air passages and fluid in sphenoid sinus

Variable		Fluid in sphenoid sinus		Chi square test statistic with continuity correction (p value)
		Present	Absent	
Foreign body	Present	70	9	0.264 (0.607)
	Absent	82	7	

Discussion

Initially epidemiological factors like age, sex and occupation were analysed. Out of 168 drowning victims, 133 (79.17%) were males and 35(20.83%) were females. This preponderance of male sex may be because males are more mobile and travel more, engage in high-risk activities where submersion is possible. The fact that habits like drinking and drugs are more in males could also be a factor. In the study by Muthumuneeswaran[4] on presence of fluid in paranasal sinuses in drowning, 90% of victims were male. In the study by Chovallur et al[5] on validity of presence of fluid in paranasal sinuses, 68% of drowned persons were males. Out of 168 drowning cases, 98 cases (58.33%) were unemployed. Mohanty et al[6] also observed in their study that majority of victims (61.8%) were unemployed.

External findings of drowning victims were observed in our study. Persistent fine white lathery froth was seen in about 60 % drowning cases and cutis anserina (goose skin appearance) was absent in 54.76% cases. Wrinkling of palms and soles was present in more than 93% cases; bleaching in about 70% cases and soddening was absent in more than 67 % of cases. The presence of froth is a positive finding for considering the diagnosis of drowning. Other findings like cutis anserina, wrinkling, bleaching and soddening are considered as signs of submersion of the bodies. Wrinkling, bleaching and soddening additionally helps in determining the time period of immersion. Jiju et al[7] in their study of 100 drowning cases observed that froth at mouth and nostrils present in 33% cases; cutis anserina present in 6% cases;31 cases showed full combination of wrinkling, bleaching and soddening. Chovallur et al[5] observed in their study that among 50 drowning cases, signs of submersion present in 50% cases and froth around mouth and nostrils seen in 56% cases. Thus, froth is not a mandatory finding in drowning deaths. Also froth at nostrils could be lost due to delay in conducting autopsy as autopsy may be conducted the next day after the incidence.

On analysing the internal findings, it was observed that foreign body in air passages was seen in more than 47% cases and was absent in 52.98 % cases. Out of 168 samples, 150 (90%) showed the appearance of lung as pale, doughy and

crepitant. Weight of right lung was more than 500 grams in 62 cases (36.90%) and weight of left lung was up to 400 grams in 62 cases (36.90%). According to the study by Chovallur et al[5] in 50 drowning cases, paltauf's haemorrhages seen in 50% cases; foreign body in air passages seen in 58% cases and emphysema aquosum seen in 76% cases. According to the study by Jiju et al[7] in 100 drowning cases, foreign body in air passages seen in 25% cases; paltauf's haemorrhages seen in 53% cases; pale, doughy and crepitant lung seen in 65% cases. The primary objective of the study was to estimate the proportion of drowning cases showing presence of fluid in sphenoidal sinus. Sphenoidal sinus can be approached intracranial and intranasal. In our study, intracranial approach was adopted as it provided good visibility and was cosmetically superior. The fluid in sphenoid sinus was withdrawn using a needle bearing syringe. Jugum sphenoidale was opened after removing the brain during autopsy thereby exposing the sphenoidal air sinus and fluid was aspirated from the sinus.

Among the 168 cases of drowning victims, 152 cases (90.48% of total with a confidence interval from 86.05% to 94.91%) showed the presence of fluid in sphenoidal sinus.16 cases (9.52% of total) showed absence of fluid in the sinus.

The results of our study were in agreement with the results of many previous research works.

In the study by Hottmar[8] (1996), out of 387 cases of fresh water drownings,75% showed fluid in sphenoidal sinus. Miltner and Heinze[9] (1989) found that 64.52% out of 31 drowning cases showed presence of fluid in the sphenoid sinus.

Bohnert et al[10] (2002) who studied on forensic significance sphenoidal sinus fluid observed that 92% out of 60 drowning cases showed presence of fluid in the sinus. According to Levy et al[11] (2007) who studied on autopsy findings in drowning using CT guide virtopsy, fluid in sphenoid sinus was seen in all 28 drowning cases (100%). Christe et al[12] (2007) who also used CT guided virtopsy observed that all 10 cases (100%) showed fluid in sphenoid sinus. Kawasumi et al[13] (2012) observed that 38 out of 39 drowning cases i.e., 97% sensitivity showed presence of sphenoid sinus fluid. But they also obtained fluid in 65% of control group. Lee and Ryu[14] (2013) investigated on significance of fluid in sphenoid sinus of Korean population and observed that 45 of the 54 cases (83%) showed presence of the fluid. According to Van Hoyweghen et al[15] (2014), though 93% of drowning cases showed fluid in sphenoid sinus, no significant difference in result was observed when compared with control group. Tanaka et al[16] (2015) observed that all 22 drowning cases showed fluid in sphenoidal sinus. They also noted that high level of chlorine and bromine in the fluid could be used as a chemical marker for seawater drowning. Lo Re et al[17] (2015) noted that 3 out of 4 drowning cases i.e., 75% showed fluid in sphenoid sinus. Lundemose et al[18] (2015) observed that 17 drowning cases and 10 controls showed presence of fluid in sphenoidal sinus.

Chovallur et al[5] (2018) noted that 43 out of 50 drowning cases i.e., 86% showed fluid in sphenoid sinus and 50 controls showed absence of fluid. Muthumuneeswaran[4] (2020) observed that 88 % showed presence of fluid in sphenoid sinus and absence of fluid in the control group. Schneppe et al[19] (2021) retrospectively studied on various drowning signs in 331 drowning cases and svechnikov's sign was positive in 86.3% cases.

The amount of fluid obtained was quantified. Out of 152 cases, maximum amount of fluid i.e., between 2 to 4 ml was obtained in 63 cases (41.45%) and least

amount of fluid i.e. less than 1 ml was obtained in 9 cases (5.92%). Thirty cases (19.74 %) showed 1 to 2 ml of fluid and 50 cases (32.89%) showed more than 4 ml of fluid in the sinus. In a study by Michael Bohnert et al[10], it was observed that in 92 % of the deaths by drowning between 1 ml and 4 ml of aqueous fluid could be found in sphenoid sinuses. However, a positive result was also obtained in 52 % of other cases autopsied, but in such cases average volume of aspirate was smaller.

Conclusion

Presence of fluid in sphenoidal sinus in adequate quantity points to death due to immersion in fluid medium (drowning). This finding could be immensely useful when decomposed bodies are retrieved from water and in which other findings of drowning could be distorted due to varying changes of decomposition.

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