



Diagnosis of drowning: Electrolytes and total protein in sphenoid sinus liquid



Akira Hayakawa^{a,b,*}, Koichi Terazawa^b, Kotaro Matoba^b, Kie Horioka^b, Tatsushige Fukunaga^a

^a Tokyo Medical Examiner's Office, Tokyo Metropolitan Government, Tokyo, Japan

^b Department of Forensic Medicine, Hokkaido University Graduate School of Medicine, Sapporo, Japan

ARTICLE INFO

Article history:

Received 12 November 2016

Received in revised form 15 February 2017

Accepted 16 February 2017

Available online 24 February 2017

Keywords:

Drowning

Forensic diagnosis

Forensic biochemistry

Liquid in sphenoid sinus

Electrolyte

Total protein

ABSTRACT

In this study, electrolyte (sodium (Na), chlorine (Cl), and magnesium (Mg)) and total protein (TP) concentrations and volume of liquid in the sphenoid sinus were examined to determine their usefulness to elucidate whether drowning occurred in freshwater or seawater. We examined 68 cases (seawater drowning group: 27 cases, freshwater drowning group: 21 cases, non-drowning group: 20 cases). There was a significant difference in Na, Cl, Mg, and TP concentrations of liquid in the sphenoid sinus among the three groups (seawater drowning, freshwater drowning, and non-drowning groups). To distinguish freshwater drowning from seawater drowning, Na, Cl, and Mg concentrations of liquid in the sphenoid sinus might serve as useful indicators.

© 2017 Elsevier B.V. All rights reserved.

1. Introduction

In forensic diagnosis, diagnosis of drowning presents a major problem [1]. Useful findings for diagnosis of drowning include the presence of micro-froth around the mouth and in the airways, pleural effusion, emphysema aquosum, water in the stomach and duodenum, and diatoms in the blood and various organs [1–9]. It is also important to determine whether drowning occurred in freshwater or seawater because it is important to determine the site where drowning occurred [1]. To determine whether drowning occurred in freshwater or seawater is greatly assisted by the characteristics of the lungs, diatom test, electrolyte concentration of the liquid in the stomach and duodenum, and electrolyte concentration of pleural effusion [1–5,10–14].

Presence of liquid in the sphenoid sinuses serves as an indicator of diagnosis of drowning [1,15–19]. It was reported that the liquid in the sphenoid sinus was significantly greater in the drowning group than in the non-drowning group [15–19]. Živković et al. reported that in putrefied bodies recovered from water, an amount of 0.55 mL of free liquid in the sphenoid sinuses

might imply that the victim was alive upon their contact with the water, but the presence of free liquid in the sphenoid sinuses did not necessarily indicate that drowning had been the cause of death [19]. Moreover, it has been reported that chlorine (Cl) and bromine (Br) concentrations of liquid in the sphenoid sinus indicate drowning in seawater [20]. However, no studies have examined the use of liquid in the sphenoid sinus to determine whether drowning occurred in freshwater or seawater.

In this study, electrolyte (sodium (Na), Cl, and magnesium (Mg)) and total protein (TP) concentrations and volume of liquid in the sphenoid sinus were examined to determine their usefulness to elucidate whether drowning occurred in freshwater or seawater.

2. Materials and methods

Of the 715 forensic autopsy cases conducted from August 2012 to September 2015 at our institution, we examined 68 cases (seawater drowning group: 27 cases, freshwater drowning group: 21 cases, non-drowning group: 20 cases) that met the following criteria: (1) postmortem interval of less than 1 week; (2) presence of ≥ 0.5 mL of liquid in the sphenoid sinus; (3) absence of severe decomposition and any injury or lesion around the sphenoid sinus by our pathological and biochemical analysis; and (4) no long-term treatment in a hospital prior to death.

* Corresponding author. Present address: Tokyo Medical Examiner's Office, 4-21-18, Otsuka, Bunkyo-ku, Tokyo 112-0012, Japan.

E-mail address: Akira_Hayakawa@member.metro.tokyo.jp (A. Hayakawa).

Drowning was diagnosed after confirming several findings, such as micro-froth around the mouth and in the airways, a large amount of pleural effusion, emphysema aquosum, detection of diatoms, as well as the absence of findings indicative of other causes of death. All drowning cases were accidental or suicidal, and places of drowning were in freshwater or seawater as revealed by police investigation and autopsy findings. There was no drowning case at brackish water area.

The causes of death in non-drowning group were as follows: ischemic heart disease in 6 cases, poisoning in 5 cases, asphyxia in 3 cases, gastrointestinal disease in 2 cases, epiglottitis in 1 case, subdural hematoma in 1 case, burn shock in 1 case, and hypothermia in 1 case.

The cases consisted of 19 males and 8 females in the seawater drowning group, 9 males and 12 females in the freshwater drowning group (28 males and 20 females in the drowning group), and 10 males and 10 females in the non-drowning group. The mean and standard deviation of the ages of the cases were 57.1 ± 16.1 (27–82) years for the seawater drowning group, 52.0 ± 20.1 (6–82) years for the freshwater drowning group (54.9 ± 18.0 (6–82) years for the drowning group), and 53.9 ± 22.4 (21–87) years for the non-drowning group. The mean and standard deviation of postmortem interval of the cases was 1.7 ± 0.6 (1–4) days for the seawater drowning group, 2.5 ± 2.1 (1–7) days for the freshwater drowning group (2.1 ± 1.5 (1–7) for the drowning group), and 2.1 ± 1.5 (1–7) days for the non-drowning group (Table 1).

At forensic autopsies, the liquid in the sphenoid sinus was collected using a syringe, from which Na, Cl, Mg, and TP concentrations and volume of liquid in the sphenoid sinus were measured. The measurements were examined according to the following three groups: seawater drowning, freshwater drowning, and non-drowning, as well as according to the drowning group (seawater and freshwater drowning groups) and non-drowning group. Furthermore, in the drowning group, we examined the correlation between Na, Cl, and Mg concentrations of liquid in the sphenoid sinus in the drowning group and those of the liquid sample obtained from the sites where the decedents were discovered (e.g., water from the sea or river).

Na, Cl, Mg, and TP concentrations of liquid in the sphenoid sinus were measured using SRL Inc. (Sapporo, Japan) according to the ion-selective electrode method for Na and Cl measurements, xylydyl blue method for Mg, and Biuret method for TP, respectively.

JMP[®] 10 (SAS Institute, USA) was used for all statistical analyses. Steel–Dwass method was used for comparison of the three groups, and Mann–Whitney U test was used for comparison of the drowning and non-drowning groups. A single regression analysis was used to examine the relationships between postmortem interval and Na, Cl, Mg, and TP concentrations and volume of liquid in the sphenoid sinus, respectively. Spearman's correlation coefficient by rank test was used to examine the correlation between Na, Cl, and Mg concentrations of liquid in the

sphenoid sinus in the drowning group and those of the liquid sample obtained from the sites where the decedents were discovered. A value of $P < 0.01$ was considered to be statistically significant.

3. Results

In the seawater drowning group ($n = 27$), measurements for Na, Cl, Mg, and TP concentrations and volume of liquid in the sphenoid sinus were 274.7 ± 66.9 (130–387) mEq/L, 294.8 ± 80.5 (142–425) mEq/L, 62.0 ± 19.3 (29.9–94.0) mg/dL, 1.2 ± 0.9 (0.4–3.7) g/dL, and 2.3 ± 1.7 (0.5–8.0) mL, respectively. In the freshwater drowning group ($n = 21$), these measurements were 64.7 ± 16.2 (30–89) mEq/L, 53.5 ± 11.8 (30–80) mEq/L, 2.7 ± 1.1 (1.5–5.4) mg/dL, 2.2 ± 0.7 (1.2–4.0) g/dL, and 2.3 ± 1.6 (1.0–7.0) mL, respectively. In the drowning group ($n = 48$), they were 182.8 ± 116.9 (30–387) mEq/L, 186.9 ± 135.3 (30–425) mEq/L, 36.1 ± 33.0 (1.5–94.0) mg/dL, 1.7 ± 0.9 (0.4–4.0) g/dL, and 2.3 ± 1.7 (0.5–8.0) mL, respectively. In the non-drowning group ($n = 20$), they were 118.5 ± 14.1 (98–142) mEq/L, 95.7 ± 7.6 (79–111) mEq/L, 5.3 ± 3.1 (1.6–15.7) mg/dL, 6.3 ± 2.6 (1.8–12.1) g/dL, and 1.7 ± 1.6 (0.5–6.0) mL, respectively (Fig. 1).

Among the three groups, a significant difference was observed in Na, Cl, Mg, and TP concentrations of liquid in the sphenoid sinus; however, there was no significant difference in volume of liquid in the sphenoid sinus. The TP concentration of liquid in the sphenoid sinus in the non-drowning group was significantly higher than that in the drowning group for; however, no significant difference was showed for Na, Cl, and Mg concentrations and volume of liquid in the sphenoid sinus showed.

No significant correlation was observed between postmortem interval and Na, Cl, Mg, and TP concentrations and volume of liquid in the sphenoid sinus in each group, respectively.

Na, Cl, and Mg concentrations of the liquid sample obtained from the sites where the decedents were discovered in the seawater drowning group were 429.0 ± 51.7 (275–481) mEq/L, 499.9 ± 35.2 (142–425) mEq/L, and 106.9 ± 20.1 (54–122) mg/dL, respectively. Those in the freshwater drowning group were 5.9 ± 1.3 (5–8) mEq/L, 12.9 ± 1.5 (11–15) mEq/L, and 0.2 ± 0.3 (0–1) mg/dL, respectively. There was no significant correlation observed between Na, Cl, and Mg concentrations of liquid in the sphenoid sinus in the drowning group and those of the liquid sample obtained from the sites where the decedents were discovered.

Table 2 shows the classification of the three groups according to Na, Cl, and Mg concentrations of liquid in the sphenoid sinus. All cases with Na concentration ≤ 90 mEq/L were in the freshwater drowning group, and those with Na concentration ≥ 150 mEq/L were in the seawater drowning group. Similarly, all cases with Cl concentration ≤ 70 mEq/L were in the freshwater drowning group, and those with Cl concentration ≥ 120 mEq/L were in the seawater drowning group. Finally, all cases with Mg concentration ≥ 20 mg/dL were in the seawater drowning group. Table 2 also shows the drowning and non-drowning groups classified according to the TP value. All cases with a TP concentration of ≤ 1.5 g/dL were in the drowning group, and those with a TP concentration of ≥ 4.5 g/dL were in the non-drowning group.

4. Discussion

With regard to Na, Cl, and Mg concentrations of liquid in the sphenoid sinus in the drowning group and those of the liquid sample from the sites where the decedents were discovered, no significant correlation shows. This indicates that Na, Cl, and Mg concentrations of liquid in the sphenoid sinus may not be

Table 1

The number of the cases and gender, mean and standard deviation of age (years) and postmortem interval (days) in the drowning (seawater drowning, freshwater drowning) and non-drowning group.

	n	Gender		Age				Postmortem interval			
		M	F	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Drowning	48	28	20	54.9	18.0	6	82	2.1	1.5	1	7
Seawater	27	19	8	57.1	16.1	27	82	1.7	0.6	1	4
Freshwater	21	9	12	52.0	20.1	6	82	2.5	2.1	1	7
Non-drowning	20	10	10	53.9	22.4	21	87	2.1	1.5	1	7

n: the number of cases, M: male, F: female, S.D.: standard deviation.

Download English Version:

<https://daneshyari.com/en/article/4760335>

Download Persian Version:

<https://daneshyari.com/article/4760335>

[Daneshyari.com](https://daneshyari.com)