

CASE REPORT

PATHOLOGY AND BIOLOGY

Giovanni Cecchetto,¹ M.D.; Alberto Feletti,² M.D.; Massimo Montisci,¹ M.D., Ph.D.; Paolo Fais,¹ M.D.; Attilio Cecchetto,³ M.D.; and Guido Viel,¹ M.D.

Fatal Drowning Accident and Undiagnosed Hydrocephalus

ABSTRACT: Bodies found in water present several diagnostic challenges for the forensic examiner, such as the identification of the time and mechanism of death, the postmortem submersion time, and above all the circumstances of drowning. We report the case of a 33-year-old security guard found dead in Venice, in the water of the lagoon, who at autopsy presented a previously undiagnosed hydrocephalus with macrocephaly. The victim remained asymptomatic until 2 months before death and had never undergone a neurological or radiological examination. In the article, we emphasize the need to perform a thorough autopsy in all suspected drownings, discuss the etiopathogenesis of the neurological disease and hypothesize a possible relationship between the hydrocephalus and the drowning accident. Finally, we discuss the major clinical and forensic implications of macrocephaly and hydrocephalus in adults.

KEYWORDS: forensic science, forensic pathology, bodies found in water, drowning, macrocephaly, hydrocephalus, reconstruction of the event

Bodies found in water present several diagnostic challenges for the forensic examiner, such as the identification of the time and mechanism of death (i.e., was the victim alive or dead at the time of entry into the water? Is drowning the real cause of death?), the postmortem submersion time, and above all the circumstances of drowning (i.e., why did the victim enter the water? Why was the victim unable to survive in the water?) (1).

There are no autopsy findings pathognomonic of drowning (2). Consequently, obtaining proof that the victim was alive on entering the water, and excluding the presence of natural, traumatic, and toxicological causes of death are critically important (2,3). In any given case circumstances surrounding death, environmental factors, victim's preexisting diseases, autopsy, and laboratory findings have to be appropriately considered (1).

We report the case of a 33-year-old security guard found dead in Venice, in the water of the lagoon, who at autopsy was found to be affected by a previously undiagnosed hydrocephalus. The etiopathogenesis of the cerebral disease and its medicolegal implications are critically discussed.

Case Report

A summer night, on the "Riva degli Schiavoni" in Venice, a young boy called the emergency number "113" reporting that he had seen a man falling down into the lagoon from a footboard connecting two boats moored along the side (Fig. 1). After 30 min, a

rescue team arrived, but no traces of the victim were found. The next day, the body was recovered from the lagoon bed by a group of police divers, about 500 m distance from the site where the man was seen falling into the water. The deceased (height = 180 cm; weight = 75 kg) was identified as a 33-year-old security guard.

Death Scene Investigation

A thorough death scene investigation was performed the day the body was found. The footboard (width: 70 cm, length: 2 m) connecting the two boats was stably fixed by means of ropes. It was unenclosed and had a smooth surface without any step (Fig. 1B). A closer inspection of the footboard and of the two boats did not reveal any stains of blood or other biological materials.

Victim's Clinical and Personal Data

Interviews with the victim's family doctor, parents, friends, and colleagues were performed. It turned out that the man was not affected by any physical or mental disorders, he was living a regular professional, private, and family life, and he had never suffered of any particular illness except for a childhood exanthematic disease. He had had a primary education and was unable to swim. Some of his colleagues reported that in the last 2 months, he used to complain of episodes of headache and disequilibrium and he had never suffered from those conditions before. The victim gained his driving license at age 20 and obtained a firearm license at age 32.

Autopsy and Histology Findings

Forensic autopsy was performed 3 days after the death. At the face and hands, multiple nonvital bruises and lacerations (produced by the marine fauna) were noticed (Fig. 2A). Vital tears were

¹Department of Environmental Medicine and Public Health, Legal Medicine, University of Padua, Via Falloppio 50, 35121 Padova, Italy.

²Department of Neurosurgery, Treviso Hospital, University of Padua, Piazzale Ospedale, 1, 31100 Treviso, Italy.

³Department of Diagnostic Science and Special Therapies, Pathology Unit, University of Padua, Via Giustiniani 2, 35121 Padova, Italy.

Received 16 Mar. 2009; and in revised form 12 May 2009; accepted 17 May 2009.

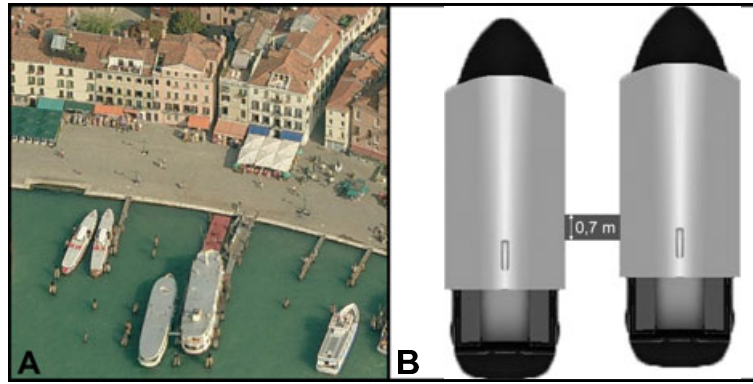


FIG. 1—(A) Aerial view of “Riva degli Schiavoni” (Venice, Italy) showing some boats moored along the side. (B) Sketch of the footboard (length 2 m; width 0.7 m) from which the victim fell down into the water.

present on the fingertips of the right index, medial, and third fingers; the fingernails of the right thumb and index were broken. The occipital frontal circumference (OFC) was 66 cm (considering the victim’s race, height, and weight the mean normal value is 60 ± 2 cm) (4). On incising the scalp, there was no evidence of ecchymosis or hemorrhagic infiltration. When opening the skull, a massive discharge of cerebrospinal fluid (CSF) followed by a collapse of the cerebral mantle was observed. The whole brain was collected and fixed in 4% buffered formalin after filling the ventricles with cotton.

Drowning liquid, sand, and fragments of mussel shells were found in the stomach and in the upper airways. The lungs were overdistended. At histology, an acute lung emphysema with lacerations of septa, capillary congestion, and moderate intra-alveolar edema was found.

Toxicological screenings on blood and urine for alcohol, opiates, cocaine metabolites, methamphetamines, benzodiazepines, and tetrahydrocannabinol tested negative.

Neuropathological Study

The brain was examined and sectioned coronally after 4 weeks of formalin fixation (Fig. 2B). A marked symmetrical dilatation of the lateral ventricles (Fig. 2C,D) and a considerable dilatation of the third and fourth ventricles were observed. The cortex and the corpus callosum were stretched (Figs. 2D and 3B), with a remarkable white matter loss.

The aqueduct was open with a medium diameter of $1000 \mu\text{m}$ and a normal ependymal epithelium (Fig. 3C). No pathological alterations of the choroid plexi were observed.

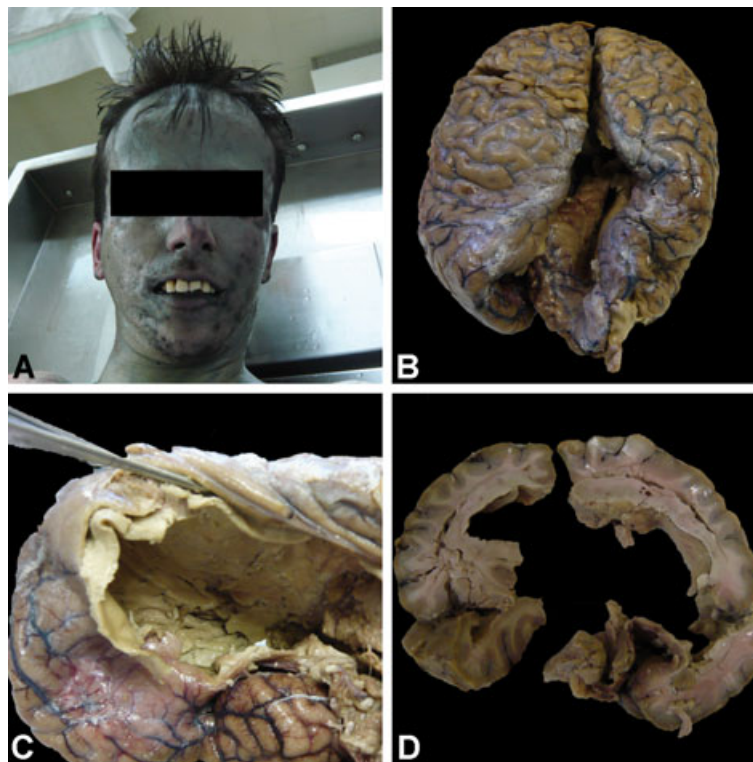


FIG. 2—(A) Picture of the victim’s face showing an enlarged head (OFC = 66 cm). Multiple non-vital bruises and lacerations produced by the marine fauna are visible. (B) Enlarged brain after formalin fixation. (C) Dilation of the lateral ventricle. (D) Coronal section of the brain showing a cortical stretch with a remarkable white matter loss. OFC, occipital frontal circumference.

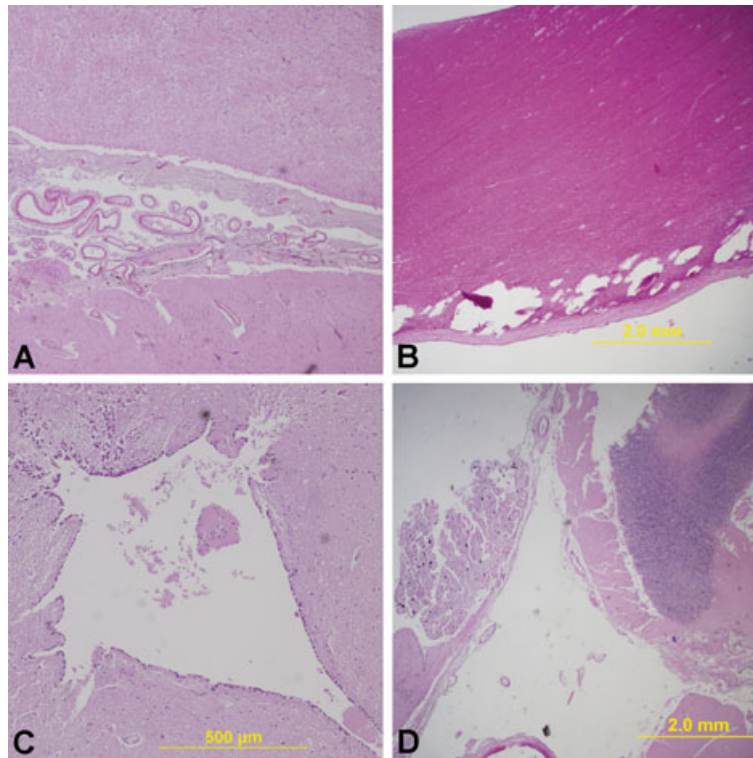


FIG. 3—(A) Fibrous thickening of leptomeninges with an abundant vascular component and focal lymphocytes next to the Pacchioni's granulations. (B) Corpus callosum showing a remarkable white matter loss. (C) Patent aquaeductus cerebri with a medium diameter of 1000 μm and a normal ependymal epithelium. (D) Fibrous thickening of leptomeninges at the fourth ventricle.

Leptomeninges, particularly at the fourth ventricle and next to the Pacchioni's granulations, were characterized by a fibrous thickening, with an abundant vascular component and focal lymphocytes (Fig. 3A–D).

Discussion

Evaluating circumstantial details, autopsy, histology, and toxicological findings, drowning was considered the most probable cause of death.

Indeed, the presence of emphysema aquosum, foreign materials in airways, lungs, and stomach, in the absence of any other pathological or toxicological conditions that could explain the death, pointed toward a form of mechanical asphyxia by drowning. Moreover, injuries to fingertips and fingernails (suggestive of a water struggle) indicated, with a high degree of probability that the victim was alive when entering the water (2). Interviews with the deceased's general practitioner, family, and friends did not reveal any mental disorders or socio-economic problems that could indicate a suicide intention. In addition, the victim was referred to be unable to swim, thus giving a possible explanation on why a healthy 33-year-old man was incapable to survive after falling into the water. However, why did the victim fall from the footboard? Was it just an accidental misstep?

Interestingly, the autopsy revealed a tetraventricular hydrocephalus sustaining a macrocephaly that was never noticed before. Therefore, we can infer that the ventricular dilation began during infancy, before the closure of the cranial sutures (5).

Hydrocephalus is an increase in CSF volume that can be caused by an obstruction to CSF flow at any point along its path, by impaired absorption or, more rarely, by an excess of CSF production (6).

It is worth noting that in our case, the *aquaeductus cerebri* was found to be open (Fig. 3C), and a diffuse leptomeningeal thickening was evident at the level of the fourth ventricle (Fig. 3D). Although a reduced CSF reabsorption through the impaired Pacchioni's granulations cannot be excluded, in our opinion the most probable etiopathogenesis of the victim's hydrocephalus is a postinfective obstruction of the fourth ventricle outlets, a previously described condition (7,8).

The chronic development of a tetraventricular dilation in the absence of any symptoms during childhood is not surprising, as subclinical meningitis is a well-known eventuality (6,9). It can be speculated that a subclinical infection during infancy caused an inflammatory reaction of the leptomeninges, leading to the development of membranes that partially blocked the foramina of Magendie and Luschka. As recently described for primary velar obstruction of the fourth ventricle outlets, also acquired membranes can often be discontinuous and allow a subcritical CSF flux until a decompensation occurs (10). Either a progressive fibrosis accompanied by an impairment of the membrane permeability, or a variation of the brain compliance because of aging could explain the late onset of symptoms in these patients (11). Chronic hydrocephalus is usually associated with headache and gait difficulties.

In the reported case, circumstantial data and clinical records pointed out that the victim remained asymptomatic until 2 months before he died and he had never undergone a neurological or radiological examination. However, the colleagues reported that during the last 2 months, he had experienced some episodes of headache and disequilibrium.

Regarding the dynamics involved in the fall from the footboard, even if a slip cannot be excluded (the footboard was narrow, about 0.7 m in width), we may hypothesize that the recent onset of gait

disturbances because of the chronic hydrocephalus could have played a role.

Moreover, it is important to notice that the year before, the victim was examined in a medicolegal setting and had obtained a firearm license without any specific clinical or radiological investigation for his macrocephaly.

Macrocephaly refers to an abnormally large head (OFC above 2.0 SD of the mean) inclusive of the scalp, cranial bone, and intracranial contents (12). It may be attributed to megalencephaly (true enlargement of the brain parenchyma), hydrocephalus, or cranial hyperostosis and is frequently associated with genetic or metabolic disorders, along with impaired mental or motor abilities (12).

In Italy, the Road Traffic Regulation Act (TU 261/2005) (13) and the Firearms Control Act (DM 143/1998) (14) state that both driving and firearm licenses should not be issued to anyone affected by neuro-psycho-physical diseases impairing alertness and/or motor and mental functions.

Considering the laws in force, the potential neuro-physical conditions associated with macrocephaly (12) and the teaching experience of the reported case, we do believe that also in a forensic setting an enlarged head should be investigated with an appropriate and thorough diagnostic approach (eventually followed by neurological and radiological examinations), to exclude any motor, mental, or psychiatric impairment.

References

- Lunetta P, Modell JH. Macroscopical, microscopical, and laboratory findings in drowning victims: a comprehensive review. In: Tsokos M, editor. *Forensic pathology reviews*, Vol. 3. Totowa, NJ: Humana Press, 2005;3–81.
- Spitz WU. Drowning. In: Spitz WU, editor. *Spitz and Fisher's medicolegal investigation of death*. Springfield, IL: Charles C. Thomas, 1993;498–516.
- Davis JH. Bodies found in the water. An investigative approach. *Am J Forensic Med Pathol* 1986;7(4):291–7.
- Bushby KM, Cole T, Matthews JN, Goodship JA. Centiles for adult head circumference. *Arch Dis Child* 1992;67(10):1286–7.
- Del Bigio MR. Pathophysiologic consequences of hydrocephalus. *Neurosurg Clin N Am* 2001;12(4):639–49, vii.
- Mori K, Shimada J, Kurisaka M, Sato K, Watanabe K. Classification of hydrocephalus and outcome of treatment. *Brain Dev* 1995;17(5):338–48.
- Dhiwakar M, Basu S, Ramaswamy R, Mallucci C. Neuroblastosis causing hydrocephalus, trapped fourth ventricle, hindbrain herniation and syringomyelia. *Br J Neurosurg* 2004;18(4):367–70.
- Harrison HR, Reynolds AF. Trapped fourth ventricle in coccioidal meningitis. *Surg Neurol* 1982;17(3):197–9.
- Montisci M, Terranova C, Snenghi R, Ferrara SD. Chronic hydrocephalus and alcohol abuse in a young male suicide. *Am J Forensic Med Pathol* 2006;27(4):320–3.
- Longatti P, Fiorindi A, Feletti A, Baratto V. Endoscopic opening of the foramen of magendie using transaqueductal navigation for membrane obstruction of the fourth ventricle outlets. Technical note. *J Neurosurg* 2006;105(6):924–7.
- Rifkinson-Mann S, Sachdev VP, Huang YP. Congenital fourth ventricular midline outlet obstruction. Report of two cases. *J Neurosurg* 1987;67(4):595–9.
- Williams CA, Dagli A, Battaglia A. Genetic disorders associated with macrocephaly. *Am J Med Genet A* 2008;146A(15):2023–37.
- <http://pionieriudine.it/Pionieri/request.php?101>. Accessed May 6, 2009.
- <http://gazzette.comune.jesi.an.it/143/gazzetta143.htm>. Accessed May 6, 2009.

Additional information and reprint requests:

Guido Viel, M.D.
 Department of Environmental Medicine and Public Health
 Legal Medicine University of Padua
 Via Falloppio 50
 Padova
 Italy
 E-mail: guido_viel@yahoo.it