ELSEVIER

Legal Medicine 3 (2001) 177–182

LEGAL MEDICINE

www.elsevier.com/locate/legalmed

Surprising drifting of bodies along the coast of Portugal and Spain

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Received 24 May 2001; received in revised form 28 June 2001; accepted 28 June 2001

Abstract

Ocean currents are extremely important as agents affecting the scene of death, because they may transport bodies long distances. Under these circumstances, considerable difficulty is involved when conducting the search for a missing person. Furthermore, when the victim's body is found on the shore of a foreign country, additional complications arise regarding identification. In the medicolegal literature, this issue has rarely been evaluated from a forensic point of view. In this paper, we present the medicolegal investigations performed at the Santiago de Compostela Department of Forensic Medicine and Pathology (Ministry of Justice, Spain) and nine cases of identification of bodies which had drifted a considerable distance from the scene of death. The two bodies were considered to be the victims who committed suicide at the sea side, and the other seven bodies were identified as the victims of the bus accident in the Duero River, Portugal. When the distance and speed of the drifting bodies of the former two were compared to those of the latter seven bodies, it was surprising that the seven victims of the bus accident were found as clustered at the coast of Spain and some of them were pushed by the currents as much as 380 km in only 60 h. Such phenomena has never been reported, and the discovery of the majority of the corpses has had international far-reaching consequences. The identification of the victims was successfully carried out by dentistry, by DNA and in most cases, especially in those related to the bus accident in Portugal, by digital photography sent by electronic mail to the victim's home country. Attention is also given to a possible explanation related to the buoyancy and displacement of the bodies.

Keywords: Forensic pathology; Identification; Ocean currents; Drowning; Aqueous environments

Introduction

Drowning is a task not easily accomplished. It is a rather complex episode governed by variable factors. The approach to a drowning situation in forensic cases is two-fold: the necropsic study of the victim and a sound understanding of the environment. Both factors are essential in order to reach substantial conclusions.

Full comprehension of the environmental conditions is not an issue pertaining to the forensic pathologist, but these serve as important clues when answering a number of crucial questions which are common to the investigation of death, such as the estimation of postmortem intervals and the identification of the victims.

The possibility of body displacement by river currents is well know, with drowning victims usually found near the point of immersion; but corpses drifting great distances at sea is something quite unusual.

Usually, the physics related to the movement of bodies in water comprises four stages: sinking to the bottom, motion along the bottom, ascension to the surface, and drifting on the surface [1]. But it is necessary to point out that in some cases ocean currents can

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1344-6223/01/$ - see front matter
PII: S1344-6223(01)00032-3

alter this sequence. They serve to discern the unpredictable circumstances of body recovery upon displacement of bodies or human remains great distances, hundreds of miles in some cases.

The present paper shows nine cases of bodies that were moved great distances from the scene of death. In seven cases, the distance range was 300–420 km covered in a short period of time (3–8 days). Forensic investigation of the circumstances of death and the identification of the victims were the most important issues.

Materials and methods

For this study we are studied the death investigation records of the Santiago de Compostela Department of Forensic Medicine and Pathology (Ministry of Justice, Spain) between 1990 and 2001. Bodies which drifted a considerable distance from the scene of death were then analyzed as to the age, sex, height, weight, season, clothing, distance covered and time covered, manner of death, degree of decomposition and strategies for identification of victims. A total of nine cases were identified.

Description of the cases

Case 1:

On December 1990, the naked body of a 67-year-old white female was accidentally discovered on the west coast of Galicia (Fig. 1, point 1b). The body showed advanced decomposition with disappearance of soft tissue from the aqueous constituents. Positive identification of the deceased was accomplished by comparison with an antemortem dental registry. The victim was identified as a Portuguese citizen, living in Caminha in NW Portugal (Fig. 1, point 1a). She had been missing for approximately 20 days and had previously suffered many attempts of committing suicide. The manner of death was established as suicide. The body covered approximately 250 km.

Case 2:

The body of a 49-year-old white male was discovered on the beach, July 1997 (Fig. 1, point 2b). He had been missing for 26 days. Pink teeth and a small volume of adipocere were present on his face. Identification was carried out by DNA analysis. Based on the psychiatric background the cause of death was consistent with suicide. He had drifted roughly 220 km from his residence (Fig. 1, point 2a).

Case 3:

A 60-year-old female was discovered quite near the coast, 1 m below the surface (Fig. 1, point 3). No putrefactive changes or traumatic lesions were observed. She was fully clothed. In her coat pocket and left breast some glass fragments from a car window were found. Internal signs of drowning were observed.

Case 4:

The body of a 85-year-old white female was discovered 4 m below the surface (Fig. 1, point 4). No external signs of decomposition were appreciated. The body showed minimal facial abrasions. As in case 3, signs of drowning were observed during the autopsy. Microscopical examination of the lungs showed extraneous material in bronchiolar space.

Case 5:

A fully clothed white female 60-years-old was found 30 km away from cases 3 and 4 (Fig. 1, point 5). Multiple abrasions on hands, legs and face were appreciated, but no decomposition was present.

Case 6:

A 60-year-old female was found dead on the beach by a fisherman at point 6 (Fig. 1). No putrefactive changes were appreciated. Some superficial contusions were observed. Internally, the body showed aqueous pulmonary emphysema as visceral congestion.

Case 7:

The scene was the same beach as in case 5. The Spanish Police observed the body of a naked 60-year-old female floating (Fig. 1, point 7), with multiple facial abrasions. Close examination of the skin and

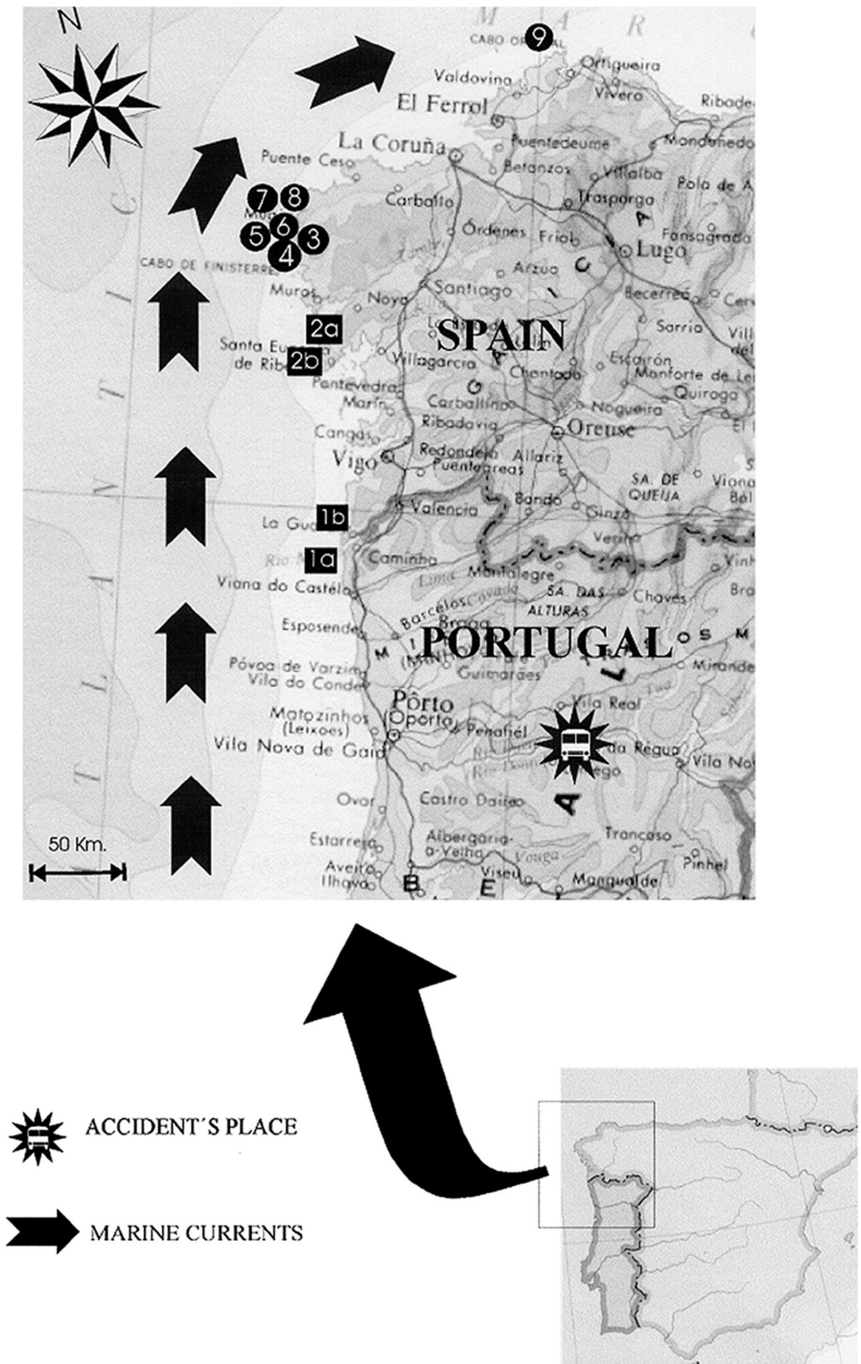

Fig. 1. Map of the coast of NW Spain and Portugal showing the direction of flow current (arrows) and the locations where corpses were found. A figure of the bus corresponds to the point of accident.

soft tissues revealed only diffuse red-brown discoloration, but no focal hemorrhages.

Case 8:

The body of a lightly clothed 65-year-old female was accidentally discovered floating on the sea (Fig. 1, point 8). No traumatic external lesions were appreciated. The autopsy results were consistent with drowning.

Case 9:

A 55-year-old white male was found dead by a coastal fishing ship (Fig. 1, point 9). External examination revealed incipient putrefactive tissue changes and animal activity (in the exposed areas of the body), but no traumatic lesions were appreciated. Internally, no specific findings of drowning were observed.

Background of cases 3–9:

In March 2001, there was a traffic accident in Castelo de Paiva, in the NW of Portugal. Due to poor maintenance conditions, a metallic bridge (built in 1886) collapsed, causing a bus with 53 passengers (the majority of which were women) and two cars with an undetermined number of occupants to fall into the Duero River. Portuguese Armed Forces and Rescue teams tried to recover the corpses near the accident site, but the search was unsuccessful. Only one victim was found in the river. The bus was located 18 days later buried in the fine-grain bottom 100 m from the accident point with ten victims inside. Up to the present moment, no other victims or cars have been found. Cases 3–9 were later identified as victims from the bus sunk in the Duero River (Portugal). All corpses were found $2^1/_2$ to 9 days later. Further information can be seen in Table 1.

Results and discussion

From the medicolegal point of view the present cases give rise to the following issues:

Postmortem changes and time of death.

Aquatic decomposition is a dynamic process that does not follow a specific timetable. Several independent degradation forces may influence the progressive decomposition of the body. They include both intrinsic properties of the body itself and also environmental factors such as water temperature, action of aquatic scavengers, currents, tides, rocks, etc., which are all interrelated with a resulting great variability.

Bodies, which have been under water, are subject to additional damage or injury which is not related to the drowning episode itself. Special importance can be placed on perimortem injuries that may indicate events immediately preceding death. In cases 3–9, most part of the traumatic lesions were related to the crash accident suffered a few days before.

Usually, a submerged body floats face down, with its buttocks up, and arms and legs hanging down. Generally, abrasions occur in exposed zones such as face and hands. Fish and shellfish may attack the body producing small cutaneous lesions and larger marine animals, e.g., sharks, may also mutilate the body. In

Table 1
Summary of cases

Case	Age	Sex	Height (cm)	Weight (kg)	Season	Dress	Total distance covered (km)	Time since death (days)	Manner of death	Identification	Decomposition
1	67	Female	155	61	Winter	None	250	20	Suicide	Dentistry	Advanced
2	49	Male	170	71	Summer	Clothing	220	26	Suicide	DNA	Advanced
3	60	Female	165	67	Winter	Clothing	350	3	Accident	Digital photo	Absent
4	85	Female	160	86	Winter	Clothing	350	3	Accident	Digital photo	Absent
5	60	Female	148	63	Winter	Clothing	380	4	Accident	Digital photo	Absent
6	60	Female	160	70	Winter	Clothing	380	4	Accident	Digital photo	Absent
7	60	Female	160	72	Winter	None	380	5	Accident	Digital photo	Absent
8	65	Female	165	62	Winter	Clothing	330	5	Accident	Digital photo	Absent
9	55	Female	156	68	Winter	Clothing	420	8	Accident	Digital photo	Incipient

the present cases, multiple superficial abrasions were appreciated on face and hands, however, we did not see lesions produced by large marine animals because these are not to be found on the coast of Galicia.

Estimation of the duration of submersion of a body must be based on the relation of the degree of the postmortem changes. Bodies exposed to cold water may show only moderate decomposition or even absence of putrefaction, such as in cases 3–9. In cases 3 and 4, the good conservation of the bodies led us to an estimation of the postmortem period. In case 2, formation of adipocere was present in only 26 days. Some authors [2,3] state that complete adipocere transformation of the soft tissue may happen in about 3–6 months. However, our observation is in accordance with Simonsen [4], who has documented extensive adipocere formation within only 22 days.

Identification strategies

Usually when an unknown body is found, the police is responsible for its identification, but the forensic pathologists should assist the police in their work. It is very important to examine a body retrieved from the water as soon as possible, because even after only a few hours its appearance may have changed completely.

When the body has been mutilated and damaged following putrefaction or prolonged immersion in water, fingerprints can not be taken and direct recognition is useless. If direct identification is not possible, such as in cases 1 and 2, other methods must be employed. In case 1, successful identification was obtained by comparative odontologic registry, and in case 2 by DNA analysis.

If the body is well preserved, the person may be recognized by direct observation of the face or from photographs. On the other hand, clothes, pieces of paper in clothing, jewelry, rings, watches, and identification badges must, of course, be recorded.

Initially, cases 3 and 4 were considered to be shellfish fishermen who had died by accidental drowning, but nobody from the surroundings knew the victims. In the NW coast of Galicia most seafood is caught on the surface of rocks. This zone is known as 'costa da morte' (coast of death), due to the great number of shipwrecks and accidental drowning episodes.

These mysterious cases were solved 1 day later, after the police had found cases 5 and 6, and two seats belonging to the battered bus. In cases 5, 6, 8 and 9, some clothing was labeled with the inscription 'fabricado en Portugal' (made in Portugal). Likewise, the victim's watch in case 6 showed Portuguese time, therefore, the Portuguese Judicial Police was notified.

Photographic identification with a digital camera in cases 3–9 (the image was sent by electronic mail to victim's home country) confirmed that they were persons who had been missing since the traffic accident in the Duero River (Portugal) a few days before.

For the purposes of the forensic research a DNA database is useful. Blood samples from relatives may be stored and used for comparison with the victim's DNA profiles, by analysis of eight polymorphic microsatellite and minisatellite loci, if new corpses are recovered [5].

Buoyancy and possibility of displacement of corpses from the scene of death

To predict whether a body will float or sink, the specific gravity is a relatively useful concept. Increase in volume without significant weight changes (for example, inspiration of air during death or gases contained in expandable body cavities) decreases the specific gravity. Increase in weight without significant volume changes (for example, filling of the stomach or lungs with water) augments the specific gravity. A body with a specific gravity greater than 1.000 will sink in freshwater, whilst one with a specific gravity of 1.000 or less will float in freshwater [6]. Other variations in specific gravity (height, weight and composition of the body tissue) have relatively little effect on buoyancy. Furthermore, it may be altered by objects attached to the body such as clothes or weights.

When the lungs are inflated to their total capacity, any person would be able to float, but at their functional residual capacity, the approximate lung volume of a dead body, some subjects would float and some would sink [7]. Changes in lung volume can produce considerable changes in the specific gravity of a human body. Any method of measuring the specific gravity that fails to consider this, is likely to be incomplete and misleading.

Regarding the amount of water inhaled during drowning, Modell and Davis [8] estimated that the majority of drowning victims aspirate 10 ml of fluid or less per pound of body weight (2.2 ml/kg) and will be more likely to sink than bodies dead by other causes. Finally, trapping of air by clothing also plays an important role in the duration of the initial buoyancy [9].

We think that interaction of all these factors is still unknown, and no categorical conclusions regarding the cause of death or body conditions, may be drawn as to whether a body will float or sink. Perhaps for these reasons, when we wrote this paper, only a small amount of victims from the bus crash were found.

On the other hand, the possibility of displacement of corpses by ocean currents has been previously described and this ability denominated as 'seafaring bodies' [10]. Trajectories of floating human remains may be shown by using hydraulic models [11]. These studies can be of forensic interest in order to establish limits for searches, and to obtain the time required to arrive at certain locations. However, the characteristics of the sea surely affected the results.

In Galicia, investigators of The Vigo Oceanographic Institute (Pontevedra, Spain), have conducted a controlled study of marine currents using floating spheres. They concluded that the course of current flow was from South to North, located at approximately 30 km from the coast (Fig. 1, arrows). Two ocean currents originating, one in the Gulf of Mexico (which crosses the Atlantic Ocean towards Europe) and another one in the Mediterranean Sea, come together and flow north along the Portuguese and Spanish coast (Fig. 1, arrows). Thus, the corpses may have drifted in a straight line, covering distances between 220 and 420 km, with considerable speed in some cases. This was especially true in cases 3 and 4 who went missing for only 60 h with a speed of at least 6.3 km/h. According to the Regional Meteorological Observatory of Galicia, for cases 3–9, the wind direction was SE to NW, which may have helped to displace the corpses, although drifting remains as the main factor of displacement. Surprisingly, only one victim of the damaged bus was found floating in the Duero River and no victims were found along the Portuguese coast.

In conclusion, these cases illustrate the different degrees of displacement of bodies by ocean currents, and how this information might be useful when conducting a search for missing people. Each portion of the sea must be examined independently and its characteristics adequately defined. On the other hand, regional or international records of missing persons at sea are helpful and convenient in order to facilitate identification of the victims, for example by Interpol [10].

Acknowledgements

We would like to express our gratitude to Sergeant Abel Amado Vila of the Judicial Police (Guardia civil) for information regarding cases 3–9, and also thanks to José Manuel Amado Vila for his valuable assistance in correction of the English.

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