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CASE REPORT

Scuba Diver with a Knife in His Chest: Homicide or Suicide?

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A scuba diver was found dead at the bottom of an undersea cave at 54.1 m water depth, with a knife protruding from his chest. Autopsy confirmed death due to both drowning and a penetrating knife wound. The incident was first considered a homicide and two suspects were arrested. Careful forensic analysis of the profile of the diver's last dive stored in the dive computer, dimensions of the undersea cave, as well as other forensic findings, showed that the case was a suicide, which the diver most probably committed while running out of air, in an attempt to avoid the agony of drowning. To the best of our knowledge, this is the first report on a suicide during diving.

Key words: *autopsy; diving; drowning; forensic medicine; suicide*

At 00:15 a.m. on Wednesday, September 11, 2002, the police precinct in Split, Croatia, received an emergency call from the members of a diving party on a sailing boat, informing the police that the diver M. K. (in the following text referred to as the victim), a 31-year-old citizen of the Czech Republic, did not return from the dive commenced about three hours earlier. The site of the incident was an undersea cave in the Poganica Bay, in the southern part of the Island of Šolta in the Croatian Middle Adriatic. The victim was on the boat with three other members of the crew at the time when he went diving, including the skipper who was asleep in the cabin. Only one of these three crew members was a diver. The rest of the group had gone diving somewhere in the vicinity about 15 minutes before the victim himself, and returned to the boat at about 10:30 p.m. Two divers went to the cave at 10:46 p.m. to search for the victim and returned at 11:41 p.m. without finding him. Since the victim was using an air-filled cylinder of 15 L, pressurized to 200 bars, it was quite obvious at the time that the diver had run out of air and drowned. He probably got trapped in the cave. On the morning of September 11, 2002, two police divers went searching for the body of the diver. One of them never returned alive – after releasing the buddy-line, he disappeared in the cave. The other found the way out, with his air source almost empty, and developed a severe form of decompression sickness. The following day, two bodies were recovered from the cave: one of the police diver, found at 24 m water depth in the multi-compartment shallow gallery of the cave, and the other of the victim, found at 54.1 m in the deep gallery at the opposite part of the cave. The victim was discovered at the bottom of the cave, lying completely equipped on his back, with a diving knife in his chest. His diving mask was not found on his head and scuba regulator was out of the mouth. His life-jacket was empty. An empty low-power flashlight was found in the vicinity of the body. The knife got pulled out of the chest during the removal of the scuba gear at the bottom of the cave and the diving computer on his arm fell off during the recovery of the body to the surface, but both items were recovered later.

The funnel-shaped cave entrance of around 2 m in diameter is 9 m below the surface (Fig. 1). The entrance widens gradually and after some 15 m reaches the point where the two galleries, the shallow and the deep one, connect. The interior of the cave is covered by ample amounts of the finest silt. When disturbed and suspended in water, the silt reduces visibility to almost zero due to Tindall's phenomenon, even if high-power flashlights are used. There are no underwater currents in the cave. The data stored in the dive computers of the crew and of the police indicated that the water temperature ranged from 24 °C on the surface to 14 °C at the bottom of the cave. The deepest of the several bottom levels of the shallow gallery is at 36 m below sea level, and the shallowest part of the roof is at 21 m (Fig. 1). The deepest bottom of the deep gallery is at a depth of some 57 m, and its shallowest roof is at 35 m. According to the anecdotal information, native islanders avoid the bay, whose very name suggests something evil and pagan.

Web-extra: Photographs of the undersea cave are available at *www.cmj.hr*

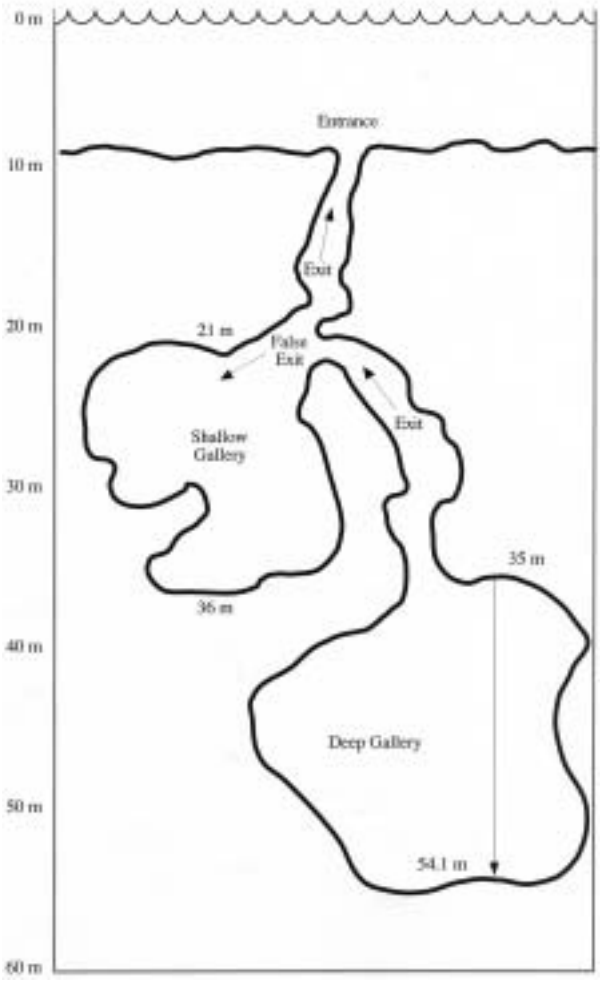

Figure 1. Profile of the undersea cave in the Poganica Bay, the Island of Šolta, Middle Adriatic, Croatia.

Forensic Procedure

All the diving equipment, including the dive computers, was collected from the crew for forensic investigation. Samples of reddish stain found on the deck and suspicious of blood were taken for analysis, as well as blood samples from the entire crew. Several knives found on the boat were also sent for analysis. All crew members consented to undergo polygraph testing and all passed but the two who were with the victim at the time he went diving. Before polygraph testing, the subjects had not been aware of the fact that the body of their diving companion had been recovered. The two crew members reacted to the words "knife" and "blood" and were therefore taken into custody, but no formal charges were pressed. The rest of the crew was released, but forbidden to leave the country. While waiting for the results of the stain samples testing, the scuba gear was analyzed. All dive computers, including the one found on the victim, proved to be in perfect condition. They were tested in an experimental hyperbaric chamber and pressurized to the pressure exceeding the greatest depth found on one of them. All dive computers displayed the same profile of this simulated dive. The model of the dive computer the crew used (Aladin-Pro™, Uwatec, Hallwil, Switzerland) records and stores dive profiles of 37 earlier dives (the beginning of a dive, maximum depth achieved, total decompression time, total ascent time, and total dive time), and provides details for graphic presentation of the last 200 minutes of several shorter dives, or for the first 200 minutes of a dive that lasts longer than 200 minutes. The computer records and stores all pressure exposures, ie, dives or simulated dives in a hyperbaric chamber, irrespective of whether or not worn on an arm. Once stored, the data in such a computer cannot be changed or deleted. The testing proved that the scuba gear of the victim was in perfect condition. The victim's air-cylinder was empty when recovered. For the needs of testing, it was pressurized to 200 bars and checked after 24 h, but no pressure drop was found with the regulator and life-jacket mounted and the main valve wide open. The regulator was tested for breathing comfort and was found to be in order. The knife, recognized by the crew to have belonged to the victim, fitted exactly into the scabbard the victim had on when found dead. The first 200 minutes of the last dive stored in the victim's dive computer are shown in Figure 2.

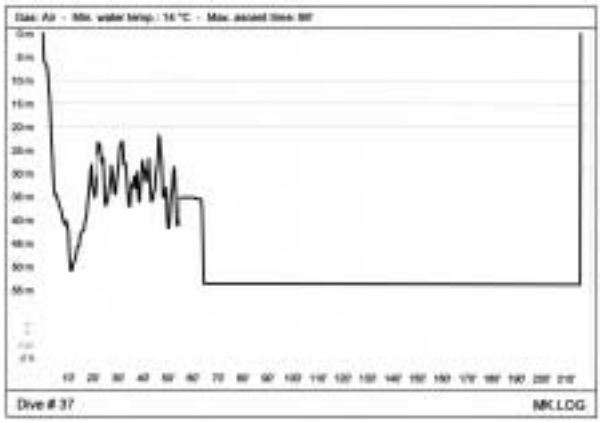

Figure 2. The computer record of the first 200 minutes of the last dive of the victim. When ascending from 50 m depth, the victim missed the exit and got lost in the shallow gallery of the cave for some 40 minutes. A drop from 35 to 54.1 meters, which was almost vertical and within a minute, was possible only from the roof of the deep gallery.

The victim entered the water on Tuesday, September 10, at 9:15 p.m. During the dive, the maximum depth he achieved was 54.1 m and predicted total ascent time immediately before the vertical drop to the bottom was 99 minutes. Computer software allowed step-by-step analysis of the dive at a precision of 20 s and 0.1 m, providing data on pressures (depths) achieved, the duration of each dive phase, total ascent time requirement (including the decompression time) at any moment of the dive, decompression stops, and temperature data. We calculated total air-consumption for the victim during the dive, using average depths for every single descent and ascent period, with the assumption of an average air-consumption of 16 L/min, which corresponds to light work or slow underwater swimming at a speed of 0.5

knots (1). At that point of the analysis, it was concluded that the victim must have run out of air in the 44th minute of the dive, ie, at 9:59 p.m., when he was at the depth of 36 m.

From the interview with the crew, we learned that the victim, a cook by profession, was in a good physical and mental condition, had basic dive training, and was rather inexperienced. During dinner, he consumed alcohol but, reportedly, not in excessive amount. He decided to go to the cave for sightseeing at the last moment, after the rest of the group had already gone diving.

The stains on the deck of the boat turned out to be paint.

Autopsy Findings

The body of a well-developed, well-nourished, young man recovered from the water about 36 h after the incident was dressed in a neoprene wet dive suit. In the front left part of the dive suit, a slightly slanted defect measuring 3x1 cm was found, with its upper corner positioned laterally and the lower medially. There was a minor defect in the suit on the posterior upper side of the left leg. The trunk of the swimming suit was full of faces. A penetrating wound, measuring 3x1 cm, was found between the left nipple and the anterior median line in a position corresponding to the defect in the suit (Fig. 3). It was concluded that the

Figure 3. The stabbing wound between the left nipple and the median line in a position corresponding to the defect found on the dive suit.

victim was stabbed through the suit. We carefully searched for other injuries, especially on hands and arms, since such injuries would indicate a defense against a knife attack. However, no other defects of the suit or other injuries on the victim's body were found. The edges of the knife wound were sharp. The upper oval and the lower angulated end of the wound corresponded to the profile of the victim's knife. The wound was 11 cm deep, which corresponded to the length of the victim's knife, and extended through the skin, left pectoral muscle, and the fourth intercostal space to the lower part of the upper segment of the left lung lobe. The knife cut through the aortal isthmus, leaving a wound of 1.2 cm in diameter. The lower margin of the fourth rib was also injured. There were some 300 mL of clear liquid and clotted blood in the left pleural space. Hyperinflated lungs showed aqueous emphysema. The weight of the left lung lobe was 780 g, and of the right 820 g. No right ventricular dilatation was found. Subpleural petechiae and a foamy whitish liquid that appeared on the cut surface of the spongy lungs indicated breathing efforts in the peri-mortem period and inhalation of water, respectively. Both findings are typical for drowning (2). It was concluded that the victim most probably died within two minutes or less after being stabbed. The signs of drowning indicated that the victim was either stabbed on the surface and thrown immediately into the water, or was stabbed under the water. If the wound was inflicted in an attempt of suicide, it must have been carried out by a right handed person, as the victim was. The victim's blood alcohol level was 0.114%. Diatoms, which are a good indicator of death due to drowning (3,4), were not found in the liver tissue.

Discussion

The dive profile and the map of the cave helped us to reconstruct the probable chain of events. The victim entered the water and reached the depth of 50 m after a smooth, non-disturbed descent. He could have reached this depth only in the deep gallery (Fig. 1). He started the ascent almost immediately after reaching the bottom, but missed the exit funnel and went into the shallow gallery. This could have happened either because of a low visibility due to Tindall's phenomenon or because the entrance to the shallow gallery, at least according to the divers who know the cave well, looks like the exit. The proof for such a scenario is the fact that the victim could not have reached the depths shallower than 35 m in the deep gallery (Fig.1). We speculated that the deceased police diver was confused for the same reasons. He was found with his scuba cylinders empty and autopsy revealed undoubted signs of drowning. The other police diver stated that he got lost because he mistook the entrance to the shallow gallery for the exit. The victim's efforts to find the exit might have lasted some 35 minutes before he finally got lost in the deep gallery. The period between the 55th and 60th minute of the dive, depicted by a flat line on the dive profile, might indicate a period of rest under the roof of the deep gallery, where the victim possibly tried to breathe from an air bubble trapped under the rocks. The depression of the dive profile curve, immediately before the vertical drop to the bottom, shows the period when the victim lost some buoyancy, possibly after he had stabbed himself and lost consciousness (Fig. 2). The increased blood alcohol must have contributed to the mental impairment of the victim already affected by nitrogen narcosis, which, at 35 m, was at least of a minor degree (5,6).

Suicide during diving is an unusual incident. We searched MEDLINE using terms "suicide" and "diving" but did not find any similar reports. It is difficult to accept that such an incident has not been described before, because hundreds of thousands of scuba divers dive in the world every day. Some of them find

themselves in most desperate situations and end tragically. Few unpublished cases include a gunshot suicide and suspicious suicide of a couple of elderly persons with terminal illnesses, who just went under the water and kept heading down. One of the victims had end-stage liver cancer (James Caruso, Office of the Armes Forces Medical Examiner, Washinhton DC, USA, personal communication).

The training of divers includes managing problem situations under the water and rescue procedures, like free emergency ascent or buddy breathing (7). We think that the victim must have been in a really desperate situation from which he saw no escape. He was very low on air, if not out of it, and able to read this from his pressure gauge. He was experiencing much trouble breathing, knew that he was under the rocks, and saw no exit. His diving computer alarm was on, and he was facing a long 96 minute decompression for which he did not have enough air.

A scenario was considered in which the victim got into a fight with the killer(s) for whatever reason: maybe the victim was stabbed on the boat, but after being thrown overboard lived for a few minutes ie, long enough to manifest vital signs (drowning) under the water. In that case, the supposed killer(s) would have to throw him overboard immediately after stabbing him, take him to 50 m depth, fake ascent, fake the victim's wondering in the shallow gallery, take him to the deep gallery, and finally drop him from the only point from which it was possible to sink vertically from 35 to 54.1 m, ie, from the roof of the deep gallery (Fig. 1). One of the two suspects, who was a diver, could have done all this using the victim's air supply and thus saving his own for return to the surface, but would not have been able to return to the boat at 10:30 p.m. or earlier and be one of the two rescuers, since he was facing either a 99 minute decompression or serious decompression sickness if had decided to omit decompression and surface directly from the last point of contact with the victim.

If stabbed on the boat, the victim would not have been able to clear his ears and sinuses during descent, what divers regularly do to avoid injuries (8). At autopsy, at least some signs of tympanic membrane(s) barotrauma, and most probably the rupture of tympanic membrane(s) and/or blood in the middle ear cavity(ies) would have been found. Why would a killer, in this scenario, drag the body down to the cave? There could be only one logical answer: to hide the victim's body at a greater depth. That would have been physically a very demanding task, with or without the victim's life jacket inflated. To do so was not necessary, since it was obvious from the data stored in the victim's diving computer that the body was already at 50 m (Fig. 2), ie, in the deep gallery and well hidden.

We also considered a scenario for premeditated murder. The possible killer could tie the computer to a rope, add some weight to it, and maneuver it into the cave funnel, so that the record of the dive profile would show something the victim had not gone through. The victim could have already been dead, and the computer could be put on the victim's arm only to confuse the police. However, the depth of 50 m could not be achieved by vertical "descent" of the computer on a rope in the funnel (Fig. 1). Indeed, there are even greater depths in the vicinity, but the dive computer would have registered the moment of entry through the entrance at 9 m, which it did not.

We also analyzed the possibility of one of the rescuers actually meeting the victim under the roof of the deep gallery, when the victim had already been low on air. The rescuer would have needed less than 10 minutes to find the victim in the dark because the victim's flash light was on. When noticing the rescuer, the victim could have decided to save himself at whatever cost and attack his rescuer, using the knife, but got stabbed in a fight. Since the rescuer would have had enough air left for the ascent, he could have returned to the surface safely and in time to alarm the police. However, we had to dismiss this scenario, because the rescuer who went into the cave searching for the victim started his descent at 10:46 p.m., when the victim had already been dead, lying on the bottom of the deep gallery. The other rescuer, who was one of the two suspects, did not go deeper than 9 m, as confirmed by the data from his dive computer. According to the statements of the crew, the second suspect was not a diver.

It would be possible to accept the suicide scenario only if the victim was consuming less air than an average of 16 L/min. This could have been the case because respiratory sensitivity to carbon dioxide is lesser if a person is under the influence of alcohol (9-11). The victim's blood alcohol level could have, at least to a minor degree, caused the decreased sensitivity to carbon dioxide. If the victim was consuming more air, he would have been out of air earlier, but then he could not have killed himself and continue diving.

This extraordinary case was discussed with the most experienced Croatian military divers, who rejected the possibility of a suicide. These divers were engaged in war operations and have found themselves in life-threatening situations many times. According to them, a suicide could not be considered as a possible behavior. Any diver would wait until the last moment and try everything possible to save him- or herself. We would share the same belief if that was a "normal" dangerous situation. The victim could have been aware of the fact that no rescue measures would result in his salvage. Our position is that the possibility of a suicide in a desperate underwater situation is the same as it would be in any other desperate situation on the ground or in the air. Suicides in desperate situations are rare, but do happen: people facing an unavoidable and painful death were jumping from the top floors of burning or collapsing towers to certain death. If there was an intention to kill the victim, the supposed killer would have probably chosen a different way. It might be relatively easy to drown a diver under the water. If another diver would approach the supposed victim from the back, tear the regulator from his mouth, and hold him, being cautious of possible defense using a knife, any diver would drown very soon. No knives or complicated

plans would be necessary. A killer could empty the victim's cylinder manually using the purge button of the regulator and an investigation, finding no external injuries, would conclude that the victim must have drowned.

The determination of the cause of death of a person whose body is found in the water requires careful investigative work on the part of both police and forensic pathologists. Conclusions as to the cause and manner of death should not be derived from the autopsy alone but should result from a logical correlation of data regarding victim's identity, circumstances, autopsy, and laboratory findings.

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