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# REVISTA DE MEDICINA LEGALA

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# Differential diagnostic elements in the determination of drowning

*Davceva Natasha*, Duma Aleksej*

**ABSTRACT:** According to Milovanovic, one of the Balkan most prominent forensic scientists, „Not every body recovered from water is a body of a drowned person", regarding the origin and manner of death, bodies recovered from water can be instances of: primary drowning, secondary drowning or non-drowned bodies. Analyzing our own experiences with bodies where the cause of death was drowning, in this paper we want to contribute to the criteria for differential determination of the manner of death of dead bodies recovered from water. A total of 29 cases of drowning were analyzed, the autopsies of which were performed at the Institute of Forensic Medicine and Criminalistics in Skopje during the period of 1997 - 2002. Classical autopsy technique was used as a basic method, along with the special approach to obtaining material during the autopsy to prove the presence of diatoms through the diatom-test. In this paper we want to emphasize the most frequent features of death by drowning, as a basis for differential determination of the manner of death of dead bodies recovered from water, and the usefulness of the diatom-test, for the same purpose.

**KEY WORDS**: drowning, diatoms, asphyxiation

According to Milovanovic, one of the Balkan most prominent forensic scientists, *"Not every body recovered from water is a body of a drowned person"* and this is the truth that every forensic pathologist, making an expertise of a body recovered from water, should face.

For a long time there has been a dilemma regarding the definition of drowning, mechanism of death and some terminological differences.

According to the original concept, the nature of drowning is asphyxiation caused by occlusion of terminal airways with water and cerebral hypoxia as a consequence (1,2). Experiments in the early 1950's (3) suggested that possible mechanisms of death in drowning are electrolyte disturbances or cardiac arrhythmias produced by large volumes of water entering the circulation through the lungs. Some authors emphasize hypervolaemia -"the blood volume in fresh water drowning may increase by 50 per cent within a minute, causing a great strain on the heart" (4), while others point to the severe hyperkalaemia from red cell potassium contributing to rapid myocardial failure (5). Observing the electrolyte changes in the cases of "near drowning" anesthesiologists have helped forensic pathologists to understand the mechanism of death in drowning. They have found that electrolyte disturbances are mild, if

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present at all, and rarely have any clinical significance (6, 7). The most frequent cause of death in this "near drowning" cases is pneumonia due to aspirated water.

Scientific research so far has indicated that the original concept is most acceptable, the main mechanism of death in drowning is violent mechanical asphyxiation caused by aspiration of water in the alveoles. It is precisely from that point of view that drowning is analyzed in this study. If immersion is the first phase of drowning, meaning the body touching the water, then submersion is most frequently the second phase of drowning, but as Tedeschi said: *"Death from submersion and death from drowning are not necessarily the synonymous"* (8).

Regarding the origin, bodies recovered from water could have been:

1) Drowned in the water.

a) Primary drowning, or true drowning, after submersion and aspiration of large volumes of water into the lungs.

b) Secondary drowning, where death occurred secondarily, due to submersion and aspiration of liquid, after the previous primary mechanisms of death had occurred and had allowed submersion, which can be of natural origin (ischaemic heart disease, apoplexy, epilepsy) or violent origin (suicidal, homicidal or accidental injuries).

2) Non-drowned, but died in the water from submersion.

If all previously mentioned mechanisms of natural or violent origin develop so quickly and immediately after entering the water, then there is not time for aspiration. These are the "Non - drowning" or "Death from submersion" cases (8). Most interesting of the non-drowning cases are the cases of "Dry-drowning" where the mechanism of death is shock due to vago-vagal reflex causing laryngeal spasm or immediate cardiac arrest (10-15 per cent of all cases that have been called "drowning" cases) (2). Another reason for death can be anaphylaxis initiated by low temperature of the liquid medium..

3) Died out of the water, and then entered the water.

**AIM OF THE STUDY:** Analyzing our own experiences with bodies where the cause of death was drowning, in this paper we want to emphasize the most frequent feature (external and internal finding) in the death by drowning, as a basis for differential determination of the origin of death of dead bodies recovered from water, and the usefulness of the diatom-test, for same purpose. This way we want to contribute to the criteria for differential determination of the origin of death of dead bodies recovered from water.

**MATERIAL:** A total of 29 cases of drowning were analyzed, the autopsies of which were performed at the Institute of Forensic medicine and Criminalistics in Skopje during the period of January 1997 - December 2002, presenting 1.69 per cent of entire forensic pathology in the aforementioned period. In comparison, in the previous 6-year period, January 1991 - December 1996, drowning had represented 1.22% of the entire forensic pathology.

**METHODS:** On a material of 29 analyzed cases, the procedure of determination of the cause of death of the bodies recovered from the water has proceeded in three stages:

a) Detailed analyses of the circumstances under which death happened - meaning complete court, police and forensic medicine investigation, regarding the place where the body was found, circumstances of finding it, identity, age, sex, psycho-social status, mental and physical health. That part of the analysis will not be discussed in this study.

b) Pathological feature - forensic autopsy using classical autopsy technique with a special approach to obtaining material during the autopsy for performance of diatom-test.

c) Laboratory analyses - histology, toxicology and diatom - test.

The value of each separate stage in the procedure mostly depended on the length of the postmortem period i. e. the level of the putrefaction changes of the cadaver. That is the reason for regarding separately:

Determination of the origin of death of fresh bodies recovered from water.

Determination of the origin of death of bodies recovered from water in a progressive stage of putrefaction and maceration.

RESULTS

**I) Determination of the origin of death of fresh bodies recovered from water** - in our material of 29 drowning-cases, there have been 17 bodies recovered from water in a fresh condition with no signs of progressive decomposition.

***Pathological feature - forensic autopsy findings***

*External finding*

From the external findings of the surveyed material, the presence and distribution of the Signs of asphyxiation, Signs of immersion and other signs were analyzed, to find out how big their relevance and evidence value is, in the procedure of determination of drowning as a cause of death.

If drowning is asphyxiation, and in the introduction we said that drowning has been analyzed from that point of view in this paper, and every other kind of death in water has its own name, it is clear that in the drowning cases we can expect signs of asphyxiation. The question is: What is the contribution of the signs of asphyxiation to making the diagnosis of drowning. In a half of the cases - 47%, cyanosis was found, which is an indicator of the increased level of karbohaemoglobin, which is one of the major signs of asphyxiation.

On the other hand, it has not been followed by congestion because in this type of violent mechanical asphyxiation there is no compromitation of a venal preloading. More than a half of the cases - 59%, have had ecchymoses in the observable mucouses, mostly Ecchymoses subconjuctivales, unlike the skin petechiaes which haven't been a frequent feature. It seems like that ecchymoses in the observable mucouses, supplemented by the ecchymoses of the serous membranes (internal finding), are a good indicator of asphyxiation on the bodies recovered from water and deserve the full attention of the forensic pathologist in the procedure of making the diagnosis of drowning. Incontinence of the sphincters which is an important sign of asphyxiation, happening in its second phase, as a result of the cerebral hypooxia, has not been a frequent finding in our material, only 1 case from 17. While analyzing this result, one should bear in mind the cleansing effect of the liquid medium in which the body was located.

From the signs of immersion, in our analyzed material of 17 fresh bodies recovered from water, the finding of "Washerwoman hands" was most frequent - 70%, while in 59% of the cases red colored livores mortis and retraction of penis, scrotum and papilla mammae was found. For a long time, the phenomenon of Cutis anserina and retraction of penis, scrotum and papilla mammae had been regarded as a "reaction phenomena" objectivising the reaction of the skin to the cold water, strongly suggesting that the person was alive in the moment of entering the water.

Today there is no doubt that these changes are postmortem and a result of a rapid occurrence of rigor mortis in conditions of a liquid medium with low temperature (2,4). Bearing in mind everything that has been said so far, all four signs of immersion are postmortem changes and have no importance in making the diagnosis of drowning, and their importance is limited only to a proof of the body's stay in a liquid medium.

In addition to the signs of immersion and signs of asphyxiation, we have also analyzed the foamy or frothy contents around the external respiratory entrances - nose and mouth, very often described as a "plume of froth", regarding it as a very special and diagnostically valuable element in the external finding of drowning,

In only 1 case from our material a typical "plume of froth" was found around the nostrils and mouth. In 65% of the cases, the existence of tiny bubbled, densiv, whitey or sometimes pinky - red and tinged with blood, was dicovered around the external respiratory entrances. Not rarely this foam or froth had dried. Many authors regard this foamy content as a continued feature of Oedema pulmonum. It is true, that in every kind of death where edema of the lungs occurs, foamy contents can be found around the outer airways (intoxication's, epilepsy, ischaemic decease of heart etc.), but the careful eye of the forensic pathologist should perceive the difference between the foamy contents in drowning and those of all aforementioned cases, where the foamy contents are never so voluminous, tinily bubbled and whitey as in the drowning cases.

Very often, the foamy contents can be washed by the liquid medium, but nevertheless our results show that it was a frequent feature in the external examination of the drowned persons. Simonin reported a feature of foam around the outer airways of the bodies recovered from water after 5 days in summer and 8 days in winter (9). This very helpful and very indicative diagnostic element, by the wards of Tedeschi: "very close to the pathognomonic feature of drowning", is still unspecific sign of drowning because there is no objective way to find out its origin (8).

*Internal findings*

These patho-anatomical changes have been analyzed from the internal feature of our material, 17 cases of drowning with no signs of progressive decomposition:

The liquid state of the blood found in all analyzed cases is only an indicator of the rapid death in all cases of violent asphyxiation. The existence of Subserosal echimoses, mostly Ecchymoses subconjuctivales and Ecchymoses subepicardii, in 16 of 17 analyzed cases, is of great significance for the fortification of asphyxiation, but have no bigger value as a proof of drowning.

Foamy contents in the trachea and bronchi found out during the internal examination in 82% of the whole material, had the same origin as the foamy contents around the outer airways which has been found out in 65% of the analyzed material. It is obvious that in 3 cases (17%), although the foamy contents around the nostrils and mouth were washed by the liquid medium, they were still observable into the lumen of the lower airways.

In 94% of analyzed cases of "fresh" drowning, during the internal examination, a state of the lungs was discovered, which is very much typical and very well known by every forensic pathologist: lungs are hypervoluminous, heavy, full of water, making crepititations, out of the body and placed on the autopsy table they do not colapse; the cutting surface seems "dry" but after pressing it voluminous foamy whitey-pink and tiny bubbled contents burst forth. This condition of the lungs has been named with deferent names: "Emphysema aquosum"; "Trockenes Odem"; "Drowning lungs", and in the forensic science literature we can still find papers where the condition is simply described as "lung edema"(10). Our considerations are that equating the condition of the lungs in drowning with the condition of the edema of the lungs is a simplification and vulgarization of the feature in drowning. We suggest that the most convenient name for this condition of the lungs is "Emphysema spumosum" or spongy emphysema, because of the phenomenon of sponge in the drowning lungs: the cutting surface seems "dry" at first sight, but pressure is applied, a great volume of foamy liquid bursts forth, so that the lungs look like a very wet sponge.

The careful eye of the forensic pathologist must differentiate this condition from lung edema, where great volumes of liquid goes out of the cutting surface spontaneously and without pressure. In the foamy liquid, foreign bodies from the liquid medium can often be found, such as sand and mud. Most of the authors consider "Emphysema spumosum" a characteristic, but not a pathognomonic feature in drowning. They support their considerations with the phenomenon of "hydrostatic lungs", where water has entered into the lungs of the dead body passively, and in their opinion this condition of the lungs could not be differentiated from Emphysema spumosum (11). As opposed to that, in the opinion of others, if water has reached the most peripheral parts of the lungs, there must have been active respiratory movements, otherwise the quantity of water should be smaller and entering only the lowest parts of the lungs. Macroscopically established Emphysema spumosum must be proved microscopically. Some authors have made a try for determination of drowning by micromorphometry of lungs (11).

In 76.5 % of the analyzed cases, the presence of more than 100 ml of liquid contents was identified in the stomach, which appearance depends on whether the stomach was empty or not before the act of drowning. In three cases sand and little plants were found in it. Only in 3 cases - 17%, the same contents were found in the duodenum, and one of them also had particles of foreign material: mud and sand. Some authors consider liquid in the duodenum to be an undoubted proof for drowning, unlike the presence of liquid in the stomach, which can be postmortem due to the passive entering of water.

| | Liquid in stomach | Liquid in duodenum |
|---|---|---|
| >500 $cm^3$ | 1 (5,8%) | 0 |
| 100-200 $cm^3$ | 12 (70%) | 3 (18%) |
| <100 $cm^3$ | 4 (23,5%) | 14 (82%) |

Only in two cases, bodies have been recovered from water immediately after drowning, but most of them had stayed in the water for several hours, when they had been exposed to the passive entering of the water. That's why, it seems that the significance of the passively entered water in the digestive organs is smaller then expected, which increases its diagnostic value in the determination of drowning. In support of what has been said so far, are the results of Reh, who didn't find presence of water in the stomach of dead bodies which had been immersed on a depth of 15 meters, during 65 hours, and also consideration of Tedeschi who said: "The finding of drowning water in the stomach and duodenum, therefore seems to indicate a vital process, namely swallowing active movements after submersion"(8).

We have no logical explanation for the feature of interlobular hemorrhage in the pancreas in 47% of the drowned persons, although the pancreas is well known as a "shock-organ" that reacts intensively in the condition of stress.

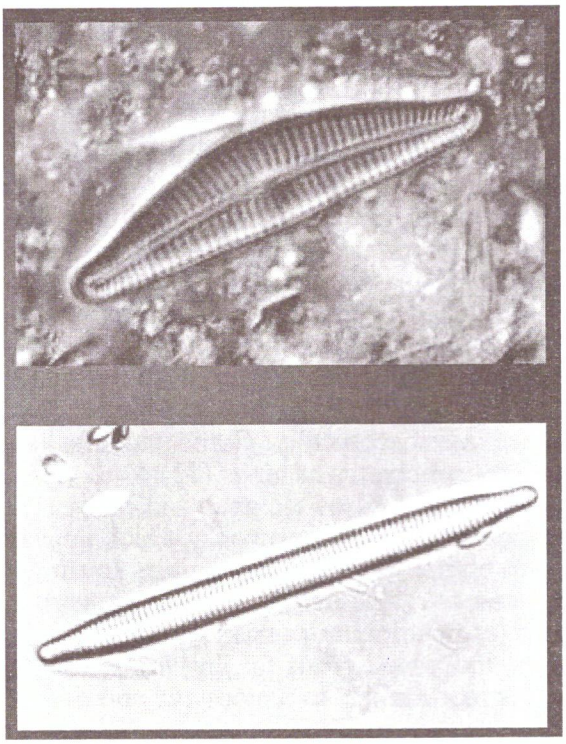
***II) Determination of the origin of death of bodies recovered from water in a progressive stadium of putrefaction and maceration.***

For the 12 bodies recovered from water in a progressive stadium of putrefaction, patho-anatomical finding was not valuable at all for the determination of drowning. Complete forensic investigation was directed to the 1-st phase - detailed analyses of the circumstances under which death happened and, especially the 3-rd phase - laboratory analysis.

Laboratory analysis:

Until this moment, a specific valuable test for an undoubted confirmation of drowning has not been found. All the "physical", "chemical" and "biochemical" tests, based upon the differences of some physical, chemical and biochemical parameters between blood from the left and right side of the heart, are considered to be limited only to the early post-mortem period (12). Unfortunately, performance of the forensic autopsy is very rare in this early period after the death. (8, 13).

Today, attention is mostly directed to proving the presence of particles with organic or inorganic origin from the liquid medium, where the drowning took place, into the lungs and other organs. From the inorganic particles, the role of the inorganic Strontium was emphasized, as a possible marker of drowning (XVI Congress of IAFS, Monplje, France 2002), (14). From the organic particles penetrating into the body with the water, greatest attention is paid to the diagnostic value of diatoms and diatom-test (10, 15-19).



**Diatom test**

The main difference between different kinds of diatom tests is in the agent used for digestion of an organic material, with a purpose to objectivize the diatom, silicate frustrul.

In the Institute of Forensic medicine from Skopje, with a collaboration of the Institute for biology at the Faculty of natural sciences, a method was implemented, that was introduced by Hustedt in 1930 for the first time, where the organic material is exposed to wet combustion by sulfuric acid, potassium permanganate and oxalic acid. The whole process of digestion, slides preparation, counting and taxonomic identification, is made by specially trained biologists, but

interpretation of the results is exclusively a task of the forensic pathologist who is deeply involved into the mechanisms of death and pathophysiological mechanisms of asphyxiation and drowning.

During the analysis of the results of the diatom-test in our series of cases, along with the long period of working on the diatom-test at our institutions, several elements have been added in the interpretation of the results of diatom-test:

1) The initial examination of the results of diatom-test should be directed to whether any diatoms have been found in the samples of tissues or not, and in what number they are present. One must understand that the quantity of diatoms does not have the same significance in different organs. In other words, finding a great number of diatom frustruls in the lungs has lower significance than finding just a few diatoms in the bone marrow.

**Result of the diatom test**

| *Takson* | sample of water | skin | hair | trachea | lungs | heart | liver | pancreas | spleen | brain |
|---|---|---|---|---|---|---|---|---|---|---|
| *Ach. lanceolata* | 2 | | 28 | 2 | | | | | | 1 |
| *Ach. minutissima* | 1 | 1 | 2 | | 1 | 1 | | | | |
| *Ach. sp:* | 1 | 3 | | | 6 | 2 | | 4 | 3 | 4 |
| *Amph. ovalis* | | | 5 | | 3 | | | | | |
| *Amphora libyca* | | | 2 | | | | | | | |
| *Amphora pediculus* | 1 | 2 | 1 | | 3 | | | | 1 | 2 |
| *Cocc. pediculus* | 14 | 11 | | 8 | 21 | 5 | 6 | | 10 | 14 |
| *C. placentula* | | 2 | | | 3 | 1 | 2 | | 1 | 2 |
| *C. plac var.euglypta* | 1 | | | | | | | | | |
| *C. plac var. lineata* | 26 | 22 | 4 | 12 | 46 | 13 | 17 | 6 | 21 | 25 |
| Cycl.menegheniana | | 1 | | 2 | | 1 | 3 | | 3 | 4 |
| Cycl. radiosa | 3 | 4 | | | 5 | 5 | 2 | 1 | 2 | 4 |
| *Cycl. sp.* | | | | | 5 | 2 | | | | 2 |
| *Cymatopleura eliptica* | | | 1 | | | | | | | |
| *Cymatopleura solea* | 1 | | | | 1 | | | | | |
| *Cym. affinis* | 1 | 1 | 5 | | 2 | | 1 | | 1 | |
| *Cym. aspera* | | | 2 | | | | | | | |
| *Cym. caespitosa* | | 2 | 24 | | | | | | | |
| *Cim. cistula* | | | 11 | | | | | | | |
| *Cym. helvetica* | 1 | 2 | 1 | | 3 | 1 | | | | 1 |
| *Cym. minuta* | 31 | 69 | 3 | 28 | 46 | 29 | 26 | 3 | 21 | 45 |
| *Cym. silesiaca* | | 2 | | 1 | | | 1 | | | 1 |
| *Cym. sinuata* | | 2 | | | 1 | | | | 1 | 1 |
| *Cym. tumida* | 1 | 1 | 2 | 1 | 1 | | 1 | | | |
| *Diat. echrembergii* | | 1 | | | 1 | | 1 | | | 1 |
| *Diat.monolifirmis* | | 1 | | | | | 1 | | | |
| *Diat. vulgaris* | 11 | 8 | 2 | 3 | 23 | 5 | 6 | | 5 | 8 |
| *Epithemia adnata* | | | 4 | | | | | | | |
| *Epithemia sp.* | 1 | | | | | 1 | | | 1 | 1 |
| *Epithemia sorex* | | | 68 | | | | | | | |
| *Frag. arcus* | | 2 | | | | | | | | |
| *Frag. capucina* | 2 | 1 | | | 2 | 1 | | | | 1 |
| *Frag. cap. var. vauch* | 1 | | 4 | | | 1 | | 1 | | |
| *Frag. ulna* | 22 | 16 | 3 | 11 | 41 | 13 | 11 | 2 | 16 | 17 |

| *Takson* | sample of water | skin | hair | trachea | lungs | heart | livert | pancreas | spleen | Brain |
|---|---|---|---|---|---|---|---|---|---|---|
| *Frag. ulna var.acus* | | | 1 | | | | | | | 1 |
| *Frustulia vulgaris* | 1 | | | | 1 | | | | | |
| *Gomph. angustum* | | | | | | | | | | 1 |
| *Gomp. gracile* | | | 7 | | | | | | | |
| *Gomph. minutum* | | 2 | | | | | | | | 1 |
| *Gomph. olivaceum* | 12 | 8 | 14 | 12 | 26 | 8 | 9 | 2 | 4 | 13 |
| *Gomph. parvulum* | 5 | 6 | 1 | 1 | 6 | 5 | 3 | 1 | 2 | 4 |
| *Gomph. sp.* | | | | | | | | | | |
| *Gomph. truncatum* | | 3 | 17 | | | | 1 | | | |
| *Gyr. scalproides* | | 1 | 1 | | | | | | 1 | |
| *Melosira granulata* | 3 | 5 | 2 | | 11 | 4 | 2 | 1 | 2 | 2 |
| *Nav. capitatoradiata* | 14 | 9 | 3 | 11 | 10 | 7 | 11 | 3 | 9 | 11 |
| *Nav. cryptotenella* | 9 | 3 | 16 | 4 | 8 | 5 | 8 | 1 | 4 | 5 |
| *Nav. decusis* | 1 | | | | | | | | | |
| *Nav. goeppertiana* | 6 | 5 | 1 | 2 | 2 | 1 | 2 | | 2 | 3 |
| *Nav.lanceolata* | 4 | 3 | 1 | 3 | 1 | 2 | 1 | | 1 | 5 |
| *Nav. menisculus* | | 3 | 1 | | | 1 | 1 | | 1 | 2 |
| *Nav. phylepta* | | 1 | 1 | | | | | | | |
| *Nav. pupula* | 1 | | | 1 | | | | 1 | | |
| *Nav. tripunctata* | 6 | 2 | 1 | 1 | 4 | 3 | 3 | 1 | 2 | 4 |
| *Nav. trivialis* | 1 | | | | 1 | | | | | 1 |
| *Nitz. amphibia* | | 6 | 4 | | | 1 | 1 | | 1 | 2 |
| *Nitz.capitellata* | 1 | | | | | | | | | |
| *Nitz. constrikta* | | 1 | 1 | | 1 | | | | | |
| *Nitz. dissipata* | 3 | 8 | | 6 | 7 | 4 | 6 | 4 | 5 | 5 |
| *Nitz. palea* | 1 | 4 | | | 1 | | 2 | 1 | 2 | 4 |
| *Nitz. recta* | 2 | | | 1 | 1 | | | | | 1 |
| *Nitz. umbonata* | 1 | | | | 1 | | | | | |
| *Rinn. microstauron* | | 1 | | 2 | 3 | | 1 | | | 1 |
| *Pinn. rupestris* | | | 1 | | | | | | | |
| *Rh. abbreviata* | 4 | 8 | 9 | 10 | 12 | 6 | 8 | | 9 | 10 |
| *Rhopal. gibba* | | | 49 | | | | | | | |
| *Stauroneis acuta* | | | 1 | | | | | | | |
| *Stephanodiscus sp.* | | 1 | | | | | | | | |
| *Sur.breb.var. kuetzingii* | 1 | | 2 | | 2 | | 1 | | | |
| *nedeterminirani* | 29 | 54 | 9 | 22 | 55 | 26 | 7 | 9 | 28 | 20 |
| TOTAL: | 226 | 288 | 315 | 144 | 367 | 154 | 145 | 41 | 159 | 230 |

2) The next step is to find out, in which organs and tissues diatoms have been found. It is not equally important in which organ diatoms are found, because of the phenomenon of passive entering of the diatoms into the organs, due to the hydrostatic pressure, which is completely different from the active entering of diatoms caused by active inspiratory movements. Organs with the greatest importance as indicators of active entering of the diatoms in the body are: bone marrow, liver, brain, kidney, spleen, heart, stomach, intestine and lungs. Finding the greatest number of diatoms in the lungs is logical having in mind the pathophysiology of drowning, but also one must bear in mind that the lungs and the stomach are organs where the diatoms enter passively most easily, after phlakciditas mortis sets in. On the other hand, bone marrow is considered to be a good "closed" tissue, not easy accessible for passive entering of diatoms. That is why it represents tissue with a great value regarding

the diatom test, especially for the bodies in progressive stage of decomposition and bodies with lacerations.

3) A taxonomic analysis of the different kinds of diatoms present in the samples of internal organs must be made, as well as the samples from the body surface - hair and skin, and the sample from the liquid medium where the body was recovered from. Some authors (10) claim that, if all kinds of diatoms from the samples of organs are present in the sample of water where submersion occurred, and if they are in the approximately same proportion, then it is an evidence of drowning. It must be mentioned that this is a very rare finding. Nevertheless, the reliability of the diatom-test is the biggest, if the same types of diatoms are found in the samples of tissues and in the liquid medium. The question is: what to do in the cases where the cadaver after submersion was replaced carried by water on a great distances, situation where diatom frustrules found in the organs, even when their presence and their number are significant, are not the same with the types from the liquid medium?

4) To answer the previous question there must be close collaboration between forensic pathologists and specialist-biologists. In our country that kind of collaboration was accomplished between our Institute and Institute for biology at the Faculty of natural sciences, where the diatomologic map of the waters in the Republic of Macedonia was worked out. This way, some rare types of diatoms can be identified and located using the diatomologic map, suggesting the possible place of the drowning.

**CONCLUSIONS:**

1) Analyzing the pathological finding in our examined material of 17 cases of drowning without progressive changes of putrefaction, the typical finding of the lungs - Emphysema spumosum, which must be differentiated from lung edema, is characterized with the greatest diagnostic value. In terms of diagnostic value, it is immediately followed by the finding of liquid in the stomach and the duodenum. We consider these signs as major patho-anatomical signs of drowning, which if present and supported by positive and regularly interpreted results from diatom test, represent the reliable proof for the diagnosis of drowning.

2). Although non-specific, the finding of the foamy contents in the airways, is characterized with a great diagnostic value. We consider this sign highly valuable in the process of determination of drowning, and every forensic pathologist should search for it, but also he/she should be very careful with its interpretation.

3) The signs of asphyxiation and of immersion are characterized with low and non-specific diagnostic value in the procedure of determination of drowning, but their role is undoubted for proving the death from asphyxia and the stay of the body in a liquid medium. That's why, although minor, these signs are of huge importance in making the diagnosis of drowning and, according to our results the importance of the ecchymoses under the mucous and serous membranes is the greatest.

4) Based on a long period of experience with the diatom test at the Institute of Forensic medicine from Skopje, based on a countless arguments for and against this method in the relevant forensic literature, and finally based on the analysis made in this study, our consideration is that the diatom test is suggestive, indicative and welcome method in the process of determination of drowning as a cause of death with the bodies with short post-mortal period, without changes of progressive decomposition. With an increase of the degradation processes and progressive passive entering of diatoms into the body, the reliability of the diatom test decreases and it is mostly limited to the tissues which are resistant to a passive entering of diatoms - primarily the bone marrow. It depends on the skill and knowledge of the forensic pathologist how much he will succeed in eliciting information for every separate case of drowning, which makes this method appropriate, useful and inevitable, but still not specific enough.

5. Every body recovered from water should be examined extensively, with regard to the cause of death and then using the principles of inclusion and exclusion, through complete forensic medicine investigation, to determinate the drowning as a cause of death. In this process, the major and minor patho-anatomical signs, along with the results of the diatom test are simply arguments contributing to a positive formulation of the diagnosis.

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