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ASPHYXIA SYNDROME IN UNDERLYING *VERSUS* DIRECT CAUSES OF DEATH

Daniela-Drăguța TĂBÎRCĂ[1]

[1] "Sf. Apostol Andrei" Emergency Hospital, Department of Legal Medicine, Constanța, Romania

Corresponding author: Daniela-Drăguța Tăbîrcă, e-mail: t_daniela_d@yahoo.com

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The purpose of this article is to see whether, based on gross and microscopic analysis, we can differentiate between an underlying versus direct cause of death. To this purpose, we performed a case control study, at the Constanța Service of Legal Medicine, with four study groups, each consisting of 50 cases, mechanical asphyxia, sudden deaths, in-hospital deaths (violent), out-hospital deaths (violent). The underlying cause of death was mostly respiratory in the mechanical asphyxia group, mostly cardiac in the sudden cardiac group, and mostly craniocerebral in both in- and out-hospital violent deaths. The direct cause of death was mostly respiratory in mechanical asphyxia, mostly cardiac in sudden death, and mostly cerebral/other in both in- and out hospital violent deaths. Our study showed that pulmonary stasis and pleural petechiae appear more often in underlying respiratory versus direct respiratory causes of death. From a practical point of view, this is important as it may allow for a more targeted approach during the autopsy, depending on the severity and characteristics of the asphyxia syndrome. In conclusion, pulmonary stasis and pleural petechiae are the best indicators for an underlying respiratory cause of death, and are able to discriminate between respiratory underlying and direct causes of death.

Keywords: asphyxia syndrome, underlying causes of death, direct causes of death, pulmonary stasis, pleural petechiae.

INTRODUCTION

Respiratory insufficiency is an extremely important diagnosis in legal medicine, as it appears on several levels of the physiopathology chain of death (cause of death, death mechanism, mode of death) in both violent and non-violent deaths. Differentiating the location in this chain where respiratory failure occurs and its association with the type of death are of particular importance in legal medicine, especially in establishing the type and characteristics of forensic causal chains[1-3]. The underlying cause of death is the initial pathological condition, initiating the thanatologic chain. It is always unique, and from a temporal point of view is the first one to appear. Is is usually a very specific disorder (such as hepatic cirrhosis, coronary atherosclerosis, gastric ulcer, acute pneumonia). The direct cause of death is the final condition, which leads irreversibly to the death of the patient. It is always unique, it is the last cause of death to appear in the thanatologic chain, and has variable degrees of specificity[4].

The purpose of this article is to see whether, based on gross and microscopic analysis, we can differentiate between an underlying versus direct cause of death.

MATERIALS AND METHODS

We have performed a case-control study, at the Constanța Service of Legal Medicine, with four study groups (each consisting in 50 cases) (Table 1). The first one was the control group (C) – subjects whose death was caused by mechanical asphyxia. In their case, the underlying and direct causes of death, the manner and mode of death were respiratory. Taking into account the fact that the entirety of the thanatological chain was respiratory, the asphyxia syndrome should be, according to the working hypothesis, obvious. The second group (Test -T1) contained strictly sudden deaths. In this group, there is a possibility to identify either respiratory causes of death, or means/modes, appearing at a short distance after the beginning of the physiopathological chain leading to death. The third group (T2) consisted of violent deaths, with hospitalization. In this group, we expected to see intermediate changes to the respiratory apparatus (caused either by or in association by direct trauma and respiratory consequences of traumatic shock). The last group (T3) contained violent deaths (other than mechanical asphyxia), without hospital admission. In this group, the survival period between the beginning of the thanatologic chain and death was extremely short; in this group, we expected to see minimal evolutive respiratory changes, but frequent respiratory/thoracic trauma. For each case, we extracted 38 variables, that were included in an excel database (initially). We included a series of histology parameters (stasis, lung edema, hemorrhage, etc.) that were quantified on a four degree scale (0 – absent, 1 – minor change, 2 – moderate changes, 3 – significant changes). After verifying the results, we transferred the database in SPSS. The statistical analysis was performed using SPSS v20 for Windows (trial version). We have performed descriptive statistics, Pearson Chi2 with Bonferroni error correction, and the Fisher test (ANOVA). A p value below 0.05 was considered statistically significant.

RESULTS

The underlying cause of death was mostly respiratory in the mechanical asphyxia group, mostly cardiac in the sudden cardiac group, and mostly craniocerebral in both in- and out-hospital violent deaths (see Table 1). The association between variables was highly statistical significant (Pearson Chi2=230, $p<0.001$). The direct cause of death was mostly respiratory in mechanical asphyxia, mostly cardiac in sudden death, and mostly cerebral/other in both in- and outhospital violent deaths (see Table 2). The association between variables was highly statistical significant (Pearson Chi2=324, $p<0.001$).

In the next stage of our study, we compared various gross and histological signs associated with asphyxia syndrome, depending on the underlying and direct causes of death, and we obtained the results that are synthesized below.

Moderate and severe pulmonary stasis identified on lung samples, histologically, appeared quasi-constant in subjects whose underlying cause of death was respiratory (94%); it had often occurred in the case of deaths with a predominantly cardiac cause (78%) and much less (less than 50%) in case of other initial causes of death. Moderate and severe pulmonary stasis appeared very often in subjects whose direct cause was respiratory (84%); it had often occurred in deaths whose direct cause of death was predominantly cardiac (63%) and much less (less than 50%) for other direct causes of death. The statistical analysis suggested a greater utility of the pulmonary (microscopic) stasis to identify an underlying than a direct respiratory cause of death.

Moderate and severe lung edema occurs very often in underlying respiratory causes of death, in about 70% of cardiac deaths and in about 50% in other deaths. Moderate and severe pulmonary edema occurs extremely frequently in the case of deaths with respiratory direct causes of death (84%), in about 66% of cardiac deaths, and in less than 50% in other deaths. The statistical analysis failed to suggest a significantly different specificity of pulmonary edema for the underlying versus direct cause of death.

Hematic extravasation occurs most often in the case of deaths with an underlying respiratory cause of death, while other types they appear extremely rare. They also occur most often in cases with respiratory direct causes of death, while in the rest of the study groups they are extremely rare. The statistical analysis failed to suggest a significantly different specificity of hematic extravasation for the underlying versus direct cause of death.

Macroscopic asphyxia syndrome occurs extremely frequently in the case of deaths with a respiratory underlying cause of death (94%), relatively often (> 75%) in cardiac deaths and much less often (less than one third) in other causes of death. Asphyxial macroscopic syndrome occurs very often in respiratory direct causes of death (88%), relatively often (59%) in cardiac deaths and much less often (less than one third) in other deaths (32%).

Epicranial petechiae are predominantly associated with an initial respiratory illness, although they also occur frequently in cardiac deaths. Regarding the direct causes of death, they occur with relatively the same frequency in cardiac and respiratory deaths. This result suggests that asphyxia petechiae tend to appear in the agonal period, regardless of whether the initial cause of death is respiratory or cardiac.

Pleural petechiae are associated with a respiratory underlying cause of death, an extremely sensitive association (although not very specific). The same can be observed with pleural hematic petechiae, which suggests their correlation with the underlying rather than the direct cause of death, unlike mechanical asphyxia.

Table 1

Underlying causes of death

		Ic				
		Respiratory	Cardiac	Cardiac and respiratory	Others	Total
Subject	Mechanical asphyxia	48	0	0	2	50
	Sudden death	0	40	5	5	50
	In hospital death (violent)	0	0	36	14	50
	Out hospital death (violent)	1	1	34	14	50
Total		49	41	75	35	200

Table 2

Direct causes of death

		Ia				
		Respiratory	Cardiac	Cardiac and respiratory	Others	Total
Subject	Mechanical asphyxia	44	0	0	6	50
	Sudden death	0	40	3	7	50
	In hospital death (violent)	2	7	0	41	50
	Out hospital death (violent)	4	7	2	37	50
Total		50	54	5	91	200

DISCUSSION

Asphyxia syndrome has an unremarkable, but specific morphological pattern, which can be identified both directly, during the autopsy, and by analyzing the results of the laboratory tests done on biological products sampled during the autopsy. At the external examination of the body we can find Tardieu spots (asphyxia petechiae), which was found to be an unspecific sign of hypo anoxic state, and which are more intense at the scleral/epicranial levels. During the internal examination of the body are identifiable unclothed blood, visceral stasis, an increase in the total lung volume, sometimes lung emphysema (especially associated with diseases causing endoluminal obstruction such as asthma or drowning). From a thanatochemical point of view can be identified increases in hypoxantine level[5], increases in the phospholipid concentration in alveolar fluid[6], increases in blood lactate-dehydrogenase (especially LDH5), and increases in plasma aldosterone[7]. In mechanical asphyxia associated with neck compression are identifiable increases in thyreoglobulin levels in the blood (above 2000 ng/ml), most likely cause by a direct trauma of the thyroid gland, and increased histamine levels in the lungs[8]. In drowning are present increased values of the atrial natriuretic peptide (normal range: 70-80pg/ml, with increases up to 190-200 in saltwater drowning and up to 350 in freshwater drowning)[9-10]. Blood strontium increases significantly both in freshwater (100-10000 microg/L) and saltwater drowning (up to 13000 microg/ml) (normal range: 20-40microg/ml)[11,12]. In CSH, magnesium levels increase up to threefold in saltwater drowning (up to 3-6m Eg/ml)[13,14].

From a histological point of view, there are some elements suggesting asphyxia, usually in the lungs. For example, some authors have descried acute hyperemia with focal hemorrhages just beneath hyperdistended lung alveolae (hemorrhagic-dishoric syndrome)[15, 16], which we could not confirm in our study. Also, this condition has also been described in cardiopulmonary resuscitation or in temporary obstruction of the upper respiratory airways[15].Other authors have described in longer asphyxia syndromes (15-30 min), an increase in the number of alveolar macrophages and a proliferation of type II pneumocytes[17]. Grellner and Madea found a strong, immune-positive reaction for CD69 in asphyxia syndromes[18].

Our study showed that pulmonary stasis and pleural petechiae appear more often in underlying respiratory versus direct respiratory causes of death. From a practical point of view, this is important as it may allow for a more targeted approach during the autopsy, depending on the severity and characteristics of the asphyxia syndrome.

CONCLUSION

In conclusion, pulmonary stasis and pleural petechiae are the best indicators for an underlying respiratory cause of death, and are able to discriminate between respiratory underlying and direct causes of death.

Conflict of interest. There is no conflict of interest.

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