H71 An Unusual Hospital Asphyxiation: Death From the Incorrect Administration of Nitrous Oxide (N_2O)

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Learning Overview: The goal of this presentation is to describe an unusual case of death due to the incorrect administration of N_2O during anesthesia. Despite a first autopsy that established death due to myocardial infarction, the effective cause was diagnosed during a second necroscopic examination. The use of immunohistochemical markers has been important in detecting hypoxic damage in tissues.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by showing a rare case of death due to the incorrect administration of N_2O during anesthesia. The role of immunohistochemistry in the investigation of hypoxic damage is also emphasized.

N_2O is the most commonly used inhalation anesthetic in dentistry.[1] However, the safety and efficacy of N_2O has been questioned; indeed, N_2O is no longer used in anesthesia.[2] N_2O produces moderate analgesia at subanesthetic concentrations and also an anxiolytic effect.[3] Anesthetic concentrations are 50%–67%; higher concentrations cause asphyxiation, indeed, the administration of N_2O is associated with hypoventilation.[4] Because of the sedative and euphoric properties of the N_2O, it is often used for recreational use.[5]

Accidental deaths are mainly associated with recreational uses of N_2O. In the literature, there are rare reports of accidental inhalation at work or due to its incorrect administration to hospitalized patients during anesthesia.[6,7] Often, asphyxia from N_2O as a cause of death is attributed thanks to the analysis of the crime scene, while the autopsy plays a marginal role. Generally, the autopsy shows only generic signs of asphyxia, but nothing that can lead directly to N_2O intoxication, such as histopathological examinations with standard Hematoxylin-Eosin (H&E) staining.[8] Immunohistochemical research of hypoxic markers and toxicological analysis are more useful.[9,10]

This case report is that of a 70-year-old man who underwent endovascular prosthesis placement surgery to treat an aneurysm of the left common iliac artery. The surgery was performed under local anesthesia. During the operation, an oxygen mask was attached to a ventilator. Suddenly, the patient became unconscious and there was rapid oxygen desaturation; the anesthesiologist subsequently switched to endotracheal intubation. Thereafter, the patient went into cardiac arrest and died.

The first autopsy diagnosed recent myocardial infarction of the left ventricle, cerebral and pulmonary edema, splenic infarction, multi-visceral congestion, atherosclerosis of the aorta, and sub-occlusion of the coronary arteries (about 60% of the lumen). Histological examination confirmed these findings. The cause of the death was acute pulmonary edema due to recent myocardial infarction of the left ventricle.

Subsequently, the operating room was checked by technicians and an inversion of the oxygen and N_2O pipes was found. This had occurred during its building, so that the patients breathed N_2O instead of oxygen.

Two months later, a new autopsy was performed by a forensic pathologist on the same body. Surprisingly, the second examination found that the coronary arteries were not sectioned and analyzed, although this was described in the first autopsy report. They sampled organs again to perform further histology and immunohistochemical investigations. Histological samples from the first autopsy were re-examined and other slides were stained with H&E staining—immunohistochemistry for E-selectin (CD62E-382), P-selectin (CD62P), monoclonal mouse anti-human (DAKO), and HIF 1-α.

Study of the slides from both autopsies revealed no coronary artery stenosis. The cardiac myofibers showed diffuse interstitial neutrophilic infiltration, without signs of necrosis, with the presence of contraction bands. Splenic infarction was not detected. Examination of the brain tissue revealed loss of Purkinje cells, suggesting hypoxic damage. Immunohistochemical staining showed that in the heart, HIF 1-α was expressed in the myocardial nucleus areas showing signs of reperfusion. HIF 1-α was also expressed in areas close to hemorrhagic extravasation and in areas with fibrotic replacement.

The P-selectin revealed positivity of platelets aggregate, expressed widely in the areas of hemorrhagic extravasation. E-selectin was expressed in the same areas, but less intensely. In the lung, P-selectin was expressed widely in medium vessels of the emphysematous lungs. Hemorrhagic areas were also positive for P-selectin. The findings suggest that all myocardial tissue had suffered from a lack of oxygen perfusion. Even the brain had suffered hypoxic damage.

So, combining the autopsy findings as well as the investigations carried out by the technicians on the operating theatre and ventilator, the truth was discovered. The real cause of death was intoxication by N_2O, with acute asphyxiation due to hypoxia.

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Nitrous Oxide, Hypoxic Damage, Anesthetic Inhalation