A FATAL GAS EMBOLISM FOLLOWING THE USE OF INTRAOPERATIVE HYDROGEN PEROXIDE AS AN IRRIGATION FLUID

Z. Hussain-Khan[1], A. A. Soleimani[*1] and M. Farzan[2]

1) Department of Anesthesiology, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

2) Department of Orthopedic Surgery, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran

Abstract- Hydrogen peroxide, an oxidizing agent used in surgery for its antiseptic properties, has been associated with life-threatening complications. We report a case of suspected gas embolism following irrigation of a tibial bone cyst with hydrogen peroxide in a five year-old boy under general anesthesia, who died despite resuscitative measures and a long stay in the intensive care unit.

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INTRODUCTION

Hydrogen peroxide (H_2O_2) is frequently used for irrigation, cleansing and dressing of surgical wounds. H_2O_2 decomposes rapidly as a result of the action of catalases in blood and tissues, releasing molecular oxygen and water. There are some reports of cases of gas embolism due to H_2O_2 administration (1-3). Here, we report a case of gas embolism in a patient that led to death after a prolonged stay in the intensive care unit. We wish to warn against the potential dangers of using H_2O_2 during surgery.

Case reports

A five year-old boy presented with a tibial bone cyst. Preoperative vital signs and laboratory data were all within the normal range. After employing routine standard monitoring, the patient underwent an uneventful induction of anesthesia with fentanyl 1 µg/kg, thiopental sodium 5 mg/kg and atracurium in a dose of 0.5 mg/kg. Anesthesia was maintained with a combination of halothane 0.5%, N_2O and oxygen each in a concentration of 50% and incremental intravenous fentanyl. The patient was placed in supine position and the table maintained in a neutral position. After preparing and draping the surgical field, a Jamshidi needle was inserted into the cyst cavity by the surgeon with the aid of fluoroscopy. After drainage of some fairly clear fluid from the cyst cavity, 10 ml of 30% H_2O_2 solution was forcibly flushed into the cavity via the same needle in order to irrigate the cystic cavity. A few seconds after the injection of H_2O_2, severe bradycardia and hypotension, accompanied by difficulties in ventilation ensued. Ventilatory pressure raised suddenly and hemoglobin saturation of oxygen (SpO_2) decreased abruptly to about 40%. There was also a reduction in end-tidal CO_2. N_2O was turned off immediately and the lungs were ventilated manually, but with difficulty, utilizing one hundred percent oxygen. The patient was placed in the Trendelenburg and left lateral position and repeated doses of atropine 0.25 mg followed by epinephrine 0.1 mg/kg (1: 1000) were injected together with rinsing of the

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*** Corresponding Author:**
A. A. Soleimani, Department of Anesthesiology, School of Medicine, Tehran University of Medical Sciences, Tehran, Iran
Tel: +98 21 6935061, Fax: +98 21 6438634
E-mail: aasolei@yahoo.com

surgical field with saline solution. Meanwhile, a needle was inserted into the heart of the patient with air gushing out (the central venous pressure had not been established prior to surgery because of a short surgical procedure). Subsequently, the initial stony bag gave way to a comparatively soft bag with resultant improvement in oxygenation culminating in an SpO_2 level of 90%. At this moment, the heart rate was about 130 beats per minute and the blood pressure was 90/60 mmHg. Dexamethasone 8 mg was given intravenously to counteract ensuing cerebral edema secondary to the hypoxemic episode. The patient was sent to the intensive care unit and mechanical ventilation (CMV mode with FiO_2= 100%) was initiated. Nearly an hour later, the patient developed a generalized seizure which was controlled with diazepam 5 mg intravenously. A neurologist was consulted and intravenous phenobarbital 30 mg three times a day was started to control further seizures. No more seizures occurred. Nutritional support was started on the third day. Unfortunately, the patient never regained his consciousness and died after a protracted stay of 18 days in the ICU.

DISCUSSION

H_2O_2 is a clear and colorless solution with a mildly piquant or acidic odor. It is unstable and decomposes violently when in direct contact with rough surfaces or trace metals (such as Cu and Fe), dirt, heat, light and biological materials such as blood (4). H_2O_2 was primarily used for bleaching straw hats. At present, it has wide-spread usages, ranging from food processing to energy production in space crafts. In medicine it is frequently used for irrigation and dressing of surgical wounds (the broad spectrum cidal effect is responsible for its wide-spread common usage as an effective antiseptic and disinfectant agent). The blood and liver of mammals contain an enzyme, catalase, that catalyzes the decomposition of H_2O_2 into water and oxygen (5,6). It is oxygen that kills bacteria (4).

$$2H_2O_2 \longrightarrow 2H_2O + O_2$$

In 1967, intravenous H_2O_2 was used in pigs. It was demonstrated that a solution of H_2O_2 3% diluted 50/ 50 with NaCl 0.9% perfused in the right ventricle, led to the rapid formation of bubbles with subsequent pulmonary and systemic embolization, severe methemoglobinemia and death (7). In a review of literature, we can find reports of sudden cardiovascular collapse and pulmonary embolism due to H_2O_2 application. Loeb reported a case of severe oxygen embolism after wound irrigation with H_2O_2 in a patient undergoing surgical dressing of a large thigh trauma under general anesthesia (1). In another report by Despound et al, an oxygen venous embolism occurred during lumbar discectomy after the use of H_2O_2 (2). There is also a report of a similar event occurring in a patient undergoing bilateral pulmonary lobectomy in whom the thoracic cavity had been irrigated with H_2O_2 at the end of the procedure (3). In the present case, although a transoesophageal echocardiography or precordial Doppler was not used to exactly diagnose and pinpoint gas embolism, the air gushing out after inserting the needle in the heart, and also the timing of the symptoms and clinical presentation, such as hypotension, bradycardia and a decrease in end-tidal CO_2 and oxygen saturation occurring abruptly after H_2O_2 irrigation, strongly and unequivocally pointed to the diagnosis of a gas embolism. Noteworthy is the fact that clinical and pathophysiological features of air and oxygen emboli are almost identical, including the management protocol. Unfortunately, medical management is not always successful and despite all efforts, some patients may die. Indeed, the present case, clearly demonstrated once again that H_2O_2 application is not totally free of danger and fatal repercussions. One milliliter of a 30% H_2O_2 solution will yield 100 ml of oxygen gas in tissue when it decomposes (8,9). This gas can enter the circulation and cause severe gas embolism. So we need to be more cautious while using H_2O_2. In our opinion, it is better to avoid the routine-use of H_2O_2, and restrict its use in highly indicated cases in whom its merits outweigh its potential hazards.

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