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Intraoperative Gas Explosion in Digestive and Proctological Surgery at Treichville University Hospital: Three Cases

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Abstract **Case Report**

Intraoperative gas explosions during digestive surgical emergencies are a rare occurrence. They occur when certain combustible intestinal gases reach a certain concentration. They can be fatal for the patient-surgeon couple. ***Purpose***: To study the contributing factors and morbidity and mortality through these three cases. ***Observations***: We present three adults men admitted for peritoneal syndrome in two cases and a complex anal fistula in one case. Two patients presented with abdominal distension, respectively after abdominal contusion in an intoxicated patient and the other for colonic perforation following a sigmoid colon volvulus. Exploratory laparotomy was indicated in two cases. The detonation followed by a blue flame occurred upon opening the peritoneal cavity in two cases and during fistulotomy after flatulence in one case. The contributing factors were predominantly intraperitoneal gas hyperconcentration (accidental or physiological) combined with the use of an electric scalpel. The lesions were characterized by gastric and visceral explosion with cardiac arrest and subsequent death in one case, and a posterior perineal burn. One patient was unharmed. ***Conclusion***: Electrocautery should be avoided in cases of emergency abdominal hyperpressure.

Keywords: Gas Explosion, Hyperconcentration, Electrocautery.

INTRODUCTION

Intestinal gas explosion during laparotomy is a rare accident [1]. It is an accidental combustion reaction triggered by an incandescent energy source when intestinal gas concentrations reach a certain threshold [2]. A few isolated sporadic cases have been described in the literature [3], particularly in the West. It is an accident with potentially fatal injuries for both operators and the patient [3]. In sub-Saharan Africa, to our knowledge, no case has been observed during laparotomy, and the factors contributing to a fatal outcome are not well understood. Through a report of 3 cases, we will review the contributing factors in order to establish precautionary measures, and we will discuss morbidity and mortality.

CASE PRESENTATIONS

1/ OBSERVATIONS 1

Mr. KM, a 41-year-old alcoholic, was admitted to the surgical emergency room of the Treichville University Hospital with an abdominal contusion following a fight involving an intoxicated patient. Clinical examination revealed peritoneal syndrome, diffuse grayness on PSA, and leukocytosis of 10,000 elements/mm3. During exploratory laparotomy, accidental gastric intubation followed by significant oxygen ingestion resulted in gastric hyperconcentration. The anesthetic gases used were isoflurane and oxygen. When the peritoneal cavity was opened with an electric scalpel, a gas detonation was heard, followed by cardiac arrest and death of the patient on the table. Exploration revealed gastric explosion, various viscera, and the celiac plexus.

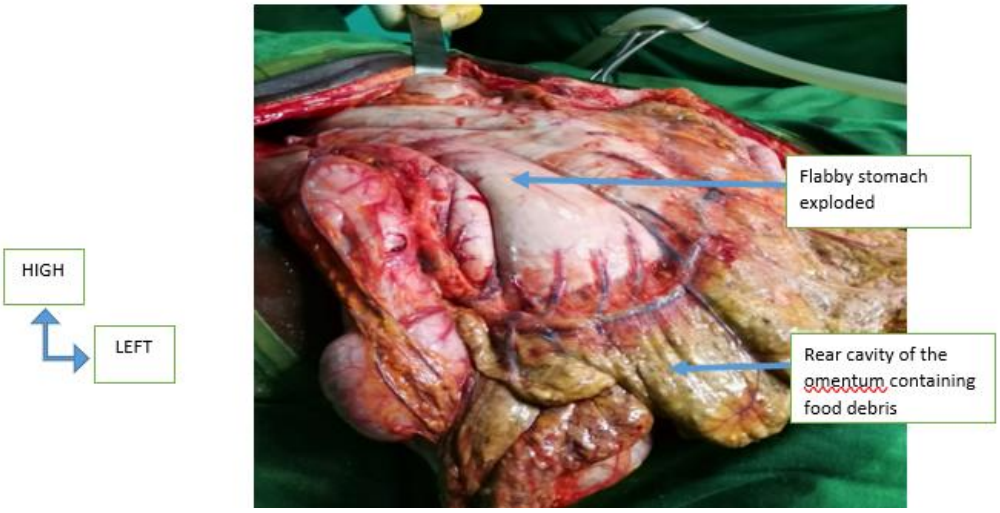

Figure 1: Photo 1 of the stomach after explosion (patient P1)

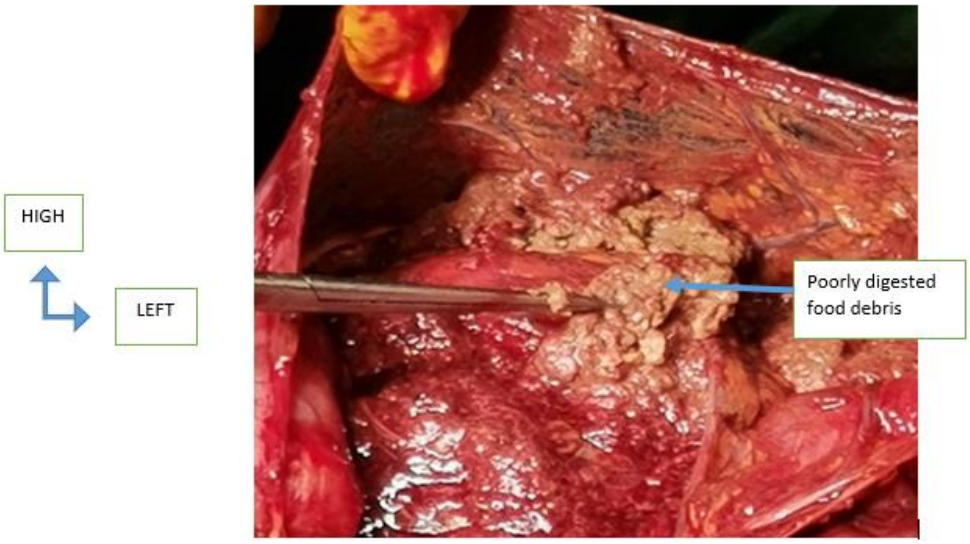

Figure 2: Photo 2 of the exploded stomach after opening of the rear cavity of the omentum (patient P1)

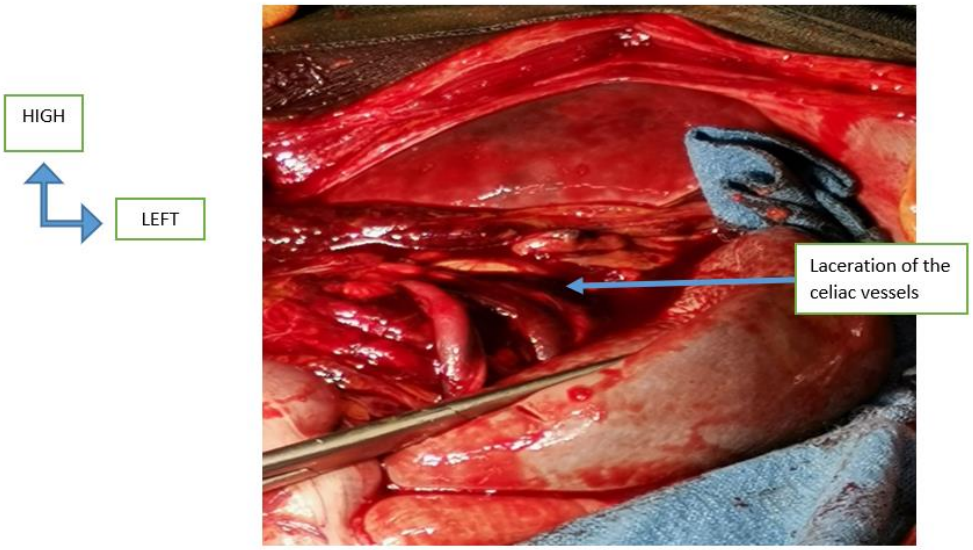

Figure 3: Photo 3 of the exploded stomach with laceration of the celiac vessels after stomach reclination (patient P1)

2/ OBSERVATION 2

A 41-year-old patient was admitted to the surgical emergency department for abdominal pain and cessation of stool and gas for approximately 3 days. Clinical examination revealed peritoneal syndrome in a distended patient. A PSA revealed significant pneumoperitoneum, and laboratory tests revealed leukocytosis at 16,000 cells/mm3. Laparotomy was indicated. General anesthesia was administered with isoflurane combined with oxygen. When the peritoneal cavity was opened with an electric scalpel, an explosion with instantaneous blue flame emission occurred. Surgical exploration revealed a volvulus of the sigmoid colon with two perforated areas. A Hartmann colectomy was performed. The course was uneventful.

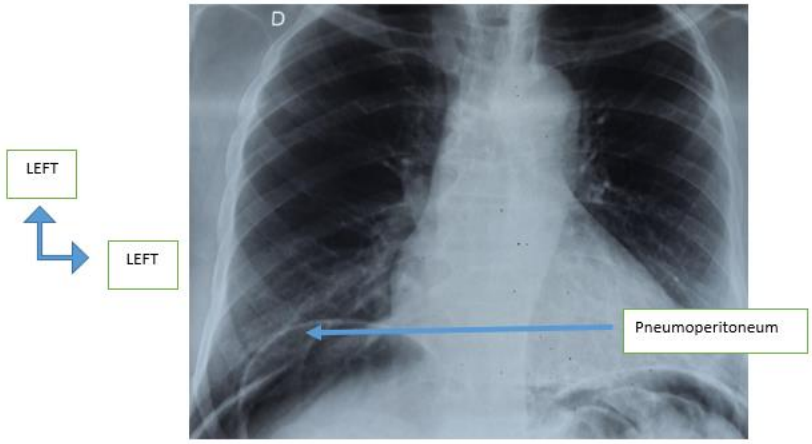

Figure 4: ASP showing pneumoperitoneum during a sigmoid colon volvulus (patient P2)

3/ OBSERVATION 3

A 29-year-old patient with chronic constipation, accustomed to lactulose-based laxatives, presented with recurrent anal suppuration, in whom clinical examination revealed a complex anal fistula. A fistulotomy was indicated. Intraoperatively, under spinal anesthesia, sphincter relaxation led to sudden significant gas emission during dissection of the fistulous tract with an electric scalpel. A blue flame was observed and caused a first-degree burn at the posterior perineal level without any other superimposed lesions. These blisters were treated with aqueous eosin. The outcome was favorable

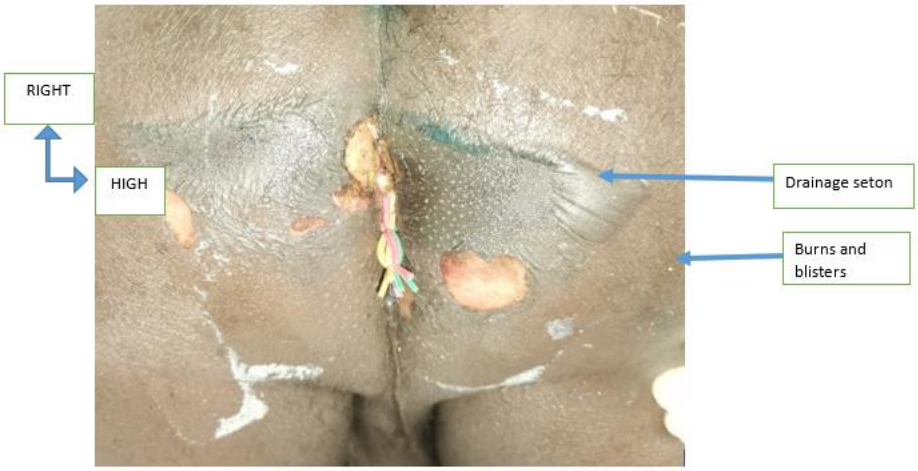

Figure 5: a first-degree burn after blue flam during fistulotomy (patient P3)

DISCUSSION

Our patients shared a common feature of gaseous hyperconcentration and the use of a worn electrocautery device. This hyperconcentration in a closed environment was contributed to by various factors. Indeed, patient P1 presented multiple factors. Initially, it was a gastric contusion that was thought to be responsible for gastric ileus. This resulting gastric stasis was thought to be responsible for the accumulation of flammable gases (methane, hydrogen). These flammable gases would come from the various reactions of incomplete food digestion and fermentation promoted by microbiota in a contused and paralyzed stomach [4]. Secondarily, the ingestion of strong alcohol. This strong alcohol, which was normally absorbed at 98% in the digestive tract [5], will be accumulated in the stomach due to ileus, knowing that alcohol was the cause of the fire in the operating room [6]. To this flammable mixture, we must add the accidental ingestion of oxygen

which occurred during intubation. Normally the oxygen concentration in the stomach is less than 10%. The flammable concentration of methane is 4.4 to 16.3% in the presence of an oxygen concentration ≥ 10.7%, while hydrogen is flammable at concentrations of 4 to 75% in the presence of oxygen ≥ 4% [7]. However, in our case it was higher due to the accidental ingestion of oxygen, which catalyzed the explosion. This was a double oxidation-reduction reaction triggered by the application of an uncontrolled external heat source, in this case the used electric scalpel. Any redox reaction is highly exothermic and potentially explosive. Here the fuels were methane, dihydrogen and alcohol while the oxidant was oxygen. In the work of Mahmood *et al*., it was exactly the same circumstances but in a context of stenosis [8]. For patient P2, it was probably a production of methane and other combustible gases kept in a closed vessel for about 3 days due to the volvulus. Indeed these flammable gases would result from a synergistic action between incomplete digestion and fermentation of carbohydrates and proteins as well as molecular reactions and also from the proliferation of germs in a closed vessel. To these gases, we must add the inhaled oxygen diffused during normal general anesthesia [2]. These combustible gases being in the peritoneal cavity after colonic perforation entered into a redox reaction with the oxygen in the ambient air of the operating room after opening the peritoneal cavity. The explosive reaction was triggered by the application of the electric scalpel. This resulted in a sudden blue flame erupting within seconds as in the case of Thomas W *et al*., [1]. Regarding the third P3 production, it was a patient accustomed to lactulose due to constipation. Indeed, several authors have stated that lactuloses lead to an increased elimination of colonic gas and especially methane [9, 10]. The action of locoregional anesthesia on the sphincter will promote relaxation with loss of continence, which would be responsible for an emission of gases maintained in the colon. These gases would be responsible for the burns once in contact with the faulty, uncontrolled electric scalpel. Regarding the lesions caused, they depended on the explosion site, the intensity and the quality of the gases. Our patient P1 had presented a gastric explosion. It is a viscus that has a large capacity. The volume of gas received (oxygen) was therefore greater than the others because of direct ingestion. It was a probable mixture of several flammable gases with strong alcohol, notably ethanol. It was therefore a double oxidation-reduction reaction. One used ethanol and the other flammable gases (H2, methane). This double oxidation-reduction would be responsible on the one hand for a gaseous hyperconcentration. This gaseous mixture being contained in the contused and paralyzed stomach will behave as if in a closed vessel, which will increase the effect of the explosion as in that Bonnet *et al*., The latter had closed the distal end of the dilated loop before any anastomosis and the explosion was severe with loss of tissue flap requiring another surgical indication [11]. The damaged neighboring organs of P1 were solid organs such as the spleen and its vascularization which are also part of the celiac trunk and were also damaged as in the case of DEBRI *et al*., [3]. The lesions of patient P2 were minimal because it was a perforation with the presence of gas in the large peritoneal cavity. Therefore the opening would have led to a progressive loss of gas and the explosion towards the outside of the peritoneal cavity. We agree with Sindani and al. who recommended letting the gas escape at the opening before any action [12]. The observation was the same for patient P3. During flatulence, the emission of gases being external, the lesions were therefore minimal and cutaneous this mechanism was rare. But a very high proportion of methane and hydrogen has been found in human flatulence [12]. However, we have not found an intraoperative gas explosion following a fart in the literature. On the other hand, Galley *et al*., reported a case of burns by eructation in a patient with gastric stenosis. The heat source was a cigarette fire [13]. The outcome was fatal in the case of P1. This could be due to damage to the celiac plexus including the pneumogastric nerve, which would be responsible for cardiac arrest and death on the operating table; in fact, the explosion can sometimes be fatal. The case reported by Debri *et al*., also died from severe injuries with diaphragm damage and laceration of multiple vessels, despite intra- and post-operative repair and resuscitation [3]

CONCLUSION

Gas explosions exist. They are potentially fatal. Electrocautery should be avoided when opening the peritoneum in any acute abdomen.

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