

Gas embolism is the phantom, but higher pneumoperitoneum pressure is not necessary

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Background

During pure laparoscopic hepatectomy, we prefer to expose the hepatic veins around the tumor on the cutting plane, even in partial hepatectomy, because it is very useful and reasonable to secure the surgical margin, while we always expose them in anatomical hepatectomy for hepato-cellular carcinoma. In our procedure, keeping the operative field dry is the most important factor to divide the liver parenchyma safely as scheduled by finding and exposing the vessels that appear in the cutting portion.

Procedures

To control the blood inflow, a tourniquet system is always prepared for Pringle's maneuver or the hemi-hepatic vascular occlusion technique, and is used intermittently as necessary. To control the bleeding from hepatic veins, we have several established approaches. Preoperatively, we exclude patients with respiratory issues that might cause insufficient ventilation by the pneumoperitoneum. During surgery, pneumoperitoneum pressure is usually set to 10mmHg. Central venous pressure is generally kept low by reducing the volume of infusion from the beginning of surgery. In the beginning, ventilation is not adjusted particularly. If the operative field is not dry due to oozing from the raw surface, which may be bleeding from a small hole in a hepatic vein, the occlusion of hepatic inflow is first initiated. If this does not have a sufficient effect, the airway pressure is reduced by an anesthesiologist. Finally, pneumoperitoneum pressure is increased; however, we rarely employ this approach. If an uncontrollable hemorrhage is encountered, artificial ventilation is often paused briefly to decrease airway pressure substantially. We do not attempt to repair the bleeding point until identifying its location. Using these approaches, we have so far completed all pure laparoscopic hepatectomies safely without any complications regarding hemorrhage or carbon dioxide gas embolism.

Discussion

The behavior of a hemorrhage from an injured hepatic vein is defined mainly by the pressure gradient between pneumoperitoneum pressure and central venous pressure. Therefore, we previously increased the pneumoperitoneum pressure. However, we noticed that the anesthesiologist had often increased airway pressure simultaneously to maintain ventilatory volume in patients with respiratory issues. We considered that maintaining every

artificial pressure as low as possible is safer for patients, so we changed our basic strategy. On the other hand, if airway pressure is kept too low continuously, this is the highest risk factor for carbon dioxide gas embolism because high levels of carbon dioxide gas can be vacuumed into the right-sided circulation due to extremely low pressure in the intrathoracic space. Careful observation of carbon dioxide gas embolism is always required for rapid recovery, although the risk for carbon dioxide gas embolism is considered to be very low because carbon dioxide gas usually dissolves into the blood quickly.