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Application of Sengstaken-Blakemore Tube in the Management of a Patient with Esophageal Fistula Complicated by Mediastinal Vascular Hemorrhage after Comprehensive Treatment for Hepatocellular Carcinoma

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Abstract: *This paper summarizes the rescue experience of a patient with stage CNLC IIIb hepatocellular carcinoma who developed mid-esophageal fistula complicated with mediastinal vascular rupture and hemorrhage after surgery, and whose bleeding was successfully controlled with a Sengstaken-Blakemore tube after failure of conventional endoscopic hemostasis. Through stepwise decompression and continuous compression with the Sengstaken-Blakemore tube for 14 days, combined with multidisciplinary comprehensive treatment (including respiratory support, anti-infection, and correction of coagulation function), active bleeding was effectively controlled, creating a window period for subsequent treatment. Eventually, the patient was successfully weaned off the ventilator and transferred from the intensive care unit to the general ward after 21 days of hospitalization. This case confirms that the Sengstaken-Blakemore tube can serve as an important bridging therapy for tumor-related esophageal arterial hemorrhage that is inoperable.*

Keywords: *Hepatocellular carcinoma; Esophageal fistula; Mediastinal vascular hemorrhage; Sengstaken-Blakemore tube; Hemorrhagic shock; Multidisciplinary treatment*

1. Introduction

Esophageal fistula complicated with mediastinal vascular hemorrhage refers to the formation of an abnormal channel between the esophagus and major mediastinal blood vessels (such as the aorta, innominate vein, azygos vein, or portal vein collaterals) due to tumor invasion, injury from radiotherapy/interventional therapy, infection, or ulcer perforation. It is clinically characterized by massive hematemesis, melena, and hemorrhagic shock within a short period of time. Against the background of comprehensive treatment modalities for hepatocellular carcinoma, direct tumor invasion and tissue necrosis caused by transcatheter arterial chemoembolization or radiotherapy can all be important predisposing factors for fistula formation. Patients are usually complicated with liver cirrhosis, portal hypertension, and coagulation dysfunction, which further amplify the risk of hemorrhage. Due to the deep location of the fistula and torrential bleeding, emergency gastroscopy is often difficult to accurately locate and effectively stop bleeding, and traditional open thoracic repair is highly invasive with extremely high mortality and complication rates. Therefore, there is an urgent clinical need for a bridging method that can quickly control bleeding and gain time for subsequent definitive treatment[1-4].

In recent years, the rescue value of the Sengstaken-Blakemore tube in refractory non-variceal upper gastrointestinal massive hemorrhage has been rediscovered, but its application in esophageal fistula complicated with mediastinal vascular hemorrhage after comprehensive treatment for hepatocellular carcinoma is still rarely reported. This paper reports a case of a patient with esophageal fistula complicated with mediastinal vascular hemorrhage after comprehensive treatment for hepatocellular carcinoma, who achieved a good prognosis through successful hemostasis with the Sengstaken-Blakemore tube combined with multidisciplinary treatment, aiming to provide new ideas and evidence-based evidence for the emergency treatment of such life-threatening complications[5].

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2. Clinical Data

2.1 General Information

A 36-year-old male patient was admitted to the emergency department with melena for 2 days and hematemesis for 1 day. He had a history of congenital hepatitis B, was diagnosed with hepatocellular carcinoma in 2022, and underwent right anterior hepatectomy, cholecystectomy, and partial diaphragmatic resection and repair in our hospital. Since then, he has received multiple courses of radiotherapy, chemotherapy, targeted drug therapy, transcatheter arterial chemoembolization, and bronchial arterial chemoembolization. He was admitted to the hospital with a tentative diagnosis of gastrointestinal bleeding. After excluding contraindications, gastroscopy was performed in the endoscopy room, which indicated esophageal fistula complicated with mediastinal vascular hemorrhage. An attempt was made to close the lesion with a 14 mm titanium clip, but the local tension was high, confirming the diagnosis of esophageal fistula complicated with mediastinal vascular hemorrhage. About 10 minutes after gastroscopy, the patient became confused, and emergency tracheal intubation connected to ventilator-assisted ventilation, invasive blood pressure monitoring and other symptomatic treatments were given, and he was transferred to the intensive care unit with the tube in place. On admission, his APACHE score was 15, SOFA score was 10, and NRS2002 score was 4.

2.2 Treatment Process

2.2.1 Stepwise Decompression and Hemostasis with Sengstaken-Blakemore Tube Compression

Immediately after being transferred to the EICU, a Sengstaken-Blakemore tube was orally placed under propofol sedation and direct laryngoscopy. The drainage volume of the gastric tube changed from bright red to light bloody 5 minutes after intubation. A stepwise decompression protocol was adopted to avoid esophageal necrosis: a cycle of "12 h compression - 30 min release" was performed from day 1 to day 5; the protocol was changed to "8 h - 30 min" from day 5, and to "6 h - 30 min" from day 10. Hemoglobin (Hb), vital signs and balloon pressure were monitored daily.For changes in other key indicators, see Table 1.

Table 1 Changes in key indicators during Sengstaken-Blakemore tube compression

Time	Hemoglobin (g/L)	Activated partial thromboplastin time (s)	Respiratory support mode	Vasoactive drugs
Before intubation	43	122.6	-	Norepinephrine 0.3 μg/kg/min
24 h after intubation	76	78.4	VC-AC	Terlipressin 2 mg/d
7 days after intubation	85	46.2	PC-BIPAP	Norepinephrine discontinued
24 h before extubation	88	41.7	SPONT	None

2.2.2 Comprehensive Treatment

Immediate hemostasis and hemodynamic stability: Rapid pressure infusion of 12 U of red blood cells and 3 U of platelets; norepinephrine at 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$. Continuous infusion of terlipressin 2 mg (reduced by 1 mg every 6 h until discontinuation), octreotide 50 μg/h, and esomeprazole 80 mg by intravenous bolus followed by maintenance at 8 mg/h.

Respiratory and neurological function support: Mechanical ventilation in SIMV+PS mode with FiO_2 40% and positive end-expiratory pressure 5 cmH_2O; the oxygenation index remained >200 mmHg. High-flow humidified oxygen therapy was initiated on day 11, and extubation was successfully performed on day 15.

Anti-infection strategy: Initial ertapenem 1 g once daily; on day 3, according to BALF-tNGS (Acinetobacter baumannii, Klebsiella pneumoniae, Pseudomonas aeruginosa, Burkholderia multivorans) and blood culture (Staphylococcus haemolyticus), the regimen was upgraded to meropenem 1 g every 8 h + polymyxin B 100 mg every 12 h + tigecycline 50 mg every 12 h; on day 9, sputum culture showed methicillin-resistant Staphylococcus aureus, and vancomycin 0.5 g every 12 h was added; on day 18, after the decrease of infection indicators, the regimen was de-escalated to sulbactam/cefoperazone + linezolid.

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2.3 Outcome

Gastroscopy confirmed the formation of blood scab at the fistula and no active bleeding 14 days after hospitalization, and the Sengstaken-Blakemore tube was removed. On day 21, the patient was conscious with spontaneous breathing and was transferred to the general ward. Outpatient follow-up 1 month after discharge showed hemoglobin 102 g/L and no rebleeding.

3. Discussion

3.1 Efficacy of Sengstaken-Blakemore Tube in Esophageal Arterial Hemorrhage

The traditional view holds that the Sengstaken-Blakemore tube is only applicable to esophagogastric variceal bleeding caused by portal hypertension. However, studies have shown that for arterial upper gastrointestinal bleeding that is difficult to control by endoscopy (including aorto-esophageal fistula, mediastinal vascular-esophageal fistula, iatrogenic arterial injury, etc.), the Sengstaken-Blakemore tube can also be used as a "bridging hemostasis" method with an immediate hemostasis rate of 80–90%, but the rebleeding rate is as high as 50%. In this case, the patient developed esophageal fistula complicated with mediastinal vascular hemorrhage after comprehensive treatment for hepatocellular carcinoma, with jet-like bleeding that failed to be closed with titanium clips. Bleeding stopped within 5 minutes after the application of the Sengstaken-Blakemore tube, which is consistent with the literature reports. It is worth noting that most patients with hepatocellular carcinoma are complicated with liver cirrhosis, coagulation dysfunction and portal hypertension, and traditional treatment regimens (such as tissue adhesive injection or transjugular intrahepatic portosystemic shunt) cannot close the arterial rupture. At this time, the Sengstaken-Blakemore tube becomes the only method to quickly achieve hemodynamic stability[6-8].The hemostatic mechanism primarily relies on the direct physical compression exerted by the balloon on the esophageal wall and fistula. This mechanical action does not depend on the patient's coagulation function, which is particularly crucial for patients with severe coagulopathy. In this case, the patient had previously undergone treatments such as hepatic arterial chemoembolization, which may have exacerbated local tissue ischemia and fragility, leading to the failure of endoscopic titanium clip closure due to excessive tissue tension. The successful application of the three-lumen, two-balloon catheter in this scenario highlights its unique value in managing complex hemorrhages associated with tumor treatment and poor tissue conditions. It serves not merely as a hemostatic tool but as a resuscitation strategy that creates a critical "time window" for subsequent multidisciplinary comprehensive treatments (such as anti-infection therapy and correction of coagulation function). Future research is needed to clarify the indications for prioritizing the use of the three-lumen, two-balloon catheter over other emergency interventional methods (such as catheter-directed arterial embolization) in similar arterial bleeding cases.

3.2 Safety and Evidence-Based Basis of Stepwise Decompression Strategy

The incidence of complications related to the Sengstaken-Blakemore tube is about 15–30%, including esophageal pressure ulcer, perforation, aspiration, arrhythmia, and gastric balloon rupture. Drawing on the experience of "intermittent deflation" for esophageal variceal bleeding, this case adopted a stepwise decompression protocol of "12-8-6 h", and liquid paraffin was injected through the gastric tube to lubricate the mucous membrane before each deflation, resulting in no esophageal necrosis or perforation. A recent domestic prospective study suggested that the incidence of esophageal ulcer in the intermittent deflation group (deflated for 30 min every 8–12 h) was significantly lower than that in the continuous compression group (6.5% vs 28.9%, $P<0.05$). Therefore, we recommend the routine application of "stepwise intermittent deflation + mucosal protection" strategy for patients with tumor-related esophageal fistula complicated with mediastinal vascular hemorrhage, and dynamic monitoring of balloon pressure (esophageal balloon ≤30 mmHg, gastric balloon ≤45 mmHg)[9-10].The physiological basis for stepwise decompression lies in balancing the paradox between sustained, effective hemostasis and the prevention of ischemic necrosis of the esophageal mucosa. A pattern of brief, regular relaxation periods allows for reperfusion of the local mucosal microcirculation, which was crucial in preventing compressive complications in this case. According to the monitoring data, as the duration of compression was reduced in a stepwise manner, the patient's physiological state improved gradually, as evidenced by stabilized hemoglobin levels and a decreased need for respiratory support.

This suggests that the decompression protocol can be dynamically adjusted according to the

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patient's real-time response. For instance, longer compression cycles can be employed during the initial high-risk period of bleeding, and as the surrounding inflammation and edema subside and clot formation occurs, the compression duration can be gradually shortened. In addition, the combined use of mucosal protectants (such as paraffin oil in this case) may further reduce mechanical friction injury. Future directions may explore non-invasive monitoring techniques (such as mucosal oxygen saturation) to provide individualized, precise guidance for the decompression cycle, thereby optimizing both efficacy and safety.

3.3 Limitations of the Sengstaken-Blakemore Tube

Although the Sengstaken-Blakemore tube plays an important role in the rescue of esophageal fistula complicated with mediastinal vascular hemorrhage, it still has the following limitations: ① It cannot cure the fistula with a high rebleeding rate; ② Intubation and maintenance require an experienced team, which limits its popularization in primary hospitals; ③ There is a lack of prospective randomized controlled trials to confirm its superiority over other bridging measures. The Sengstaken-Blakemore tube is only a temporary hemostatic method. Once hemodynamic stability is achieved, digital subtraction angiography, surgical repair, or self-expandable covered metal stenting should be adopted as soon as possible.

4. Conclusion

This case shows that for life-threatening massive hemorrhage caused by esophageal fistula complicated with mediastinal vascular hemorrhage after comprehensive treatment for hepatocellular carcinoma, the Sengstaken-Blakemore tube can quickly control bleeding when endoscopic or surgical treatment is limited; the stepwise intermittent deflation strategy significantly reduces complications and improves prognosis. This case provides new ideas for the treatment of such critical illnesses.

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