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Original Article

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Endoscopic Placement of Sengstaken-Blakemore Tube Effectively Reduces Esophageal Rupture Resulting from Tube Malposition: A Propensity Score Analysis

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ABSTRACT

OBJECTIVE This study aimed to evaluate the effectiveness of endoscopically assisted Sengstaken-Blakemore tube placement in reducing the tube malposition rate and resulting complications.

METHODS Data was collected on 45 patients with massive esophageal variceal bleeding who underwent Sengstaken-Blakemore tube placement between January 2011 and June 2016 at our institute. This retrospective study compared the malposition rate, complication rate, and treatment outcome between the conventional blind technique (n = 28) and the endoscopically assisted technique (n = 17), using propensity score analysis to account for differences in baseline characteristics.

RESULTS The rate of malpositioning of the Sengstaken-Blakemore tubes was significantly higher in the conventional blind technique group, while there were no incidents of malpositioning in the endoscopically assisted technique group (25% vs. 0%; $p = 0.034$). All cases of tube malpositioning in the conventional blind technique group resulted in esophageal perforation, while no perforation occurred in the endoscopically assisted group. The propensity score analysis showed that endoscopic placement was significantly better than the conventional method for esophageal rupture (adjusted RR = 0.78, 95% CI = 0.68–0.91, $p = 0.002$), but not significantly better for death rate (adjusted RR = 0.68, 95% CI = 0.38–1.21, $p = 0.186$).

CONCLUSIONS Endoscopic-assisted Sengstaken-Blakemore tube placement can effectively reduce esophageal ruptures resulting from tube malpositioning.

KEYWORDS endoscopic assistance, malposition rate, Sengstaken-Blakemore tube

INTRODUCTION

Since its initial introduction in 1950, Sengstaken-Blakemore tube insertion has become an important procedure for reducing the incidence of massive esophageal variceal bleeding (1, 2). Since that time, many different endoscopic and inventory techniques have emerged to control massive variceal bleeding; however, the use of the Sengstaken-Blakemore tube is still considered the last resort in the control of hemorrhage, especially in cases not responding to other treatments (3, 4). The Sengstaken-Blakemore tube gives favorable results; however, complications from the procedure are frequently reported, primarily resulting

from tube malposition. Malposition of the tube can lead to many devastating complications, such as rupture of the esophagus due to gastric balloon inflation or airway obstruction resulting from esophageal balloon insertion. (5-7). To prevent these very serious complications, many maneuvers have been proposed to confirm that the tube is in the proper position. The endoscopic placement of the Sengstaken-Blakemore tube was first proposed in the year 2000 (8). In our institute, this technique has been available, adopted, and used, depending on physician preference, since 2011. This study reviews the treatment outcomes of patients who underwent Sengstaken-Blakemore tube insertion between January 2011 and June 2016. The study includes data from both the conventional and the endoscopically assisted techniques performed during these years.

METHODS

The Research Ethics Committee of the Faculty of Medicine of Chiang Mai University granted approval for this retrospective cohort study, assigning certificate number 284/2016. We examined the electronic medical records of patients on whom the Sengstaken-Blakemore tube had been used at Chiang Mai University Hospital from January 2011 to June 2016. We gathered demographic information on the patients, including gender, age, preexisting conditions, and current medications. We also obtained medical data including vital signs, the severity of shock, manifestations of chronic liver disease, the technique of Sengstaken-Blakemore tube insertion used, endoscopic findings and interventions, pharmacological treatment involving a proton pump inhibitor and a somatostatin analog, and the treatment outcomes. The patient data was categorized into two groups according to the Sengstaken-Blakemore tube insertion technique: conventional or endoscopic-guided.

Procedure

Before starting the procedure, an endotracheal tube was inserted for airway protection. All patients received a fluid resuscitation consisting of a crystalloid solution. If the patient did not respond to the initial crystalloid solution or if their Hct was less than 21%, we performed a transfusion of packed red cells. We corrected coagulation abnormalities and thrombocytopenia as needed.

The conventional technique involves inserting the tube completely through the nostril. Auscultation of the epigastric area confirms proper tube positioning. Once we confirmed the correct tube position, we inflated the gastric balloon with 50 ml of air and gently pulled back the tube until the gastric balloon snugly fit the esophagogastric junction. Next, we continued to inflate the gastric balloon until it reached a total volume of 250 ml. A sphygmomanometer measured the pressure of the esophageal balloon at 40 mmHg only when the gastric balloon failed to control the bleeding. Once the procedure was complete, we inserted a number 12 nasogastric (NG) through the other nostril to a level of 25 cm to drain saliva. After that procedure, we performed a chest x-ray to confirm the correct placement of the tube. We kept the balloon inflated for 24 hours. After that, if the bleeding was under control, we removed the Sengstaken-Blakemore tube. However, if the bleeding was still ongoing, we re-inflated the balloon after 30 minutes of deflation. We removed the Sengstaken-Blakemore tube 48 hours after the insertion regardless of whether the bleeding had stopped or not.

The endoscopic guided Sengstaken-Blakemore tube insertion procedure was performed under general anesthesia with endotracheal tube intubation as follows:

1. After an endoscopic examination discovered variceal bleeding that had failed to be controlled by endoscopic methods, the Sengstaken-Blakemore tube was checked with air inflation to examine whether there was any leakage.
2. We inserted the tube into the nostril and passed it through to the hypopharynx.
3. We inserted an endoscope into the patient's mouth through the mouth gag. We used a 9.8-mm-diameter endoscope to facilitate insertion through the hypopharynx area. We also briefly deflated the endotracheal tube balloon during this step to reduce the pressure at the hypopharynx. When inserting the endoscope posterior to the esophageal inlet, we selected a path that passed through one side of the corniculate cartilage, where the Sengstaken-Blakemore tube was already passing. We maintained direct visualization of the upper esophageal sphincter while advancing the endoscope (Figure 1).

4. We inserted the tube and endoscope simultaneously through the esophagus which facilitated the tube insertion. In most cases, this step required neither grasping nor fixing.

5. After the endoscope had entered the stomach, the endoscopist performed a J turn, after which the gastric balloon of the Sengstaken-Blakemore tube would normally be visible (Figure 2).

6. We inflated the gastric balloon under direct visualization before withdrawing the endoscope (Figure 3).

7. The procedure for inflating both the gastric and esophageal balloons followed the same steps as the conventional procedure. An NG tube as a salivary drain was placed in the same fashion. We routinely performed a chest x-ray after the procedure to confirm the proper position. The protocol for the removal of the Sengstaken-Blakemore tube was identical to the conventional technique.

Statistical method

Statistical analysis was done using the STATA program version 16.0. The student's t-test and rank-sum test were used in the analysis of continuous data, and Fisher's exact test was used for categorical data.

As a retrospective study, the two contrast groups were observational and not randomly allocated. Direct comparisons of the outcomes between the two contrast groups would have likely resulted in biased estimates. Two potential sources of bias, confounding by indication and confounding by contraindication, would likely have affected the true association between insertion techniques and outcomes (esophageal rupture and mortality rate). The use of the propensity score method enabled the investigators to create contrast groups that more accurately measured the relationship between treatment and outcomes. The propensity score was estimated as a surrogate of the likelihood or the probability of being assigned to each group. It was calculated in the form of logit as a function of factors (age, shock grading, and Child-Pugh) most likely to influence the likelihood of being assigned to each insertion technique. The calculated propensity score was then used as a covariate to control for confounding by indication and confounding by contraindication in the final model. The effect of each insertion technique on the results of treatment was analyzed by log-risk regression, which was adjusted by propensity score modeling.

RESULTS

This study included a total of 45 patients with massive esophageal variceal bleeding who underwent Sengstaken-Blakemore tube placement. Twenty-eight patients underwent the conventional technique, while 17 patients underwent the endoscopically assisted technique. In the endoscopically guided group, the mean age of the patients was slightly higher than that of the conventional group (58.8±14.7 vs. 50.0±13.6 years; p = 0.046). Overall, there was no statistically significant difference between the patients in the two groups regarding other baseline characteristics. Most patients were males, presenting with a high grade of shock and decompensated liver function. All patients fell into a high-risk category when stratified using the Rockall score. Some of the patients in both groups had previously undergone an endoscopic examination, which identified most of them as high-risk (Grade 2, 3 in quantitative guidelines, > 5 mm) for the variceal lesion, as per the American Association for the Study of Liver Disease (AASLD) practice guidelines (9). The majority of fluid used in resuscitation in both groups of patients was a crystalloid solution, and the amounts used were not statistically different. Patients in the endoscopic group and conventional group received similar medical treatment: 58.8% vs. 82.1% somatostatin analogue, 94.1% vs. 85.7% tranexamic acid, and 35.3% vs. 48.2% vasopressor. There were no statistically significant differences in these data. Patients in both groups had anemia. Both groups had a high level of BUN and low levels of HCO_3, which are results of hypovolemic shock. Patients received on average two units of PRC and four units of fresh frozen plasma, equal in both groups (Table 1).

In the endoscopic insertion group, the 17 patients underwent an endoscopic examination first, and then the endoscopic-guided Sengstaken-Blakemore insertion. The median duration from the start of the endoscopic examination to full balloon insufflation was 48 minutes, with a range of 10 to 155 minutes. There were no complications during the procedures. Most patients were at a high grade of variceal, distributed between Grades

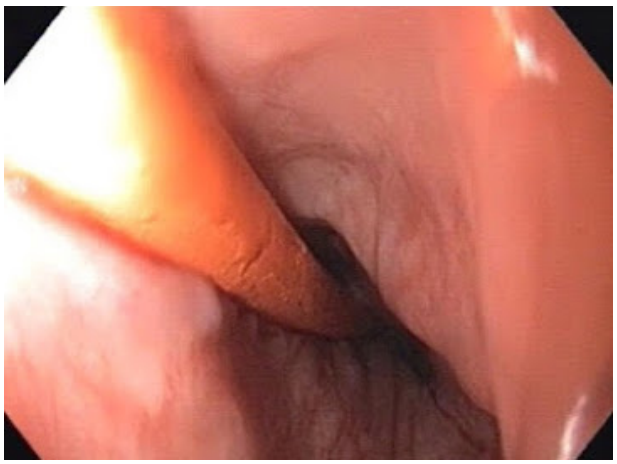

Figure 1. Sengstaken-Blakemore tube in the esophagus after passing the hypopharynx and upper esophageal sphincter

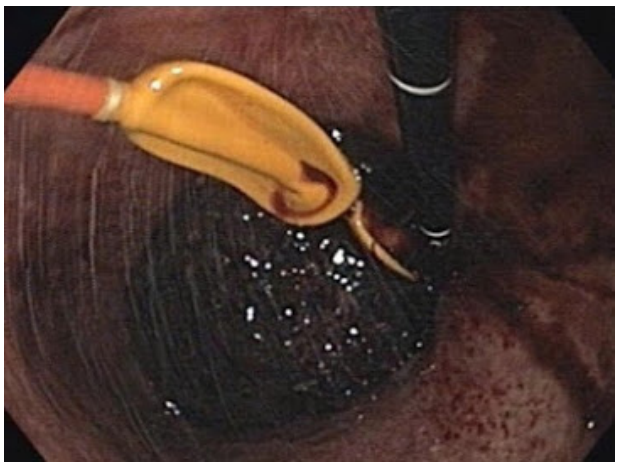

Figure 2. Gastric balloon seen after performing an endoscopic J turn

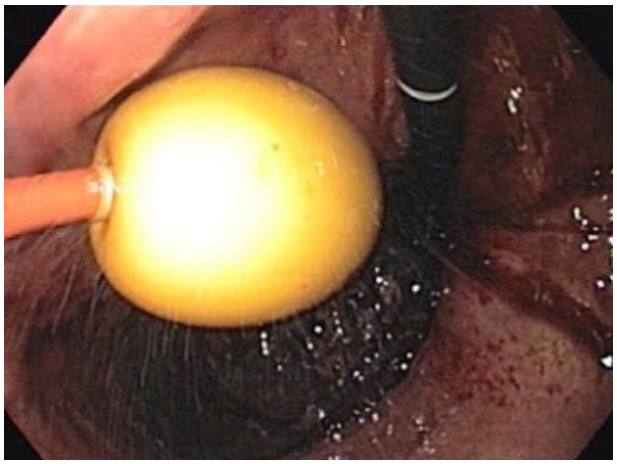

Figure 3. Gastric balloon inflation under direct visualization

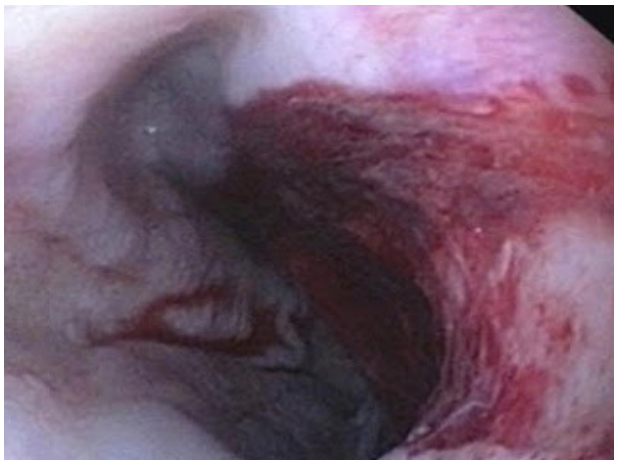

Figure 4. Esophageal perforation from a Sengstaken-Blakemore tube (muscular layer completely torn with visible periesophageal adventitia)

2 and 3 (60% vs 40%); data were not recorded in seven cases. Most patients in both groups also had gastric varices, with the majority having gastro-oesophageal varice (GOV) type 1 (76.9%). The median blood loss as recorded by the anesthesiologist during the procedure was 300 ml. This group of patients had a median of two units of PRC transfusion, and almost all patients had no FFP or platelet transfusion (Table 2).

A post-procedure portable chest x-ray revealed malposition of the Sengstaken-Blakemore tube in seven cases in the conventional group (25% vs. 0%, p = 0.034), a significantly higher rate than in the endoscopic group. In the group with a malpositioned tube, all patients ultimately had an esophageal perforation. The treatment outcomes following the Sengstaken-Blakemore tube procedure for temporary bleeding control showed no statistical differences between groups. The overall bleeding control rate was 46.7%. There was a very high mortality rate, 52.9% vs. 67.9% in the endoscopic group and conventional group, respectively (p = 0.357). The leading cause of death was hemorrhagic shock (Table 3).

The association between prognostic factors and the result of treatment was analyzed. In the endoscopically guided group, there was a lower mortality rate; however, this was not statistically significant. The only prognostic factor that showed a significant association is the Child-Pugh score (p = 0.003). The Child-Pugh C group had the highest mortality rate at 79.3% (Table 4).

Child-Pugh is an important parameter in creating a propensity score. The propensity score analysis indicated a significant superiority in avoiding esophageal rupture with endoscopic placement compared to the conventional technique (adjusted RR = 0.78, 95% CI = 0.68-0.91, p

Table 1. Baseline characteristics of patients before Sengstaken-Blakemore tube insertion

Characteristics	Endoscopic guided technique (n=17)	Conventional guided technique (n=28)	*p*-value
Age (years), mean±SD	58.8±14.7	50.0±13.6	0.046
Gender, n (%)			0.350
Male	14 (82.4)	26 (92.9)	
Female	3 (17.6)	2 (7.1)	
Shock grade, n (%)			1.000
Grade 1	1 (5.9)	3 (10.7)	
Grade 2	2 (11.8)	2 (7.1)	
Grade 3	9 (52.9)	14 (50.0)	
Grade 4	5 (29.4)	9 (32.1)	
Child-Pugh, n (%)			1.000
Class A	1 (5.9)	1 (3.6)	
Class B	5 (29.4)	9 (32.1)	
Class C	11 (64.7)	18 (64.3)	
Rockall score (pre-endoscopic)			0.137
0-2 (low risk)	2 (11.8)	0 (0.0)	
3-7 (high risk)	15 (88.2)	28 (100.0)	
Previous endoscopic findings: esophageal variceal grading, n (%)			0.752
Grade 1	1 (12.5)	5 (27.8)	
Grade 2	3 (37.5)	4 (22.2)	
Grade 3	4 (50.0)	9 (50.0)	
Fluid resuscitation in first 24 hrs. (mL), median (range)			
Crystalloid	1,500 (100-4,000)	1,000 (0-5,180)	0.176
Colloid	0 (0-4,000)	0 (0-1,500)	0.920
Medication, n (%)			
Somatostatin analogue	10 (58.8)	23 (82.1)	0.163
Tranexamic acid	16 (94.1)	24 (85.7)	0.635
Vasopressor	6 (35.3)	13 (48.2)	0.535
Laboratory results, median (range)			
Hb	7.1 (4.0-10.5)	7.4 (2.7-11.9)	0.609
Hct	21.7 (12.2-31.4)	23.1 (9.2-36)	0.532
WBC	9,070 (3,590-182,000)	9,740 (1,380-19,700)	0.833
Platelets	126,000 (30,000-288,000)	95,500 (12,000-298,000)	0.198
PT	17.3 (12.1-26.9)	20.3 (12.3-90.2)	0.761
PTT	36.8 (24.5-132.9)	36.9 (23.5-200.0)	0.935
INR	1.6 (1.1-2.6)	2.0 (1.2-8.2)	0.468
BUN	24 (6-86)	26.5 (7-90)	0.851
Creatinine	1.3 (0.7-6.8)	1.4 (0.6-10.5)	0.833
HCO_3	15 (8-21)	16.5 (6-35)	0.264
Blood products received (units), median (range)			
PRC	2 (1-5)	2 (0-9)	0.691
FFP	4 (0-8)	4 (0-8)	0.660
Platelets	0 (0-10)	2 (0-20)	0.667

= 0.002) but a non-significant superiority in mortality rate (adjusted RR = 0.68, 95% CI = 0.38-1.21, p = 0.186) (Table 5).

DISCUSSION

End-stage liver disease can cause bleeding from esophageal varices, a devastating emergency condition with a grave prognosis. Even with proper management, an exsanguinous, uncontrolled hemorrhage can lead to patient mortality. Introduced as a sole therapy for dealing with variceal hemorrhage in 1950 (1), the Sengstaken-Blakemore tube is still used as a rescue procedure in cases when the physician cannot stop the

Table 2. Clinical data for endoscope-guided procedure patients

Variables	Endoscopic guided technique (n=17)
Duration (minutes), median (range)	48 (10-155)
Complications, n (%)	0 (0.0)
Endoscopic findings	
Esophageal variceal grading, n (%)	
Grade 1	0 (0.0)
Grade 2	6 (60.0)
Grade 3	4 (40.0)
Sarin classification, n (%)	
GOV1	10 (76.9)
GOV2	3 (23.1)
Blood loss during procedure, (ml) median (range)	300 (30-2,000)
Blood product received during the procedure (units), median (range)	
PRC	2 (0-6)
FFP	0 (0-6)
Platelets	0 (0-4)

GOV, gastro-oesophageal varice

Table 3. Results of Sengstaken-Blakemore Tube Placement Hemorrhagic Control and Complications

Variables	Endoscopic guided technique (n=17)	Conventional guided technique (n=28)	*p*-value
Proper positioning of the tube, n (%)			0.034
Good positioning	17 (100.0)	21 (75.0)	
Malpositioning	0 (0.0)	7 (25.0)	
Shock grading at 24 hrs. after the procedure, n (%)			0.389
Grade 1	10 (58.8)	11 (39.3)	
Grade 2	2 (11.8)	2 (7.1)	
Grade 3	0 (0.0)	3 (10.7)	
Grade 4	5 (29.4)	12 (42.9)	
Blood products received after the procedure (in a 24 hrs. period) (units), median (range)			
PRC	2 (0-9)	2 (0-10)	0.709
FFP	4 (0-6)	4 (0-16)	0.583
Plt	4 (0-11)	0 (0-10)	0.013
Medication use, n (%)			
Somatostatin analogue	15 (88.2)	24 (85.7)	1.000
Tranexamic acid	16 (94.1)	26 (92.9)	1.000
Vasopressor	7 (41.2)	16 (57.1)	0.365
Results of laboratory follow-up at 24 hrs. after procedure, median (range)			
Hb (g/dL)	8.4 (4.3-11.2)	7.4 (2.1-10.6)	0.178
Hct (%)	25.8 (15.6-35.2)	22.8 (6.8-32.3)	0.145
WBC (cells/mm^3)	11,300 (2,200-27,400)	11,890 (2,450-19,220)	0.662
Platelets (cells/mm^3)	106,000 (10,400-228,000)	88,000 (26,000-203,000)	0.435
PT (sec)	17.9 (11.8-27.1)	16.9 (11.5-200.0)	0.888
PTT (sec)	35.1 (24.7-88.7)	35.2 (20.4-200.0)	0.759
INR	1.7 (1.1-2.6)	1.6 (1.1-10.0)	0.828
BUN (mg/dL)	27 (10-81)	31 (6-93)	0.898
Creatinine (mg/dL) (mEq/L)	1.6 (0.5-6.2)	1.6 (0.4-11.4)	0.847
HCO_3 (mEq/L)	16 (6-22)	18 (3-38)	0.563
Complication (esophageal rupture), n (%)	0 (0.0)	7 (25.0)	0.034
Length of hospital stay (days), median (range)	9 (1-30)	6 (1-120)	1.000
Result of treatment (%)			0.357
Discharge	8 (47.1)	9 (32.1)	
Death	9 (52.9)	19 (67.9)	
Cause of death, n (%)			0.371
Hemorrhagic	5 (55.6)	15 (79.0)	
Sepsis	4 (44.4)	4 (21.0)	

Table 4. Association between prognostic factors and results of treatment

Prognostic factors	Result of treatment, n (%)		*p*-value
	Death (n=28)	Discharge (n=14)	
Technique			0.357
Endoscopic-guided technique	9 (52.9)	8 (47.1)	
Conventional guided technique	19 (67.9)	9 (32.1)	
Child-Pugh			0.003
Class A	0 (0.0)	2 (100.0)	
Class B	5 (35.7)	9 (64.3)	
Class C	23 (79.3)	6 (20.7)	
Shock grading			0.226
Grade 1	2 (50.0)	2 (50.0)	
Grade 2	1 (25.0)	3 (75.0)	
Grade 3	14 (60.9)	9 (39.1)	
Grade 4	11 (78.6)	3 (21.4)	
Rockall score (pre-endoscopic)			1.000
0-2 (low risk)	1 (50.0)	1 (50.0)	
3-7 (high risk)	27 (62.8)	16 (37.2)	
Esophageal perforation, n (%)			1.000
No	24 (63.2)	14 (36.8)	
Yes	4 (57.1)	3 (42.9)	

Table 5. Univariable and multivariable risk ratio of esophageal rupture and mortality rate after sengstaken-blakemore tube insertion, adjusted by propensity score analysis

Outcomes	Univariable analysis		Multivariable analysis	
	Crude RR (95% CI)	*p*-value	Crude RR (95% CI)	*p*-value
Esophageal rupture				
Insertion technique (endoscopic guided over conventional)	0.80 (0.70-0.91)	0.001	0.78 (0.68-0.91)	0.002
Mortality rate				
Insertion technique (endoscopic guided over conventional)	0.78 (0.46-1.31)	0.351	0.68 (0.38-1.21)	0.186

RR, risk ratio; CI, confidence interval

bleeding with an endoscopic intervention (10). In some rural areas where endoscopy is not available, the tube remains the sole treatment. The results of treatment with a Sengstaken-Blakemore tube vary. Previous studies have reported that initial bleeding control was achieved at a rate of 80.0-91.5%. However, rebleeding occurred frequently in almost half of the patients. Overall, definite control of bleeding was achieved at a rate of 47.7-67.0% (3, 4). In our study, rebleeding occurred in 53.3% of patients, a rate comparable to that found in previous studies.

Unfortunately, complications associated with Sengstaken-Blakemore tube insertion have continued to be reported. Various devastating complications, ranging from acute airway obstruction to esophageal perforation (Figure 4), can potentially occur due to the malposition of the initial placement or subsequent migration. These complications often lead to more complex situations requiring invasive intervention or surgery. In this group of patients, there is usually a higher rate of morbidity and mortality (5-7, 11).

In response to the potential severe problems and challenges related to Sengstaken-Blakemore tube implantation, numerous alternative approaches have been suggested, including the guidewire-assisted technique, which involves confirming the guidewire's position via fluoroscopy, followed by the insertion of a Sengstaken-Blakemore tube over the guidewire under fluoroscopic observation. Authors of some studies have suggested employing ultrasound, commonly utilized in emergency clinics, as a verification method for tube

placement that produces favorable outcomes. The endoscopic guiding approach has also been examined and shown to produce positive results (8, 12, 13).

According to variceal bleeding treatment guidelines, early endoscopic treatment of bleeding is highly recommended (9). Therefore, the placement of the Sengstaken-Blakemore tube should be employed only after the use of the endoscopic procedure has failed to achieve bleeding control. One variation in the endoscopic technique involves using an endoscopic grasper to directly grab the tube or attaching a suture loop at the tube's tip to serve as a grasping point (8, 14). Our team discovered that we could gently insert the Sengstaken-Blakemore tube simultaneously with the endoscope without using a grasping or fixing method.

In our study, we found no statistically significant difference between the endoscopic-guided technique and the conventional technique regarding the patient's hemodynamic status at 24 hours. This includes bleeding control (endoscopic guided vs. conventional, 58.8% vs. 39.3%, p = 0.389) and overall mortality (52.9% vs. 67.9%, p = 0.357). This might be due to the poor initial condition of most of the patients in our study. Most patients in both groups were categorized as having Child-Pugh C cirrhosis, which is associated with a high risk of rebleeding according to the Rockall score and a high grade of shock.

Due to the direct visualization of the gastric balloon in the stomach, the endoscopic-guided technique achieved proper tube placement at a significantly higher rate than the conventional technique (100% vs. 75%, p = 0.034). The endoscopic procedure, which included both endoscopic diagnosis and therapy, took an average of 48 minutes to complete (range 10-155 minutes). The mortality rate for the endoscopically guided technique was slightly but non-significantly lower, which could be attributed to a lower rate of complications. Our study found a generally higher rate of complications than previous reports (25% vs 7-10%), potentially due to the fact that most often a general practitioner and an intern rather than a gastroenterologist performed the insertions in the conventional group (3, 4). The endoscopic procedure does have limitations, including the necessity to move the patient to the endoscopic suite, which requires the patient's condition to be relatively stable, as well as the availability of the endoscopist. In cases of significant hemorrhage where patients do not respond to resuscitation or in hospitals without endoscopic facilities, traditional techniques remain the primary treatment approach.

For both variceal and non-variceal bleeding, endoscopy is a standard procedure that serves both diagnostic and therapeutic purposes, and it should always be the initial therapy of choice (9, 15). The insertion of a Sengstaken-Blakemore tube under direct visualization of endoscopy should be done immediately after a diagnosis of variceal bleeding is confirmed and endoscopic therapy has failed to stop bleeding. Performing this procedure as part of the endoscopic procedure could potentially prevent unnecessary insertions and complications.

Limitations

The retrospective cohort study design may have been subject to selection bias. Additionally, given the high morbidity rate with variceal hemorrhage, the therapeutic interventions given to the patients may not have had a significant impact on outcomes.

CONCLUSIONS

The endoscopic guided technique can improve the accuracy of tube positioning and could potentially serve as an optional treatment for Sengstaken-Blakemore tube insertion.

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CONFLICTS OF INTEREST

There are no potential financial and non-financial conflicts of interest.

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