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Effect of Endotracheal Intubation Performed by Trauma Surgeons on Patients with Severe Traumatic Brain Injury: A Prospective Observational Cohort Study

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Abstract

Background: The patients with severe trauma traumatic brain injury (STBI) should be intubated as early as possible, and most of the intubation was performed by anesthesiologists. With the construction of trauma centers in China, more and more trauma surgeons have mastered endotracheal intubation skills after standardized training, more and more trauma patients were intubated by trauma surgeons. We undertook a prospective observational cohort study of endotracheal intubation in emergency resuscitation room to study the effect of endotracheal intubation respectively performed by trauma surgeons and anesthesiologists on patients with STBI.

Methods: We collected data of all intubated patients with STBI between January 2018 and March 2020. Patients were divided into trauma surgeons, intubation (TI) group and anesthesiologists, intubation (AI) group according to intubation performer. We recorded age, gender, GCS, ISS, admission RR, admission HR, admission SpO2, admission PO2, admission PCO2, admission SBP, mechanism of injury, type of intracranial lesion, endotracheal intubation time, 1-min success rate of intubation, intubation related complications, the time from arrival at hospital to intubation, incidence of aspiration pneumonia, mechanical ventilation time, 30-day mortality. Comparison was made between the two groups.

Results: Among 356 STBI patients, 219 patients met the inclusion criteria (TI group N=142, AI group N=77). There were no significant statistical differences between the groups in age, gender, GCS, ISS, admission RR, admission HR, admission SpO2, admission PO2, admission PCO2, admission SBP, mechanism of injury, type of intracranial lesion. There were also no significant statistical differences between the groups in endotracheal intubation time, 1-min success rate of intubation and intubation related complications. The time from arrival at hospital to intubation in the TI group significantly lower than the AI group ($p<0.01$). Compared with the AI group, the incidence of aspiration pneumonia and the mechanical ventilation time were decrease ($p<0.05$). 30-day mortality had no significant statistical difference between the groups.

Conclusion: The trauma surgeons can master endotracheal intubation skills through standardized training, and the intubation effect is not significantly different from that of anesthesiologists. Moreover, endotracheal intubation by trauma surgeons allow the patients with STBI to be intubated earlier and reduce the incidence of aspiration pneumonia and the mechanical ventilation time. So early intubation is beneficial for the patients with STBI, and trauma surgeons should be encouraged to master endotracheal intubation skills.

Keywords: Severe traumatic brain injury; Endotracheal intubation; Trauma surgeons; Anesthesiologists

Introduction

Traumatic brain injury (TBI) is a main reason of death in developing and developed countries. At present, the incidence of TBI in China is on the rise, and the incidence has reached 100/100,000 persons, among which severe traumatic brain injury (STBI) accounts for 18% to 20%.[1,2] Recent studies reveal that only in the US, there are more than 1 million patients with STBI annually, 50,000 of these patients eventually will die and 90,000 will suffer permanent neurologic disability. So STBI leads to a heavy socioeconomic burden because of permanent disability. Road traffic accidents and falls account for the majority of STBI.[3] Moreover, the aging population and the increase of the motorized travel in many countries, STBI will continue to be the main health issue in the future.

It has been shown that hypoxemia and hypotension frequently occur in patients with STBI. The avoidance of hypoxemia and hypercapnia can reduce raised intracranial pressure, which are the key principles in the management of STBI. Endotracheal intubation for these patients can constitute the mainstay of treatment to secure a threatened airway and normalize ventilation.[4] There is no doubt that the patients with STBI require immediate intubation.[5] Endotracheal intubation is managed jointly by emergency physicians and anesthesiologists in the United States and European countries. However, endotracheal intubation of trauma patients is performed by anesthesiologists in most hospitals in China. When a trauma patient needs endotracheal intubation, the trauma

surgeon will invite an anesthesiologist to intubate and the anesthesiologist rush from the anesthesiology department to the emergency resuscitation room. This process takes about 10 minutes.

The trauma care center of the first affiliated hospital of Soochow university is the first batch of trauma treatment centers certified by China trauma treatment alliance and the provincial trauma care center of Jiang Su province. Our trauma care center encourage early intubation for the patients with STBI upon emergency resuscitation room admission. Early intubation can certainly protect the airway, effectively avoid of hypoxemia and hypercapnia, reduce aspiration caused by vomiting and shorten operation preparation time. The trauma surgeons in our trauma care center are composed of all emergency surgeons and some specialist surgeons, all of whom have received China Trauma Care Training (CTCT) and obtained CTCT certificates. They have mastered endotracheal intubation skills through standardized training, and most trauma patients are intubated by trauma surgeons. We undertook a prospective observational study of endotracheal intubation in emergency resuscitation room to study effect of endotracheal intubation respectively performed by trauma surgeons and anesthesiologists on patients with STBI.

Methods

Study design

We performed a prospective observational cohort study involving all patients with STBI who have been intubated in the emergency resuscitation room between January 2018 and March 2020.The data was obtained from the trauma care center of the first affiliated hospital of Soochow university. The patients with STBI who were intubated by trauma surgeons were divided into trauma surgeons, intubation (TI) group. The patients who were intubated by anesthesiologists were divided into anesthesiologists, intubation (AI) group. All intubation doctors were proficient in endotracheal intubation skills, and all of them used the video laryngoscope (Zhejiang UE Medical Corp) for intubation. The patients were intubated upon emergency resuscitation room admission or after completion of CT examination. The patient's endotracheal intubation time points included: (1) the Glasgow Coma Scale (GCS) <9; (2) airway obstruction; (3) abnormal respiratory rhythm and rate, such as nose-like breathing, sobbing breathing, respiratory rate > 30 or <10; (4) PO2 < 60 mmHg and (or) PCO2 >50 mmHg, sustained SpO2<90% after mask oxygen inhalation. When the patients with STBI met one or more above points, they needed to be intubated as soon as possible. Our protocol for intubation of patients used a standard rapid sequence induction (RSI) technique. The protocol included preoxygenation with 100% oxygen and the administration of succinylcholine (2.0 mg/kg) and propofol (2.0mg/kg) for patients with STBI. During the procedure, blood pressure, cardiac rhythm and oxygen saturation were monitored.

Inclusion criteria

Inclusion criteria for the patients in this study were as follows: (1) GCS<9, age>16 years old; (2) There is a definite trauma; (3)The patients were intubated in our emergency resuscitation room; (4) All patients were assisted by ventilator after endotracheal intubation.

Exclusion criteria

Exclusion criteria for the patients in this study were as follows: age>70 years old; The patients had cardiac arrest on admission; The patients died within 24 hours after injury; The patients were intubated before they reached hospital; The patients had hemodynamic instability on admission; The patients were associated with other fatal trauma, such as tension pneumothorax, pericardial tamponed, hemorrhagic shock and solid organ rupture;The patients with chronic respiratory disease or chronic heart disease; Pregnancy women.

Data collection

We have recorded prospectively data about all endotracheal intubation patients with STBI performed in the emergency resuscitation room. The intubating doctors recorded data on a specifically designed form immediately after intubation. Investigators regularly checked the resuscitation room log and electronic records to ensure all patients with STBI are included. Records were reviewed by a senior trauma surgeon and senior anesthesiologist to identify trends and patients for discussion. We documented details in three main sections: patient details and pre-induction physiology; details of the intubation procedure; and immediate complications associated with endotracheal intubation. Partial data was obtained from the trauma care center database and the hospital electronic patient records. The observed indicators include age, gender, GCS, Injury Severity Score (ISS), admission respiratory rate (RR), admission heart rate (HR), admission SpO2, admission PO2, admission PCO2, admission SBP, mechanism of injury and type of intracranial lesion, endotracheal intubation time (time from laryngoscope entrance to guide core removal), 1-min success rate of intubation, intubation related complications (endotracheal tube in the mainstem bronchus, esophageal intubation, dental or oropharyngeal injury), the time from arrival at hospital to intubation, the incidence of aspiration pneumonia (gastric contents are aspirated from the endotracheal tube or witnessed aspiration by radiologic evidence), mechanical ventilation time, 30-day mortality. All patients were managed according to trauma brain foundation guidelines and advanced trauma life support (ATLS) principles as appropriate.

Statistical analysis

Statistical analysis was performed by using SPSS 25.0 (IBM, Armonk, NY). For normally distributed data, means were reported along with standard deviation (SD), and comparisons were made using the independent samples t test. Categorical data were compared using the chi-square test. The Mann-Whitney U test was used to compare nonparametric variables. A p-value of less than 0.05 was considered statistically significant.

Results

Comparison of the Demographic and Clinical Characteristics of Patients between TI Group and PI group

There were 356 patients admitted to the study during the study period. 137 patients met one or more exclusion criteria. Of the remaining 219 patients, 142(64.8%) patients were intubated by trauma surgeons (the TI group), and 77 (35.2%) patients were intubated by anesthesiologists (the AI group). The mean age of patients was 45 years and 64% were male. Traffic related injuries were the main mechanism of injury. There were no significant statistical differences between the groups in age, gender, mechanism of injury, admission GCS, ISS, admission SBP, admission HR, admission RR, admission SpO2, admission PO2, admission PCO2 and type of intracranial lesion (Table 1).

Comparison of endotracheal intubation between TI group and AI group

There were no significant statistical differences between the two groups in endotracheal intubation time and 1-min success rate of intubation. There were 9 patients with intubation related complications in the TI group, and 3 patients with intubation related complications in the AI group. There was no statistical difference between the two groups. The time from arrival at hospital to intubation in the TI group significantly lower than the AI group [(19.5±9.3 min) vs (31.7±13.2 min); p<0.01] (Table 2).

Comparison of the outcome of patients between TI group and AI group

The incidence of aspiration pneumonia in the TI group were significantly lower than the AI group [7.8% vs 18.2%; (p=0.02)]. Compared with the AI group, the mechanical ventilation time [3(1–46) vs 4(1–58); p=0.02] in the TI group were obviously decrease. 30-day mortality was lower in TI group (21.8% versus 28.6%, □ = 0.32), but there were no significant statistical differences (Table 3).

Variables	TI group (n=142)	AI group (n=77)	P value
Age (mean ± SD) (years)	45.2±14.5	46.5±15.1	0.53
Gender (male/ female)	89/53	51/26	0.66
Mechanism of injury			0.72 for all
Traffic related injuries (%)	74.6	70.1	
Fall from height (%)	12	10.4	
Fall of heavy object (%)	2.1	5.2	
Blow or assault (%)	6.3	7.8	
Other (%)	5	6.5	
GCS	6 (3-8)	5 (3-8)	0.84
ISS	22.5±7.6	23.1± 8.8	0.6
Admission SBP (mmHg)	151.4±43.7	154.2±46.5	0.66
Admission HR(beats/ minute)	97.6±31.8	98.9±33.3	0.78
Admission RR (beats/minute)	22.1±8.2	21.3± 9.5	0.52
Admission SpO2 (%)	93.8±25.1	93.1± 28.4	0.86
Admission PO2 (mmHg)	117.2±41.4	111.6±44.5	0.35
Admission PCO2 (mmHg)	40.6±11.1	42.4±11.9	0.27
Type of intracranial lesion			0.91 for all
Subdural hematoma (%)	17.6	14.3	
Epidural hematoma (%)	21.8	24.7	
Cerebral contusion (%)	44.4	45.5	
Intracerebral hemorrhage (%)	16.2	15.5	

GCS: Glasgow coma scale; ISS: injury severity score; SBP: systolic blood pressure; HR: Heart rate; RR: Respiratory rate

Table 1: Comparison of the demographic and clinical characteristics of patients between TI group and PI group.

Variables	TI group (n=142)	AI group (n=77)	P value
Endotracheal intubation time (s)	27.5 ± 7.1	25.1 ± 6.7	0.02
1-min success rate of intubation (%)	94.4	96.1	0.75
Intubation related complications, n	9	3	0.55
The time from arrival at hospital to intubation (min)	19.5 ± 9.3	31.7 ± 13.2	<0.01

Table 2: Comparison of endotracheal intubation between TI group and AI group.

Variables	TI group (n=142)	AI group (n=77)	P value
Aspiration pneumonia, n (%)	11(7.8)	14(18.2)	0.03

Mechanical ventilation time (d)	3(1-46)	4(1-58)	0.02
30-day mortality, n (%)	31(21.8)	23(28.6)	0.32

Table 3: Comparison of the outcome of patients between TI group and AI group.

Discussion

We undertook this prospective observational cohort study of endotracheal intubation in emergency resuscitation room to study effect of endotracheal intubation respectively performed by trauma surgeons and anesthesiologists on patients with STBI. We found that endotracheal intubation time, 1-min success rate of intubation and intubation related complications in the two groups had no significant statistical differences. The time from arrival at hospital to intubation in the TI group significantly lower than the AI group. Because the patients with STBI were intubated earlier by trauma surgeons, the incidence of aspiration pneumonia and the mechanical ventilation time in the TI group were significantly lower than the AI group. However, early intubation could not obviously reduce hospital mortality.

The patients with STBI in the state of consciousness disorder are often accompanied with glossopteris, swallowing and coughing reflex significantly weakened or disappeared. Oral secretions, vomitus, traumatic bleeding or cerebrospinal fluid leakage can be inhaled into the airway and cause respiratory obstruction, which further leads to hypoxemia and hypercapnia.[6] In the acute phase of STBI, it is very important to prevent hypoxemia and hypercapnia as early as possible, because these factors may initiate pathophysiological mechanisms leading to secondary injury.[7] The relationship between intracranial hypertension caused by STBI and hypoxemia is a vicious circle. STBI causes brain swelling and intracranial hypertension, which leads to respiratory depression and aggravating hypoxemia. Hypoxemia promotes progressive damage of brain cells and tissues, aggravates brain swelling, and further increases intracranial pressure. Meanwhile, hypoxemia also aggravates the damage of cardiovascular and pulmonary tissues, leading to hypotension and acute respiratory distress syndrome (ARDS).[8] Hypoxemia causes erosion and bleeding of gastrointestinal mucosa, destruction of intestinal mucosal barrier, intestinal bacteria and endotoxin translocation into the blood, which induces systemic inflammatory mediators waterfall reaction and damage of free radicals to the body, results in systemic inflammatory response syndrome (SIRS), causes extensive tissue damage and ultimately leads to multiple organ dysfunction syndrome (MODS). The adverse effect of hypoxemia on the outcome of patients with STBI has been demonstrated in many studies.[9-11]

Airway control is the first priority in the management of the patients with STBI who are accompanied by insufficient or absent breathing. Endotracheal intubation is not only the most rapid and effective method to maintain airway patency, but also can provide oxygen, maintain ventilation and reduce the risk of aspiration.[12] Recognizing the importance of airway control, the Eastern Association for the Surgery of Trauma (EAST) published indications for early intubation in trauma patients. The EAST indications include cardiac arrest, airway obstruction, severe hypoxemia, hypoventilation, severe hemorrhagic shock and severe cognitive impairment (GCS <9).[13] The Glasgow Coma Scale (GCS) is a valuable tool for assessing TBI, and an updated version is endorsed in the ATLS -10.[14] The patients with STBI require early endotracheal intubation.[15] However, endotracheal intubation is performed by anesthesiologists in most hospitals. When a patient needs intubation, the emergency surgeon will invite anesthesiologist to intubate and the anesthesiologist rush from the anesthesiology department to the emergency resuscitation room. This process takes about 10 minutes.

At present, there is no research to study the effect of endotracheal intubation respectively performed by trauma surgeons and anesthesiologists on patients with STBI except our study. From our research, we can find that the trauma surgeons can master endotracheal intubation skills through standardized training, and the intubation effect is not significantly different from that of anesthesiologists. Moreover, endotracheal intubation by trauma surgeons allows the patients with STBI to be intubated earlier and reduce the incidence of aspiration pneumonia and the mechanical ventilation time. Although there is no specific comparative study on endotracheal intubation performed by trauma surgeons, there are comparative studies on endotracheal intubation between emergency physicians and anesthesiologists. An earlier census of UK emergency departments found almost 80% of intubations were performed by anesthesiologists, but emergency physicians performed almost three-quarters of intubations in Dean Ker slake study.[16, 17] Emergency physicians achieved similar laryngoscope views but lower initial intubation success rates than anesthesiologists over the 13-year period of their review. However, since 2007 the difference in initial success rate is no longer apparent (first time successful intubation: anesthesiologists 88%, emergency physicians 87%, p = 0.909). These figures suggest emergency physicians are now better at intubation than previously through training, and anesthesiologists are now involved more frequently in initial attempts where intubation is anticipated to be difficult. Around 95% of practitioners in their study had spent at least three months in formal anesthesia related training. This may help to explain the intubation success rate for emergency physicians.[17]

Successful airway management is a critical skill in emergency departments .[18] At present, the majority of emergent intubations in emergency departments (EDs) are managed by emergency physicians using rapid-sequence intubation, with success rates as high as 99%.[19, 20] Because of the popularity of video laryngoscope and the standardized training of anesthesia intubation, the trauma surgeons have been skilled in endotracheal intubation technology, and there are no significant differences in intubation success rate and intubation related complications between anesthesiologists and trauma surgeons. The idea that trauma is a time-dependent disease is widely accepted by trauma medical workers. In the emergency treatment of patients with severe trauma, we must recognize

the relationship between the effect of first aid and time. "Time is life, time is speed" explains the general requirements of traumatology.[21,22] For patients with severe trauma, intubation by the emergency surgeon can allow the patient to be intubated earlier, so that patients can get earlier airway protection and prevent hypoxemia and hypercapnia.

This study found that the hospital mortality of the TBI in two groups had no significant statistical differences. There are many factors that affect the mortality of the patients with STBI, such as age, admission GCS score, intracranial hematoma volume, intracranial hematoma location, surgical operation method, related complications (hypernatremia, hyperthermia, gastrointestinal bleeding, multiple organ failure, etc.).[23, 24] So earlier endotracheal intubation cannot significantly affect the hospital mortality.

Conclusions

The trauma surgeons can master endotracheal intubation skills through standardized training, and the success rate of intubation is not significantly different from that of anesthesiologists. Moreover, endotracheal intubation by trauma surgeons allows the patients with STBI to be intubated earlier and reduce the incidence of aspiration pneumonia and the mechanical ventilation time. So early intubation is beneficial for the patients with STBI, and trauma surgeons should be encouraged to master endotracheal intubation skills.

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