Clinical Research Report

Journal of INTERNATIONAL MEDICAL RESEARCH

Journal of International Medical Research
2019, Vol. 47(4) 1565–1572

DOI: 10.1177/0300060518822243
journals.sagepub.com/home/imr
SAGE

Application of second-generation Shikani optical stylet in critically ill patients undergoing cerebral aneurysm embolization

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Abstract

Objective: This study was performed to compare the clinical value of the second-generation Shikani optical stylet with that of the Macintosh laryngoscope for tracheal intubation of patients undergoing cerebral aneurysm embolization.

Methods: Thirty-six patients who underwent cerebral aneurysm embolization were included. The intubation time, intubation success rate, blood oxygen saturation, heart rate, systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured. Adverse reactions during tracheal intubation and the local tissue injury rate were recorded. Comparisons between the groups were performed with one-way analysis of variance.

Results: The heart rate, SBP, and DBP upon tracheal intubation and at 1 and 3 minutes were significantly higher in the Macintosh laryngoscope group than in the Shikani optical stylet group. The time to completion of tracheal intubation was significantly shorter and the tissue injury rate was significantly lower in the Shikani optimal stylet group than in the Macintosh laryngoscope group.

Conclusions: The second-generation Shikani optical stylet is a simple, safe, and reliable tool for tracheal intubation in critically ill patients undergoing cerebral aneurysm embolization.

Keywords

Optical stylet, cerebral aneurysm embolization, critically ill patients, Macintosh laryngoscope, tracheal intubation, tissue injury rate

Date received: 9 July 2018; accepted: 7 December 2018

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Introduction

Subarachnoid hemorrhage due to a ruptured cerebral aneurysm is a common brain disease[1] caused primarily by congenital factors, cerebral arteriosclerosis, and brain trauma. For critically ill patients undergoing cerebral aneurysm embolization, vital signs must be kept stable throughout the perioperative period because a severe fluctuation in hemodynamics may have a serious impact on the procedure outcome for such patients and may even be fatal.[2] Interventional embolization and craniotomy clipping surgery are two common surgical operations for the treatment of cerebral aneurysms.[3,4] In both operations, blood vessels are blocked, causing insufficient blood and oxygen supply to tumors, resulting in their gradual shrinkage or disappearance. However, patients must be anesthetized before both operations. The incidence of cerebral aneurysm rupture caused by tracheal intubation during anesthetic induction is 1% to 2%.[5]

Tracheal intubation is closely related to the anatomy of the nasopharynx, oropharynx, laryngopharynx, and trachea. Brevicollis, micromandible, macroglossia, and other abnormal anatomical structures often result in incomplete alignment of the axes of the mouth, pharynx, and throat during tracheal intubation, leading to difficult airway.[6,7] The success of tracheal intubation directly affects the outcome of surgical operations; however, it may cause a significant stress response, leading to severe fluctuations in hemodynamics and intracranial pressure, especially in patients with difficult airway.[8] The focus of anesthesia management in cerebral aneurysm embolization is the avoidance of adverse effects such as cough, body movement, and severe hemodynamic fluctuations[9] because while these adverse effects may be ordinary in other procedures, they may be fatal for patients undergoing cerebral aneurysm embolization.

Controversial results have been obtained from studies that compare the ease of operation, success rate, likelihood of throat injury, and changes in hemodynamics between the Macintosh laryngoscope and Shikani optical stylet (Clarus Medical LLC, Minneapolis, MN, USA) during tracheal intubation.[10] Compared with the first-generation Shikani optical stylet, the second-generation version does not rely on spot positioning but instead relies on an external video display that is more intuitive, reliable, and convenient for exposure and observation of the pharynx, larynx, and glottis.[11]

In the present study, the intubation time, intubation success rate, blood oxygen saturation (SpO_2), heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP) were measured before tracheal intubation (T_0), upon tracheal intubation (T_1), and at 1 minute (T_2), 3 minutes (T_3), and 5 minutes (T_4) after tracheal intubation. Adverse reactions during tracheal intubation, the local tissue injury rate, and the time to intubation completion were recorded and compared between patients who underwent intubation with the Shikani optical stylet (Group A) and those who underwent intubation with the Macintosh laryngoscope (Group B). The goal was to assess the clinical value of the second-generation Shikani optical stylet during tracheal intubation of critically ill patients undergoing cerebral aneurysm embolization.

Materials and methods

Drugs

The following drugs were used in the present study: remifentanil hydrochloride (Yichang Humanwell Pharmaceutical Co., Ltd., Yichang, Hubei, China), cisatracurium besilate (Zhejiang Xianju Pharmaceutical Co., Ltd., Taizhou, Zhejiang, China), propofol (Beijing Fresenius Kabi

Pharmaceutical Co., Ltd., Beijing, China), etomidate (Jiangsu Hengrui Medicine Co., Ltd., Lianyungang, Jiangsu, China), ephedrine (Chifeng Addisun Pharmaceutical Co., Ltd., Chifeng, China), sevoflurane (Shandong New Time Pharmaceutical Co., Ltd., Linyi, Shandong, China), phenylephrine (Shanghai Harvest Pharmaceutical Co., Ltd., Shanghai, China), urapidil (Guangdong Kingho Pharmaceutical R&D Co., Ltd., Guangdong, China), and atropine (Hubei Jiuzhoukangda Technology Co., Ltd., Hubei, China).

Machinery and equipment

In this study, we used a Shikani optical stylet, type 30000-v (Clarus Medical LLC) (Figure 1), a Macintosh Laryngoscope (Truphatek, Netanya, Israel), and a vein pump (Shanghai Taiyi Medical Apparatus Equipment Co., Ltd., Shanghai, China).

Figure 1. The Shikani optical stylet.

Patients

Patients who underwent cerebral aneurysm embolization in the emergency department of our hospital from January 2015 to October 2016 and had a thyromental distance of $\geq$6.5 cm were included in this study after approval from the ethics committee of the hospital was obtained. The patients were randomly assigned to Group A or Group B with an equal number of patients in each group. The study was approved by the Ethics Committee of The Second Clinical Medical College of Jinan University, Shenzhen People's Hospital. Every procedure was approved by our hospital and was performed in conformity with the guidelines of the National Institute of Health (No. 81004). All patients provided written informed consent before participating in the study.

Anesthesia method

According to routine practice, all patients fasted before surgery and were administered preoperative medication. Electrocardiography, HR, SpO_2, end-tidal carbon dioxide, SBP, and DBP of the left radial artery were continuously monitored after the patients were sent to the operating room. Anesthesia was induced with a solution of fentanyl (2.5 μg/kg), cisatracurium besilate (0.2 mg/kg), propofol (1.0 mg/kg), and etomidate (0.2 mg/kg). Tracheal intubation was performed after 4 minutes of assisted ventilation. The Shikani optical stylet was used for tracheal intubation in Group A, while the Macintosh laryngoscope was used in Group B. Tracheal intubation for both groups was performed by the same anesthesiologist, who was skilled at using both intubation tools. An anesthesia machine was used for mechanical ventilation during surgery. After inhalation of sevoflurane (1.0%–1.5%), the patients were given propofol (1.5–2.0 mg/kg/h) and remifentanil (0.05 μg/kg/minute) via intravenous pump

Table 1. Comparison of general information between the two groups.

Group	n	Age (years)	Sex		Height (cm)	Weight (kg)
			Male	Female		
A	18	51.7 ± 6.6	8	8	168.3 ± 7.7	66.2 ± 6.1
B	18	52.6 ± 7.1	10	10	165.9 ± 8.2	65.3 ± 6.7

Data are presented as n or mean ± standard deviation.
Group A, Shikani optimal stylet group; Group B, Macintosh laryngoscope group.

infusion. If their blood pressure during anesthesia was 20% lower than that at baseline, ephedrine (6 mg) was administered; if their blood pressure was continuously low, an intravenous drip of phenylephrine (60–100 μg) was given; if their HR was <50 beats/minute, atropine (0.3 mg) was administered; and if their blood pressure was 20% higher than that at baseline, urapidil (7.5–10 mg) was administered.

Outcome measures

The intubation time, intubation success rate, SpO_2, HR, SBP, and DBP were measured at T_0, T_1, T_2, T_3, and T_4. Adverse reactions during tracheal intubation and the local tissue injury rate were recorded and compared between the two groups.

Statistical analysis

SPSS13.0 statistical software (SPSS Inc., Chicago, IL, USA) was used for the statistical analyses. Continuous variables are shown as mean ± standard deviation, and categorical variables were compared with the chi-square test. Comparisons between the two groups were performed with one-way analysis of variance, and $P < 0.05$ was considered statistically significant.

Results

General information

Thirty-six patients were included in this study (Group A, n = 18; Group B, n = 18). All patients had a Hunt and Hess grade of III or IV, underwent whole cerebral angiography, had a Glasgow coma scale score of 7 or 8 points, and had an American Society of Anesthesiologists physical status of 3 or 4. The patients ranged in age from 56 to 72 years. There was no significant difference in age, sex, height, or weight between the two groups, as shown in Table 1.

Hemodynamic changes

There was no significant difference in SpO_2, HR, SBP, or DBP at T_0 between the two groups. The HR, SBP, and DBP at T_1, T_2, and T_3 were significantly higher in Group B than A ($P < 0.05$). The HR, SBP, and DBP at T_4 were higher in Group B than A, but the differences were not statistically significant (Table 2).

Adverse reaction rate, intubation success rate, intubation time, and local tissue injury rate

As shown in Table 3, the overall adverse reaction rate was significantly lower in Group A than B ($P < 0.05$). The intubation success rate was defined as the ratio of patients for whom successful tracheal intubation was achieved at the first attempt. The two groups differed slightly in the intubation success rate, but the difference was not statistically significant. The intubation time was significantly shorter in Group A than B ($P < 0.05$), as shown in Table 4. Finally, the tissue injury rate was

Table 2. Comparison of intraoperative hemodynamic parameters between the two groups.

Parameter	Group	T0	T1	T2	T3	T4
SpO_2 (%)	A	92.6 ± 3.7	98.9 ± 1.5	99.0 ± 1.5	99.0 ± 1.6	97.6 ± 2.4
	B	93.1 ± 4.0	99.1 ± 1.3	98.8 ± 1.6	98.9 ± 1.5	98.0 ± 2.1
SBP (mmHg)	A	146.6 ± 9.0	151.7 ± 13.1	130.2 ± 9.0	119.3 ± 8.2	110.3 ± 8.2
	B	144.3 ± 9.3	169.6 ± 12.7*	147.4 ± 8.6*	136.4 ± 8.4*	109.4 ± 7.9
DBP (mmHg)	A	89.3 ± 8.9	97.5 ± 7.3	89. 8 ±6.6	81.2 ± 7.0	71.6 ± 5.1
	B	88.1 ± 8.4	109.8 ± 8.0*	99.9 ± 5.9*	90.9 ± 6.5*	72.0 ± 6.0
HR (beats/minute)	A	85.4 ± 6.7	112.6 ± 8.8	95.4 ± 8.6	80.4 ± 6.6	79.4 ± 7.7
	B	86.8 ± 7.0	129.3 ± 9.7*	110.8 ± 8.2*	91.8 ± 7.2*	82.0 ± 7.3

Data are presented as mean ± standard deviation.
Group A, Shikani optimal stylet group; Group B, Macintosh laryngoscope group; SpO_2, blood oxygen saturation; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.
*$P < 0.05$ compared with Group A.

Table 3. Comparison of intubation success rate and adverse reaction rate between the two groups.

Group	Intubation success rate	Irritating cough	Restlessness	Loose teeth	Laryngeal spasm
A	18 (100.0)	1 (5.6)	0 (0.0)	0 (0.0)	0 (0.0)
B	17 (93.3)	3 (16.7)*	1 (5.6)	2 (11.1)	1 (5.6)

Data are presented as n (%).
Group A, Shikani optimal stylet group; Group B, Macintosh laryngoscope group.
*$P < 0.05$ compared with Group A.

Table 4. Comparison of time to completion of tracheal intubation between the two groups.

Group	Patients	Time to completion of tracheal intubation (s)
A	18	30.7 ± 3.9
B	18	49.6 ± 8.4*

Data are presented as n or mean ± standard deviation.
Group A, Shikani optimal stylet group; Group B, Macintosh laryngoscope group.
*$P < 0.05$ compared with Group A.

Table 5. Comparison of local tissue injury rate between the two groups.

Group	Patients, n	Number of patients with tissue injury	Ratio
A	18	3	16.7%*
B	18	6	33.3%

Group A, Shikani optimal stylet group; Group B, Macintosh laryngoscope group.
*$P < 0.05$ compared with Group A.

significantly lower in Group A than B ($P < 0.05$), as shown in Table 5.

Discussion

Tracheal intubation is an extremely important step for critically ill patients undergoing cerebral aneurysm embolization because its success directly affects the patients' outcome.[11] A tracheal intubation-induced stress response will inevitably lead to changes in blood pressure and HR and will increase the intracranial pressure. Additionally, although no cerebral aneurysm rupture due to tracheal

intubation occurred in the two groups of the present study, other studies have confirmed that severe hemodynamic fluctuations may cause cerebral aneurysms to rupture at any time.[7,12] A tracheal intubation-induced stress response is generally related to laryngoscope exposure, tracheal intubation operating techniques, narcotics, underlying diseases, and many other factors. In particular, direct stimulation of the oral, pharyngeal, and laryngeal tissue by the laryngoscope may induce a stress response, increase catecholamine levels, and cause a series of hemodynamic changes. Such hemodynamic changes can become more significant with prolonged operating times, and this is an important cause of tracheal intubation-induced cardiovascular stress responses.[13,14] Therefore, reducing stimulation of the epiglottis and its surrounding tissue by the laryngoscopic lens, shortening the intubation time, and reducing adverse reactions during intubation are critical for alleviating tracheal intubation-induced stress responses.

A good tracheal intubation tool and/or method for critically ill patients undergoing cerebral aneurysm embolization reduces not only the incidence of the tracheal intubation-induced stress response but also the incidences of hypoxia, carbon dioxide accumulation, and possible tissue and organ injuries during intubation,[15,16] thereby improving patient outcomes. The second-generation Shikani optical stylet is a new tracheal intubation tool that results in fewer intubation-induced injuries, allows for direct visualization, is convenient to use, and provides simple intubation conditions. In particular, it can be employed in patients with unexpectedly difficult airways, thereby providing a strong guarantee for an improved intubation success rate while reducing complications.[17] Compared with the traditional Macintosh laryngoscope, the J-shaped lens body of the second-generation Shikani optical stylet is an optical fiber coated with stainless steel and can be bent and shaped to a certain degree. During tracheal intubation, it enables the surgeon to progressively look for the glottis and trachea from the mouth and pharynx, then insert the tracheal catheter into the trachea with the aid of the images shown on an external video display. In this way, intubation is efficient, simple, safe, and accurate.[18,19] The glottis can be clearly exposed without strenuously lifting the laryngoscope throughout intubation, significantly reducing the damage to the epiglottis and its surrounding tissue, reducing the difficulty of tracheal intubation, shortening the intubation time, and reducing unnecessary injury.

The results of this study indicate that the second-generation Shikani optical stylet is a simple, safe, and reliable tool for tracheal intubation in critically ill patients undergoing cerebral aneurysm embolization. The hemodynamic fluctuations upon intubation and at 1 and 3 minutes after intubation in Group A were significantly smaller than those in Group B, while there was no significant difference in the hemodynamic indicators 5 minutes after intubation between the two groups. In addition, the intubation time in Group A was significantly shorter than that in Group B, while the overall adverse reaction rate in Group B was significantly higher than that in Group A. The participants in this study were critically ill patients undergoing cerebral aneurysm embolization, and the sample size was limited. The patients were not grouped according to their difficulty of intubation because they were critically ill and required extremely smooth anesthesia. Due to the above limitations, this study could not provide a more comprehensive evaluation of the advantages of the second-generation Shikani optical stylet. However, this study demonstrated some of the beneficial functions of the second-generation Shikani optical stylet.

The second-generation Shikani optical stylet is simpler and easier to operate than its first-generation predecessor. The learning curve of the Shikani optical stylet is reportedly short. New resident physicians in anesthesiology departments can master the skills required to operate this stylet after seven attempts at tracheal intubation,[18] which is very conducive to clinical promotion of the product. It is important to emphasize that anesthesiologists using the second-generation Shikani optical stylet for tracheal intubation in critically ill patients undergoing cerebral aneurysm embolization must be familiar with throat anatomy and proficient in manipulation of the tool; otherwise, its use may be counterproductive.

In summary, the second-generation Shikani optical stylet offers great advantages and clinical practicability in reducing tracheal intubation-induced injury, stress responses, and adverse reactions in critically ill patients undergoing cerebral aneurysm embolization. The use of this stylet can effectively protect patients undergoing tracheal intubation during anesthesia induction.

Author contributions

Xicheng Liu performed the experimental work, designed the study, analyzed the data, wrote and revised the manuscript, and reviewed and approved the final manuscript. Yaoxian Zhang, Zhanli Liu, Qiuli Zhang, Wenyan Wu, and Zihao Zheng jointly conducted the experimental study and reviewed and approved the final manuscript. Zhongjun Zhang designed the study, wrote and revised the manuscript, reviewed and approved the manuscript before submission, and read and approved the final manuscript.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Funding

This work was supported by the Shenzhen Science and Technology Innovation Committee funded project (grant number JCYJ20140416122812031).

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