Original Article

Evaluation of Endotracheal Intubation with a Flexible Fiberoptic Bronchoscope in Lateral Patient Positioning: A Prospective Randomized Controlled Trial

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Abstract

Background: There is an unmet need for a reliable method of airway management for patients in the lateral position. This prospective randomized controlled two-center study was designed to evaluate the feasibility of intubation using a flexible fiberoptic bronchoscope in the lateral position during surgery.
Methods: Seventy-two patients scheduled for elective nonobstetric surgery in the lateral decubitus position requiring tracheal intubation under general anesthesia at Lishui Central Hospital of Zhejiang Province and Jiaxing First Hospital of Zhejiang Province from April 1, 2015, to September 30, 2015, were enrolled in this study. Patients were randomly assigned to the supine position group (Group S, $n = 38$) and the lateral position group (Group L, $n = 34$). Experienced anesthetists performed tracheal intubation with a fiberoptic bronchoscope after general anesthesia. The time required for intubation, intubation success rates, and hemodynamic changes was recorded. Between-group differences were assessed using the Student's *t*-test, Mann–Whitney *U*-test, or Chi-square test.
Results: The median total time to tracheal intubation was significantly longer in Group S (140.0 [135.8, 150.0] s) compared to Group L (33.0 [24.0, 38.8] s) ($P < 0.01$). The first-attempt intubation success rate was significantly higher in Group L (97%) compared to Group S (16%). Hemodynamic changes immediately after intubation were more exaggerated in Group S compared to Group L ($P = 0.02$).
Conclusion: Endotracheal intubation with a flexible fiberoptic bronchoscope may be an effective and timesaving technique for patients in the lateral position.
Trial Registration: Chinese Clinical Trial Register, ChiCTR-IIR-16007814; http://www.chictr.org.cn/showproj.aspx?proj=13183.

Key words: Airway Management; Bronchoscope; Intubation; Patient Positioning

Introduction

Anesthesiologists may encounter situations in which a accidental loss of airway patency occurs in patients in a lateral patient position during surgery. Intubation is required in the lateral position in cases of oropharyngeal bleeding to reduce the risk of aspiration, or in airway management in some patients with limited posture.[1,2] Previous studies have revealed that intubation with direct laryngoscopy is more difficult and time-consuming in patients in the lateral compared to the supine position, especially when there is a sudden loss of airway patency.[3,4] These observations suggest that there is an unmet need for a reliable method of airway management for patients in the lateral position.

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Fiberoptic intubation (FOI) was first described in the late 1960s and has since become an effective and well-established technique for airway management in awake, sedated, and anesthetized patients. FOI is especially useful in patients with known or suspected difficult airways such as those with an elevated risk for aspiration, cervical spine injury, limited mouth opening, reduced neck mobility, or obesity.[5] The benefits of FOI also include fewer complications such as tooth injury and oropharyngeal bleeding; and the opportunity for optimal positioning of double-lumen tubes in patients undergoing thoracic surgery. Accordingly, we propose that FOI has clinical application in patients constrained in the lateral decubitus position. Therefore, we evaluated the efficacy and safety of endotracheal intubation using a flexible fiberoptic bronchoscope in patients in the lateral position.

Methods

Trial design

A prospective randomized controlled two-center study of intubation in the supine or lateral position was conducted in two tertiary hospitals (Lishui Central Hospital of Zhejiang Province and Jiaxing First Hospital of Zhejiang Province) from April 1, 2015, to September 30, 2015 (Chinese Clinical Trial Register, ChiCTR-IIR-16007814). The study was approved by the Ethics Committee of the First Affiliated Hospital of Zhejiang University. Written informed consent was provided by all patients or their immediate relatives. To ensure the consistency, all the three anesthesiologists were simultaneously trained and one of them (Hui Li) took a supervisory role during the intubation of every patient at the two centers.

Patients

A total of 103 patients were assessed for eligibility. Exclusion criteria included: patients with a history of poor cardiopulmonary function, coronary artery disease, asthma, or cerebrovascular disorders; American Society of Anesthesiologists (ASA) ≥III; and patients undergoing lung surgery using a double-lumen endobronchial tube. The patients were randomly assigned to the supine position group (Group S) and the lateral position group (Group L) according to a random number table provided by an independent statistician. General anesthesia was administered by the specified anesthesiologist at each hospital.

Procedure

All patients underwent a ≥8 h preoperative fast. Preoperative medication was not administered. Patients were subjected to standard heart rate (HR), noninvasive blood pressure, and pulse oximetry monitoring in the operating room. Then, they were positioned in the lateral or supine position according to their group designation. This position was maintained during induction of anesthesia and intubation. Following adequate preoxygenation using 100% oxygen via a face mask for 3 min, general anesthesia was administered via an intravenous injection of 2 mg midazolam, 1–2 mg/kg propofol, 0.4–0.6 μg/kg sufentanil, and neuromuscular blockade with 0.2 mg/kg cisatracurium besylate. After confirming ease of mask ventilation, the patients' heads and necks were maintained in the neutral or relatively extended position supported by a pillow. A suction tube was used to clear patients' oropharyngeal secretions, and a bite-block was positioned on one of the premolars. An experienced anesthetist, who stood at the head of operating table, performed intubation using a flexible fiberoptic bronchoscope (TIC-SC-II, UE Medical, Taizhou, Zhejiang, China) following standard procedures [Supplementary Video Material 1], without manipulating the mandibular angle or assistance from other health-care professionals or tools. Patients' head and neck positions were adjusted as needed. To maximize patient safety, attempts at intubation that took >120 s were considered failures. After the first unsuccessful intubation attempt, an assistant immediately manipulated the mandibular angle to facilitate reintubation. If the attempt at reintubation failed, the patient was immediately placed in the supine position and intubated by conventional laryngoscopy. If oxygen saturation (SpO_2) dropped to 95%, intubation was suspended, and patients were immediately oxygenated by face mask.

Study outcomes

The primary outcomes were intubation time and intubation success rate. Secondary outcomes included mean arterial blood pressure (MAP), pulse oximetry saturation (SpO_2), and HR at different time points. Patient demographic and clinical characteristics were documented. Intubation time was measured using a stopwatch; each failed intubation attempt was recorded as 120 s. Hemodynamic stability was assessed based on MAP, SpO_2, and HR, which were measured at the following time intervals: before induction of anesthesia at baseline (BA), after induction of anesthesia but before tracheal intubation (T1), and immediately after successful intubation (T2). Patients were followed up for 24 h after surgery. Perioperative side effects and complications were noted.

Statistical analysis

Based on our previous experience of a 26.7% intubation success rate in the supine position and 100% intubation success rate in the lateral position, a sample size of 16 participants (8 per group) would be required to have 90% power, assuming a Type 1 error of 5%. Assuming 10% of participants would drop out, a minimum sample size of 18 participants was established. To achieve clinical significance and generalizability, we conducted this trial at each hospital for 3 months.

All analyses were conducted using the SPSS 17.0 for Windows (SPSS, Inc., Chicago, IL, USA). Data are presented as mean ± standard deviation (SD), median (Q_1, Q_3), or the percentage. Between-group differences were evaluated using the *t*-test for normally distributed continuous variables, the Mann–Whitney *U*-test for nonnormal continuous variables, and the Chi-square test for categorical variables. $P < 0.05$ was considered statistically significant.

Results

Of the 103 patients, 31 patients (2 for asthma, 18 for ASA ≥III, 11 for undergoing lung surgery using a double-lumen endobronchial tube) were excluded. Finally, 72 patients (male, $n = 24$; female, $n = 48$; age, 23–77 years) (ASA Grade I and II) scheduled for elective nonobstetric surgery in the lateral decubitus position requiring tracheal intubation under general anesthesia were enrolled in this study.

Demographic and clinical characteristics including age, gender distribution, body weight, and height were similar between Group S ($n = 38$ patients; male, $n = 12$; female, $n = 26$) and Group L ($n = 34$ patients; male, $n = 12$; female, $n = 22$) [Table 1]. All patients received mask ventilation with no complications.

Median total time to tracheal intubation was significantly longer in Group S (140.0 [135.8, 150.0] s) compared to Group L (33.0 [24.0, 38.8] s) ($P < 0.01$). The median intubation time on the first attempt was significantly longer in Group S (120.0 [120.0, 120.0] s) compared to Group L (33.0 [24.0, 38.8] s) ($P < 0.01$). The median intubation time on the second attempt was also significantly longer in Group S (20.0 [15.8, 30.0] s) compared to Group L (0 [0, 0] s) $P < 0.01$) [Table 2].

Table 1: Basic characteristics of patients undergoing endotracheal intubation in supine or lateral position

Items	Group S ($n = 38$)	Group L ($n = 34$)	Statistics	P
Female/male	26/12	22/12	0.11*	0.81
Age (years)	52.6 ± 12.3	50.5 ± 12.3	0.72†	0.47
Height (cm)	160.7 ± 7.6	160.5 ± 6.5	0.11†	0.91
Weight (kg)	60.8 ± 9.8	63.2 ± 10.7	−0.99†	0.33

*χ^2 values, †t values. Data were shown as n or mean ± SD. Group S: Intubation with flexible fiberoptic bronchoscope in the supine position; Group L: Intubation with flexible fiberoptic bronchoscope in the lateral position; SD: Standard deviation.

The first-attempt intubation success rate was 97% in Group L and 16% in Group S. Nearly 84% of patients in Group S required reintubation after an unsuccessful first attempt, while only one patient required reintubation in Group L. When an assistant manipulated the mandibular angle, all patients were successfully intubated [Table 2].

MAP and HR gradually declined from BA to T1 and increased rapidly from T1 to T2 in all patients [Table 3]. There were no significant differences in MAP or HR between patients in Group S and Group L at BA and T1 ($P > 0.05$); however, MAP and HR were significantly higher in Group S than in Group L at T2 ($P = 0.02$) [Table 3].

SpO_2 remained >95% during induction of anesthesia and intubation in all patients. No patients experienced complications such as oral mucosal bleeding, dental injuries, or lacerations.

Discussion

This prospective randomized controlled trial showed that tracheal intubation with a flexible fiberoptic bronchoscope resulted in a shorter time to intubate and a higher first-attempt intubation success rate, as well as hemodynamic stability during intubation, with lateral patient positioning compared to supine patient positioning. In addition, this approach is simple and does not require displacing the mandibular angle or assistance from other health-care professionals. In contrast, direct larygoscopy is challenging with lateral patient positioning.[4,6] Tracheal intubation in the lateral position is necessary and desirable under certain circumstances. Endotracheal intubation with a flexible fiberoptic bronchoscope may be a simple, safe, and timesaving technique in surgical patients in the lateral position.

The shorter time to intubate with the flexible fiberoptic bronchoscope with lateral patient positioning compared to supine patient positioning may be due to the effect of gravity. Anesthesia administration in the supine position causes a patient's tongue and soft tissue of the throat to sag downward, which can obstruct the operator's view and the forward motion of a flexible fiberoptic bronchoscope.[7] The improvement in the intubation success rate reported in the

Table 2: Time to intubate and intubation success rate in patients undergoing endotracheal intubation in supine or lateral position

Items	Group S ($n = 38$)	Group L ($n = 34$)	Statistics	P
Intubation time (s)				
All attempts	140.0 (135.8, 150.0)	33.0 (24.0, 38.8)	−6.44*	<0.01
The first attempt	120.0 (120.0, 120.0)	33.0 (24.0, 38.8)	−6.79*	<0.01
The second attempt	20.0 (15.8, 30.0)	0 (0, 0)	−6.29*	<0.01
Success rate, % (n/N)				
All attempts	100 (38/38)	100 (34/34)	-	-
The first attempt	16 (6/38)	97 (33/34)	47.74†	<0.01
The second attempt	100 (32/32)	100 (1/1)	-	-

*Z values; †χ^2 values. Data were shown as median (Q_1, Q_3) or percentage. Group S: Intubation with flexible fiberoptic bronchoscope in the supine position; Group L: Intubation with flexible fiberoptic bronchoscope in the lateral position; -: Not applicable.

Table 3: MAP, HR, and SpO_2 during induction of anesthesia and intubation in patients undergoing endotracheal intubation in supine or lateral position

Items	Group S (n = 38)	Group L (n = 34)	Statistics	P
MAP (mmHg)				
BA	97.7 ± 15.2	100.0 ± 14.5	−0.66*	0.51
T1	81.6 ± 17.4	76.0 ± 18.8	1.32*	0.19
T2	100.4 ± 23.4	88.5 ± 17.7	2.45*	0.02
△T	18.8 ± 21.4	12.5 ± 2.5	1.36*	0.18
HR (beats/min)				
BA	75.8 ± 10.2	80.4 ± 13.1	−1.65*	0.11
T1	74.2 ± 15.6	69.6 ± 15.2	1.27*	0.21
T2	89.0 ± 13.1	81.3 ± 14.4	2.37*	0.02
△T	14.8 ± 15.1	11.7 ± 4.8	0.88*	0.38
SpO_2 (%)				
BA	99.5 (98.0, 100.0)	99.0 (97.0, 100.0)	−0.86†	0.39
T1	100.0 (100.0, 100.0)	100.0 (100.0, 100.0)	−0.63†	0.53
T2	100.0 (99.0, 100.0)	100.0 (99.8, 100.0)	−1.53†	0.13
△T	0.(0, 1.0)	0 (0, 0)	−1.63†	0.10

*t values; †Z values. Data were shown as mean ± SD or median (Q_1, Q_3). Group S: Intubation with flexible fiberoptic bronchoscope in the supine position; Group L: Intubation with flexible fiberoptic bronchoscope in the lateral position; BA: Before induction of anesthesia at baseline; T1: After induction of anesthesia but before tracheal intubation; T2: Immediately after successful intubation; △T: the changes between T2 and T1. SD: Standard deviation; MAP: Mean arterial blood pressure; HR: Heart rate; SpO_2: Oxygen saturation.

current study is in accordance with a previous study.[8] Gill *et al*. showed that the mean time of FOI was 40 ± 7 s with the help of oropharyngeal airway in a supine patient.[9] The first-attempt intubation time in a supine patient of the current study was longer than that because it did not utilize any tools and help. When our assistant manipulated the mandibular angle after the first unsuccessful intubation attempt, the median intubation time was 20 s that was attributed to significantly improved intubation conditions.

Overall, the current study showed a stable hemodynamic response during FOI in the lateral position. These findings are in contrast to a previous report that showed an exaggerated hemodynamic response to laryngoscopy and intubation in the lateral position.[4] This discrepancy may be attributed to the benefit of performing FOI in the lateral position does not require manipulation of the mandibular angle, and the manipulation of the mandibular angle is a bigger stimulation. A transient increase in hemodynamic response was observed in this study, reflected by changes in HR and MAP. These changes are well tolerated by patients with ASA Grade I and II. Sudden changes in body position during anesthesia can cause injury, substantial decreases in blood pressure and HR, and can be life-threatening, especially in elderly and obese patients.[10,11] FOI in the lateral position minimizes the need to reposition patients during surgery.

Evidence suggests that endotracheal intubation via lightwand-guided intubation or intubating laryngeal mask airway is the reliable approaches for airway management in an emergency situation of sudden accidental loss of airway in patients in the lateral position,[12-14] but there is a risk associated with esophageal intubation. Studies showed that esophageal intubation occurs in 5% of cases undergoing endotracheal intubation via the intubating laryngeal mask airway, and 2.5%, 7.5%, and 7.5% of cases undergoing endotracheal intubation via lightwand-guided intubation in a supine, left lateral, and right lateral position, respectively.[12,15,16] In contrast, the flexible fiberoptic bronchoscope provided an excellent view of the glottis and the trachea, and had a low probability of esophageal intubation.

The superiority of this technique is reflected in two separate aspects: First, patients who must remain in the lateral position during surgery following anesthesia do not have to chang position and have less significant hemodynamic fluctuations when undergoing endotracheal intubation. Second, in case that anesthesia administration is changed or there is a accidental loss of airway patency, this technique can immediately rescue the airway without changing the patient's position and compromising the surgical field.

This study has several limitations. First, the results represent findings from a relatively small sample size. Clinical studies with a larger number of patients are required to confirm the observations reported here. Second, selected time points for hemodynamic monitoring might not be enough. Third, blinding was not possible as the intubation position was clearly visible.

In summary, tracheal intubation with a flexible fiberoptic bronchoscope showed a shorter time to intubate and a higher first-attempt intubation success rate with lateral patient positioning compared to supine patient positioning, as well as hemodynamic stability during intubation. Endotracheal intubation with a flexible fiberoptic bronchoscope may be an effective and timesaving technique for patients in the lateral position.

Supplementary information is linked to the online version of the paper on the Chinese Medical Journal website.

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Conflicts of interest

There are no conflicts of interest.

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