Original Article

Endotracheal intubation of patients in left semi-prone position before endoscopic retrograde cholangiopancreatography: A randomised controlled study

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ABSTRACT

Background and Aims: Endoscopic retrograde cholangiopancreatography (ERCP) is generally performed with the patient in the left semi-prone position. The patients are usually intubated in the supine position and subsequently turned to the left semi-prone position. This turning procedure may cause the injuries to the patient or unstable haemodynamics. Previous studies show that the success rates of intubation in the lateral position are comparable to that of intubation in the supine position, even so, there are some difficulties. Therefore, this study is aimed to investigate the effect of the semi-prone position on the success rate of intubation. **Methods**: This randomised controlled trial included 88 patients aged 18 to 80 years with an American Society of Anesthesiologists physical status (ASA PS) of I–III with no predicted difficult intubation, and who were undergoing ERCP. The subjects were randomly assigned to be intubated in the supine or semi-prone position. The 44 patients in the supine group were intubated in the supine position. The other 44 patients were intubated in the semi-prone position. The primary outcome was the success rate of the first intubation attempt. **Results**: There were no differences between the two groups in age, ASA PS and preoperative airway characteristics. Endotracheal intubation was successful in all patients with the first intubation attempt successful in 43 patients (97.7%) in the supine group and 42 (95.5%) in the semi-prone group (P = 0.556). **Conclusion**: For patients undergoing ERCP, the success rate of endotracheal intubation in the left semi-prone position was comparable to that in the supine position.

Key words: Airway management, endoscopic retrograde cholangiopancreatography, intubation, laryngoscopy, patient positioning

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) is performed to illustrate the pancreatic duct and biliary tree to diagnose pathology in the biliopancreatic system. ERCP is mainly done with the patient in the left semi-prone position. This position facilitates the easy passing of the scope, a clear fluoroscopic image and a comfortable posture for endoscopists.[1] In our institute, patients undergoing ERCP are generally intubated in the supine position followed by a decubitus shift from the supine to the left semi-prone position. However, the risk of perioperative cervical nerve injury is increased because of rotation

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and placement of head and neck positions after the induction of anaesthesia.[2,3]

Most anaesthesiologists do not routinely perform endotracheal intubation with patients in the semi-prone or lateral position because this procedure is more complex and time-consuming than in the supine position.[4-6] These complexities are related to the distorted airway anatomy, unfamiliarity with the patient's intraoral structures and challenging head and neck positioning that can lead to a compromised laryngeal view.[7,8] Our pilot study in semi-prone airway management found obstacles involving patients' alignment and limited working space in airway management. We, moreover, found beneficial methods to improve airway management in the semi-prone position. The present study aimed to compare the success rate of intubation, ease of mask ventilation and laryngoscopic view with the patient in the semi-prone position versus the supine position.

METHODS

This single-centre, prospective, randomised controlled study was conducted from November 2018 to October 2019 at a tertiary care teaching hospital. The study was approved by the institutional ethics committee for human research and was registered in the Thai Clinical Trials Registry (identifier TCTR20200528001). Informed consent was obtained from all the patients before study enrolment and the study was conducted in accordance with the principles of declaration of Helsinki.

This study population included all patients aged 18–80 years with an American Society of Anesthesiologists (ASA) physical status grade of I–III who were scheduled to undergo elective ERCP. The exclusion criteria were predicted difficult intubation based on the combination of a short thyromental distance and limited cervical spine movement, body mass index (BMI) greater than 30 kg/m^2; severe abdominal pain when lying in a semi-prone position, end-stage renal or hepatic disease, history of stroke and requirement for invasive monitoring.

After preoperative evaluation, 88 patients were randomly allocated in a 1:1 ratio to either the supine group or the semi-prone group using computer-generated randomisation with permuted blocks of 4, 6 patients. The research coordinator who maintained the random allocation numbers and sealed envelopes was otherwise not involved in the study. After the preoperative assessment, the anaesthesiology residents called the research coordinator to open the envelope. However, the attending anaesthesiologist and anaesthesiology residents could not be blinded [Figure 1].

In the supine position group, the patients were supine for anaesthetic induction, mask ventilation and endotracheal intubation. After the endotracheal tube was secured, the patients were moved to the left semi-prone position and reverse Trendelenburg position. On the morning of the operation, the patients in the semi-prone position group were given verbal instructions and shown a picture demonstrating the preinduction position [Figure 2a]. The attending anaesthesiologist verbally explained the step-by-step process of semi-prone intubation to the participating residents and did not give any help for manipulation during the intubation except for leaning against the patient's back and pulling the patient's right shoulder. In the operating room, the patients were requested to lie in a left semi-prone position. The patient's head was laid on a stack of sheets that was high enough to support the neck in the neutral position. The edge of the sheets was on the patients' cheek [Figure 2a]. Both arms were tucked into the patient's sides. Before the induction of anaesthesia, the surgical table was positioned slightly to the reverse Trendelenburg position with the patient axis aimed toward the operator's eyes. Before intubation, the attending anaesthesiologist pulled and held the patient's right shoulder towards himself/herself to create sufficient space for the operator to apply a laryngoscopic blade and perform intubation [Figure 2b]. In case of failed mask ventilation or intubation, a stretcher was kept inside the room for emergency turning of the patient to the supine position for airway management.

In both groups, the patients were intubated by residents who had each performed more than 300 endotracheal intubations. If the first intubation attempt failed, the mask ventilation was reapplied and a stylet was inserted into the endotracheal tube. If the second intubation attempt failed, the attending anaesthesiologist managed the subsequent mask ventilation and intubation.

Every patient was monitored with standard monitoring equipment including non-invasive blood pressure monitoring, electrocardiography, pulse oximetry and end-tidal capnography. The patients' blood pressures were measured on their left arm. Before induction, all

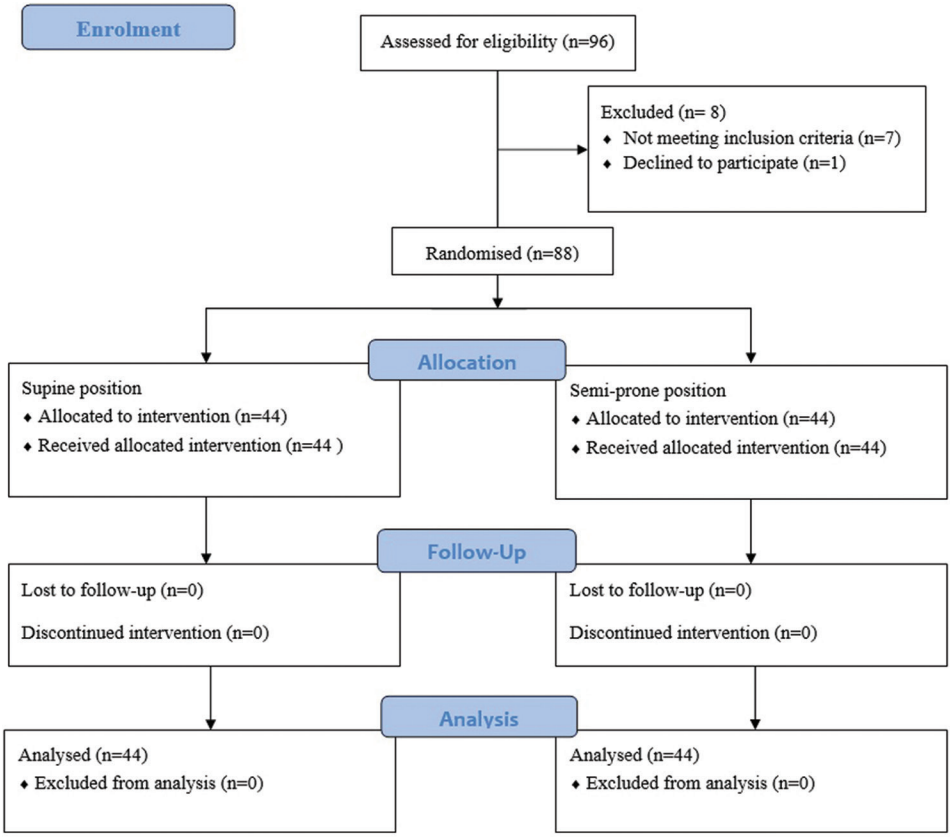

Figure 1: Consolidated Standards of Reporting Trials (CONSORT) flow diagram of patient enrolment

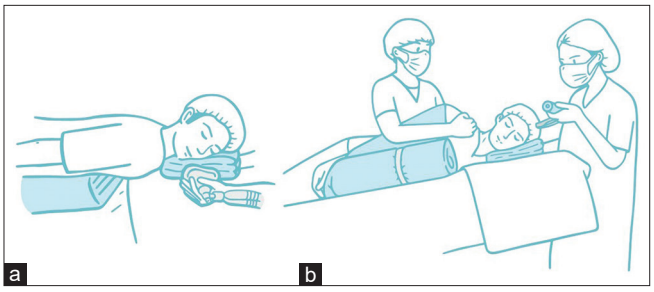

Figure 2: Photographs showing a patient being prepared for induction and endotracheal intubation in the left semi-prone position. (a) The patient lays down on the stack of sheets. (b) The surgical table is positioned in the slightly reverse Trendelenburg position, aiming the patient axis toward the operator's eyes. The attending anaesthesiologist pulls and holds the patient's shoulder

patients were preoxygenated with 6 litres of 100% oxygen until the end-tidal oxygen was 90%. Anaesthesia was induced via the administration of propofol (1.5–2 mg/kg), fentanyl (1 μ/kg), and atracurium (0.6 mg/kg). The operators held the facemask with their left hand and applied the chin lift manoeuvre. Mask ventilation was administered for 4 minutes to allow sufficient time for maximal muscle relaxation. Intubation was performed with a tracheal tube (7.5 mm internal diameter (ID) for females and 8.0 mm ID for males) using a number 3 Macintosh laryngoscope blade. The endotracheal tube was inserted after applying external laryngeal manipulation to obtain the best laryngoscopic view. After successful intubation, anaesthesia was maintained with one minimum alveolar concentration of sevoflurane.

The patients' demographic data and airway characteristics included the Mallampati grade and thyromental distance. The mean arterial pressure (MAP) and heart rate (HR) were recorded at baseline, immediately after intubation, and 5 and 10 minutes after intubation in the semi-prone group, and at baseline, immediately after intubation, and 5 and 10 minutes after changing from the supine to the semi-prone position in the supine group. The ease of mask ventilation was graded as easy (adequate ventilation by one person and no need for increased fresh gas flow or use of the oral airway), difficult (adequate ventilation but needed increase fresh gas flow or use of the oral airway), and inadequate (inadequate ventilation with any procedure). The adequacy of ventilation was confirmed by observing chest movement and achieving a good capnographic trace. The laryngoscopic view was graded using the Cormack-Lehane scoring system during direct

laryngoscopy with and without external laryngeal manipulation. Failure of the intubation attempt was defined as inadvertent oesophageal intubation or a decrease of ≥3% in the patient's oxygen saturation from when the laryngoscope was applied. Successful intubation was defined as three consecutive waves of acceptable end-tidal carbon dioxide readings. The total procedural time was measured from the time of anaesthesia induction until the patient was placed in the appropriate position for the ERCP procedure in the supine group and from the time that the patient took to self-position himself/herself until the airway was secured and ready for the ERCP procedure in the semi-prone group. The primary outcome was the success rate of the first intubation attempt. The secondary outcomes were the laryngoscopic view grade, ease of mask ventilation and haemodynamic changes (immediately after intubation and 5 and 10 minutes after intubation or repositioning).

Based on our pilot study in ERCP, the first-attempt success rate of intubation in the supine position was 98%. The maximal acceptable difference for the success rate of semi-prone intubation to be considered clinically non-inferior is 15%. With a statistical power of 80%, an alpha error of 5% and an expected 20% withdrawal rate, a sample size of 44 patients per group was needed.

Statistical analysis was performed using Statistical Package for Social Sciences Statistics for Windows, Version 20.0. (International Business Machines Corp, Armonk, New York, United States of America). Categorical data were presented as percentages and compared using the Chi-square test or Fisher's exact test. Continuous data were presented as mean ± standard deviation (SD) and compared using the Student's t-test or Mann-Whitney U test. The haemodynamic values at immediately 5 and 10 minutes after intubation were compared with the baseline values using the paired t-test. A value of *P* lesser than 0.05 was considered statistically significant for all the tests.

RESULTS

The 88 patients who were scheduled for elective ERCP were randomised into two groups. The intubations were performed by 29 Anaesthesiology residents including 14 residents with no experience in semi-prone intubation and 15 residents who had performed semi-prone intubation once.

There was no significant difference between the two groups in demographic data and preoperative airway characteristics including age, gender, body weight, height, diagnosis, ASA physical status, comorbidities, Mallampati grade and thyromental distance [Table 1].

Mask ventilation was more manageable in the semi-prone group than in the supine group; an oral airway was needed for adequate ventilation in six patients in the supine group. No patient had inadequate ventilation.

The laryngoscopic view without external laryngeal manipulation was worse in the semi-prone group than in the supine group. However, the external laryngeal manipulation improved the laryngoscopic view in both groups [Figure 3]. The laryngoscopic view improved after the external laryngeal manipulation in 15 of 20 patients (75%) in the supine group and 24 of 27 patients (89%) in the semi-prone group ($P = 0.210$).

All patients were successfully intubated within two attempts. The first intubation attempt was successful in 43 patients (97.7%) in the supine

Table 1: Demographic data

	Supine group (*n*=44)	Semi-prone group (*n*=44)	*P*
Age, years	62.3±19.9	60.9±14.7	0.125
Gender (male/female)	18/26	15/29	0.508
Body weight, kg	63.3±13.4	64.8±13.1	0.376
Height, cm	162.6±8.63	163.8±9.31	0.059
Diagnosis			0.850
Common bile duct stone	21 (47.7)	24 (54.5)	
Cholangiocarcinoma	7 (15.9)	5 (11.3)	
Pancreatic cancer	4 (9.1)	3 (6.8)	
Cholangitis	6 (13.6)	8 (18.2)	
Other	6 (13.6)	4 (9.1)	
ASA physical status			0.788
I	6 (13.6)	6 (13.6)	
II	18 (40.9)	21 (47.7)	
III	20 (45.4)	17 (38.6)	
Comorbidity			
Diabetes mellitus	7 (15.9)	6 (13.6)	0.763
Hypertension	27 (61.4)	21 (47.7)	0.198
Chronic kidney disease	4 (9.1)	4 (9.1)	1.000
Airway assessment			
Mallampati grade			0.382
1	16 (36.4)	15 (34.1)	
2	20 (45.4)	25 (56.8)	
3	8 (18.2)	4 (9.1)	
Thyromental distance			0.693
>6 cm	41 (93.2)	40 (90.9)	
≤6 cm	3 (6.8)	4 (9.1)	

Values are presented as mean±standard deviation, number of patients (%); ASA – American Society of Anesthesiologists, *n* – number

group and 42 patients (95.5%) in the semi-prone group ($P = 0.556$). For patients in the semi-prone group, the first intubation attempt was successful in 28 of 29 intubations conducted by first-time operators and in 14 of 15 intubations conducted by second-time operators. The procedural time did not significantly differ between the supine group (16.7 ± 5.2 minutes) and the semi-prone group (14.5 ± 6.3 minutes) [Table 2].

The baseline MAP and HR did not significantly differ between the two groups [Figure 4]. Compared with the baseline value, the HR was significantly increased immediately after intubation in both the supine and semi-prone groups ($P = 0.023$ and $P = 0.001$, respectively). The HR at 5 and 10 minutes did not significantly differ from the baseline value in either of the two groups.

DISCUSSION

The success rate of intubation in the semi-prone position performed by residents under the supervision of the experienced anaesthesiologist was comparable to that of intubation in the supine position. Furthermore, the incidence of difficult mask ventilation was significantly lower in the semi-prone group than in the supine group.

No patient in the semi-prone group had difficult mask ventilation in this study. However, previous studies have reported difficult mask ventilation in 9%–20% of patients in the lateral position.[4,5] Mask ventilation is more accessible to perform with the patient in the lateral position than in the supine position, presumably, because of the effect of gravity on the soft tissues in the oral cavity. According to a study by Hui Li *et al*.,[8] the time needed for intubation with a flexible fibreoptic bronchoscope is shorter with the patient in the lateral position than in the supine position because the tongue and soft tissues of the throat move downward with gravity; this prevents the soft tissue in the oral cavity from causing the airway obstruction that occurs in the supine position. Our pilot study revealed that it is difficult for the operator to hold the mask with the left-hand during mask ventilation; the operator's hand cannot properly fit the mask to the patient's face because the pillow or sheets underneath the patient's head impede the operator's hand and mask attachment. In the present study, we improved the management of mask ventilation by positioning the sheets approximately underneath the patient's cheek to create more available space and achieve a proper seal between the patient's face and the mask.

Previous studies have reported that the airway anatomy in the lateral position might become distorted

Table 2: Study outcomes

	Supine group (*n*=44)	Semi-prone group (*n*=44)	*P*
Mask ventilation			0.026
Easy	38 (86.4)	44 (100)	
Difficult	6 (13.6)	0 (0)	
Laryngoscopic view (%)			0.273
1	24 (54.5)	17 (38.6)	
2	14 (31.8)	21 (47.7)	
3	6 (13.6)	6 (13.6)	
Laryngoscopic view with ELM (%)			0.358
1	35 (79.5)	37 (84.1)	
2	7 (15.9)	7 (15.9)	
3	2 (4.5)	0 (0)	
Success rate of intubation (%)			0.556
1st attempt	43 (97.7)	42 (95.5)	
2nd attempt	1 (2.3)	2 (4.5)	
Procedural time (minutes)	16.7±5.2	14.5±6.3	0.161

Values are presented as mean±standard deviation, number of patients (%); ELM – external laryngeal manipulation, *n* – number

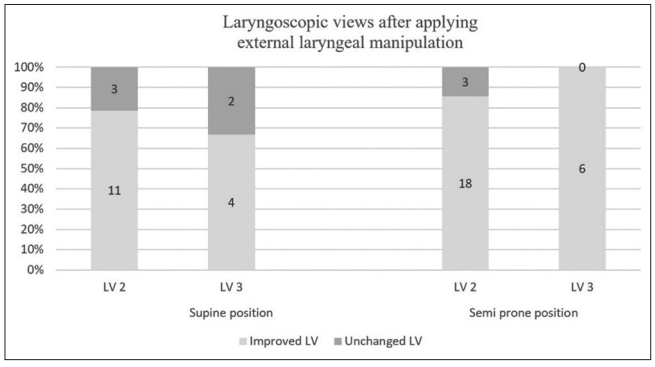

Figure 3: Changes in the grading of the laryngoscopic view (LV) after applying external laryngeal manipulation

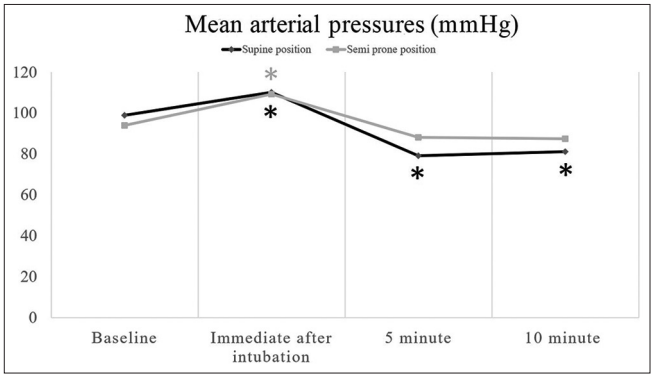

Figure 4: Changes in the mean arterial pressure (MAP) after intubation. *$P < 0.05$, statistically significant differences compared with baseline MAP

and force the operator to apply the laryngoscope blade in an uncomfortable posture. As a result, the laryngoscopic views were more difficult to obtain than in the supine position.[4,8,9] The present study showed that the proportion of laryngoscopic view classified as grade 2 in the semi-prone group was higher than in the supine group. However, applying external laryngeal manipulation was still useful to improve the laryngeal views in the semi-prone position.

To our knowledge, the only prior study that evaluated intubation with a direct laryngoscopic blade in the patient in the semi-prone position was a paediatric simulation study.[6] From our pilot study, we optimised the methods including the patient's position, operation table and the role of an assistant in improving the success rate of semi-prone intubation. Therefore, the success rate of the first intubation attempt in this study was 95.5% which is higher than the success rates of 79.4% and 93.1% reported for intubation in the lateral position in previous studies.[10,11] The level of the surgical table was adjusted approximately to the level of the operator's waist and was then set to the reverse Trendelenburg position to align the patient axis toward the operator's eyes. Several studies have demonstrated that the laryngoscopic view with direct laryngoscopic blade improves when the patient is in the back-up position.[12-15] This is because, applying the blade in this position moves the laryngeal view closer to the alignment of the laryngeal axis and gives the operator a better laryngoscopic view.[12] We speculated that simultaneous reverse Trendelenburg position with semi-prone intubation would improve the ergonomic posture of the operators and the intubation conditions, resulting in a better laryngoscopic view and easier intubation. Another problem with endotracheal intubation in the semi-prone position was that the patient's right shoulder was wrapped on lying down, especially under anaesthesia, resulting in limited space for applying the laryngoscope blade and endotracheal tube. We found that these problems were alleviated by applying traction and pulling back the patient's right shoulder. Our results suggest that our airway management methods provided efficient outcomes. However, inexperienced operators should be cautious in the implementation of our technique, especially in patients who have predictors of difficult facemask ventilation and intubation.

In our institute, the ERCP procedure is performed with the patient in a combined semi-prone with reverse Trendelenburg position. Our study showed that the MAP in the supine group was significantly decreased from baseline after the patient was turned to ERCP position. This finding is consistent with previous studies that showed that an abrupt change in the patient's position after the induction of anaesthesia might cause haemodynamic instability.[16-19] After intubation, the MAP was fairly stable in the semi-prone group. The possible explanation maybe that the patients in the semi-prone group who initially lay in the ERCP position had adequate time for haemodynamic adjustment.

Additionally, the results of our study suggest that these methods can be more broadly applied in a situation requiring emergency airway management for procedures which usually are performed in semi-prone or lateral position as in non-intubated video-assisted thoracic surgery, hip surgery and oesophagogastroduodenoscopy.[20,21] Our technique can be performed immediately with basic airway equipment or adjuncts.

Our study has several limitations. First, the experience of operators in the semi-prone group was an important factor that affected the success rate of intubation. Therefore, the success rate of inexperienced operators may differ from the success rate achieved in this study. Second, the patients with anticipated airway difficulties were excluded. Finally, the degree of the reverse Trendelenburg position was individually adjusted for each patient which might have contribute to the success rate of intubation.

CONCLUSION

In patients undergoing ERCP, endotracheal intubation in the left semi-prone position by supervised anaesthetic trainees showed a high success rate. The success rate was comparable to that in the supine position. Moreover, mask ventilation in the semi-prone position was easier than in the supine position.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that

their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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