

A Novel Way of Positioning for Intubation: Bed-Up-Head-Elevated Using Bed Controls

by Dr Samuel Ern Hung Tsan
University of Malaysia, Sarawak

INTRODUCTION

Intubation is a skill that anaesthesiologists must have as part of their arsenal in managing patients undergoing surgery or critically ill patients. It is a skill gained through years of training and experience, finally culminating in anaesthesiologists being considered as masters of airway management. As every anaesthesiologist will know, the positioning of a patient prior to intubation is one of the most important aspects of successful intubation.

Most anaesthesiologists in Malaysia are familiar with and, in fact, regularly practice the sniffing position for intubation, using pillows or head rings. For obese patients, the ramping position is commonly used, utilizing pillows, blankets, or specialized positioning devices. Lee et al in 2007 introduced a novel ramping position, by studying the effects of back elevation of 25° using bed controls compared with the supine position.¹ This new positioning, also termed bed-up-head-elevated (BUHE) position for intubation, has gained more and more popularity in recent years. Despite that, few anaesthesiologists in Malaysia have heard of the BUHE position.

The BUHE position is a variation of the ramping position, using bed controls alone to elevate the head of the bed (by breaking the bed at the level of the patient's hip to prevent patient from sliding off) until alignment of the patient's sternal angle and external auditory meatus is achieved (Figure 1).² To achieve this endpoint, the bed elevation could range from 15° to 45°. This article will discuss the benefits and potential complications of the BUHE position, and its applications in the operating theatre (OT) and the intensive care unit (ICU).



Figure 1: Bed-up-head-elevated position. The head of bed is elevated until the endpoint of horizontal alignment between the sternal angle and external auditory meatus is achieved

BENEFITS OF BUHE POSITION

Improved laryngeal exposure

One of the main advantages of the BUHE position is improved laryngeal exposure, facilitating intubation. In their pioneering RCT, Lee et al investigated the 25° back-up position for intubation in 40 surgical patients undergoing general anaesthesia. The authors found that the 25° back-up position provided a more superior laryngeal view, by increasing the percentage of glottic opening (POGO) (Figure 2) score from mean 42.2% in the supine group to 66.8% in the back-up group.¹



Figure 2: Percentage of glottic opening (POGO). A 100% POGO score refers to visualization of the entire glottic opening from the anterior commissure of the vocal cords to the interarytenoid notch. A POGO score of 0% refers to no visualization of laryngeal structures

The finding by Lee et al has been confirmed by a recent RCT investigating the BUHE position, carried out by Tsan and colleagues, which compared the BUHE position with video laryngoscopy (VL).² In this study, 138 surgical patients undergoing general anaesthesia had a baseline Macintosh blade laryngoscopy in the SSP position, followed by randomization to one of two groups preceding intubation, namely Group BUHE (direct laryngoscopy in BUHE position) or Group GLSC (VL using Glidescope). The authors found that mean POGO scores between both groups differed by -6.3% (98% CI, -13.2% to 0.6%), indicating non-inferiority of BUHE laryngoscopy to VL within the prespecified margin of 15% difference. For patients undergoing intubation in the BUHE position, there was a clinically significant mean improvement in the POGO scores compared with the baseline SSP position [mean improvement 25.8%, $p < 0.0001$]. Importantly, a subgroup of patients with Cormack-Lehane (CL) grade III classification in the SSP demonstrated a mean 49.17% improvement in POGO scores, converting potentially difficult intubations into straightforward intubations.

Further evidence on the superiority of the BUHE position over SSP for optimizing laryngeal exposure has also been suggested by a recent systematic review and meta-analysis.³ This study compared the ramping position and the SSP [ramping position defined as the back elevated position in which the sternal notch and external auditory meatus were horizontally aligned, irrespective of the methods used (specialized pillows, blankets, head-of-bed elevation, etc)]. There was no difference found between groups with regards to odds for CL 1/2 or CL 3/4 views. However, further subgroup analysis based on type of population [surgical vs intensive care unit (ICU) patients] revealed that in surgical OT patients, patients in ramping position had a significantly higher odds of CL 1/2 views, and a lower odds of CL 3/4 views.

In the only RCT to date investigating the BUHE ramping position for intubation in ICU patients, Semler et al compared the ramped position (head of bed elevated to 25°) and the SSP for emergency intubation.⁴ The authors discovered that there was a higher incidence of CL 3/4 views in the ramped group (25.4%) compared to the SSP group (11.5%) ($p = 0.01$). Of note, a majority of the intubators reported having more experience intubating in the SSP compared to the ramped position. Until further evidence becomes available, this study provides the most current evidence with regards to the effect of BUHE position on laryngeal exposure in ICU patients.

The explanation for improved glottic exposure in the BUHE position may be that this position confers a biomechanical advantage during intubation. When compared to the SSP position, the BUHE position allowed the operator to change the direction of force (relative to the horizontal plane) required to lift the laryngoscope handle, from about 45° in the SSP to about 20° in the BUHE position.¹ This subsequently led to a change of force and torque, by increasing horizontal force and reducing vertical force against gravity. In other words, with the same force, the operator is able to push the laryngoscope blade further forward rather than upward to obtain the most optimal laryngeal exposure. Another potential explanation for the improvement in laryngeal exposure is the movement of the laryngeal structures in the BUHE position. When the torso is elevated, laryngeal structures are pulled more caudally directly through the effects of gravity, or indirectly through the pulling down of the whole upper thorax which is connected to laryngeal structures. This could affect the laryngeal axis, bringing it nearer to alignment with the line of sight, and hence improving laryngeal view.¹

Effective preoxygenation

Aside from facilitating a better glottic view during tracheal intubation, the BUHE position also has the added advantage of improving the effectiveness of preoxygenation during intubation. There is strong evidence that the BUHE position improved the tolerance of apnoea in surgical OT patients, by prolonging the safe apnoea period (SAP), defined as the time taken for oxygen saturation to drop to a low level during apnoea. Boyce et al in 2003 were the first to investigate the impact of positioning on apnoea tolerance.⁵ They randomized 26 obese surgical patients to one of three groups, namely 30° reverse Trendelenburg, 30° back-up, or horizontal-supine positions. They demonstrated that the SAP was significantly prolonged in the ramped positions compared to the supine position ($p < 0.001$). Subsequently, other RCTs have also showed similar findings in obese and non-obese OT population, with all demonstrating statistically and clinically significantly prolonged SAP in the ramped position compared to the supine position.⁶⁻⁸

On the other hand, available data on the effectiveness of preoxygenation in BUHE position for ICU patients remain limited. The only RCT to date which have focused on critically ill ICU patients was carried out by Semler et al.⁴ The authors reported no difference in the lowest arterial oxygen saturation peri-intubation (defined as time from induction to 2 minutes after successful endotracheal intubation) between groups. Additionally, there was no difference in incidence of hypoxaemia $SpO_2 < 90\%$ or $SpO_2 < 80\%$ between groups. These findings, however, have been criticized and should be interpreted with caution as patients in both groups may not be comparable.⁹ There were significantly more difficult airways in the ramped group (CL 3/4 views) compared to the sniffing group, and hence time required for intubation in these patients were longer.

The reason for improved effectiveness of preoxygenation in the BUHE position can be understood from a physiological perspective. Studies have shown that the ramped BUHE position is associated with increase in functional residual capacity (FRC).¹⁰ In the raised torso position, the pressure exerted by abdominal contents on the diaphragm is reduced, allowing the diaphragm to descend further. Additionally, the weight of the chest wall tissues compressing the lungs is also reduced. All this lead to an increased FRC, which serves as a storage for oxygen molecules. The additional oxygen reserve subsequently allows a longer period of apnoea without adverse complications.

Success of intubation

The BUHE position has been found to be associated with a higher rate of successful intubation. A well-designed RCT conducted by Lee et al investigated the rate of successful intubation between the ramped and sniffing positions in surgical patients with expected difficult intubation.¹¹ In their study, the authors found that the ramped position was significantly associated with a higher rate of successful intubation (Ramped 63% vs Sniffing 42%, $p < 0.05$). Additionally, more patients in the ramped group were successfully intubated within the first two attempts compared to the sniffing group.

Meanwhile in the critically ill population, the evidence of BUHE position on intubation success at first attempt remains controversial. In a prospective observational cohort study, Turner et al analysed 231 emergency intubations performed in the supine (head elevation 0 - 10°), inclined (11 - 44°) and upright ($\geq 45^\circ$) positions. They found a higher first pass success rate in the upright group (85.6%) and inclined group (77.9%) compared to the supine group (65.8%) ($p = 0.024$). Interestingly, the authors also demonstrated increased odds of first pass success for every 5° increase in angle of bed elevation (Adjusted OR 1.11, 95% CI 1.01 - 1.22, $p = 0.043$).¹² On the other hand, Semler et al in their study on ICU patients found a lower rate of success at first intubation attempt in the ramping position (76.2%) compared to the sniffing position (85.4%) ($p = 0.02$).⁴

Time required for intubation

Several studies have shown that the BUHE position does not prolong the time to intubation, but may in fact shorten it. Tsan et al investigated the BUHE position and showed that the time to intubation in BUHE direct laryngoscopy patients (mean 36.23 seconds) was shorter than the time to intubation for patients undergoing VL (mean 44.33 seconds).² In addition, a prospective cohort study demonstrated that the 25° back-up position was associated with a shorter median time to intubation (median 24 seconds) when compared to the SSP (median 28 seconds) ($p = 0.031$).¹³ Although the differences in time required may not be clinically significant, it is an added benefit when performing intubations in this position, especially in patients undergoing rapid sequence intubation or those with poor pulmonary reserves.

Complications during intubation

In patients requiring intubation in the ward and ICU, there is data to suggest the BUHE position is associated with a lower risk of peri-intubation complications.

Khandelwal et al conducted a retrospective cohort study investigating complications associated with the BUHE position and SSP. The authors found that the BUHE position was associated with a lower risk of complications (any of difficult intubation, oesophageal intubation, hypoxaemia, or pulmonary aspiration) (Adjusted OR 0.47, 95% CI 0.26 - 0.83, $p = 0.01$).¹⁴

Other benefits

Additional benefits of placing patients in the BUHE position for intubation include the ease with which patients' positions can be adjusted. In the majority of OTs in Malaysia, the OT table is equipped with electronic controls, allowing staff to manipulate the table position with the press of a button. This allows much easier positioning compared to physically lifting patients to place pillows or blankets below their torsos and heads. Moreover, risks of cervical trauma or intravenous lines disconnection is greatly minimized. In the event the patient has to be placed supine for any reason post-intubation, this can be easily done with bed controls, without the need to lift an anaesthetised patient up to remove the pillows and blankets.

POTENTIAL COMPLICATIONS

From a physiological standpoint, there is a theoretical complication associated with the BUHE position. Due to venous pooling in the lower extremities and subsequent reduced venous return to the heart, cardiac output and cerebral perfusion can be compromised during induction of anaesthesia. The potentially detrimental impact of a transient reduction in cardiac output, in the setting of sympathetic stimulation from laryngoscopy and intubation, has yet to be proven from scientific data. To date, no studies investigating BUHE position have reported any adverse events such as hypotension during intubation in the ramping position. However, until more evidence is available, it is important to keep in mind the possible dangers of hypotension and cerebral hypoperfusion when intubating patients in the BUHE position. In physiologically vulnerable patients, it is important to immediately place the patient back supine after induction of anaesthesia and treat hypotension accordingly with vasopressor agents.

APPLICATIONS IN OT AND ICU

In the OT population, endotracheal intubation in the BUHE position is associated with many advantages and lack of proven disadvantages. Because of this, it is an ideal time to reconsider whether the SSP should still be the starting position for intubation. The development of the

SSP was based on a few descriptive articles from 1852 to 1944, and yet it has become the gold standard for positioning.¹⁵ Newer evidence in the 21st century has challenged the superiority of the SSP for intubation, finding that it may not be as beneficial as once thought.¹⁶ With the amount of scientific data supporting the BUHE position, it is sensible to replace the SSP with the BUHE position as the ideal starting intubation position. In patients who may be vulnerable to hypotension or the effects of hypotension, the BUHE position may still be used with adequate precautions taken such as optimizing volume status and usage of vasopressor agents.

On the other hand, the application of BUHE position as a starting intubating position in critically ill patients is not so straightforward. Arguments for it state that there is

evidence the BUHE position is associated with lesser peri-intubation complications. However, there is a risk of worsened glottic exposure based on available evidence. There is also conflicting data to suggest either a higher or lower rate of successful intubation. Until more research is available, the decision to place critically ill patients in the SSP or the BUHE position should be on a case-by-case basis, depending on the clinical judgment of the clinician.

CONCLUSION

The BUHE position is a novel and easy way to position patients for intubation, with multiple benefits and no proven disadvantage. Anaesthesiologists should consider the BUHE position as a starting position for endotracheal intubation in the OT for the majority of patients. More research is needed to determine the suitability of BUHE positioning for intubations in the emergency setting.

REFERENCES

1. Lee BJ, Kang JM, Kim DO. Laryngeal exposure during laryngoscopy is better in the 25 back-up position than in the supine position. *British Journal of Anaesthesia*. 2007;**99**:581-6
2. Tsan SEH, Lim SM, Abidin MFZ, Ganesh S, Wang CY. Comparison of Macintosh laryngoscopy in bed-up-head-elevated position with GlideScope laryngoscopy: a randomized, controlled, noninferiority trial. *Anesthesia & Analgesia*. 2020;**131**:210-9
3. Tsan SEH, Ng KT, Lau J, Viknaswaran NL, Wang CY. A comparison of ramping position and sniffing position during endotracheal intubation: a systematic review and meta-analysis. *Revista Brasileira de Anestesiologia*. 2021;**70**:667-77
4. Semler MW, Janz DR, Russell DW, Casey JD, Lentz RJ, Zouk AN, Santanilla JI, Khan YA, Joffe AM, Stigler WS. A multicenter, randomized trial of ramped position vs sniffing position during endotracheal intubation of critically ill adults. *Chest*. 2017;**152**:712-22
5. Boyce JR, Ness T, Castroman P, Gleysteen JJ. A preliminary study of the optimal anesthesia positioning for the morbidly obese patient. *Obesity Surgery*. 2003;**13**:4-9
6. Altermatt FR, Munoz HR, Delfino AE, Cortinez LI. Pre-oxygenation in the obese patient: effects of position on tolerance to apnoea. *British Journal of Anaesthesia*. 2005;**95**:706-9
7. Dixon BJ, Dixon JB, Carden JR, Burn AJ, Schachter LM, Playfair JM, Laurie CP, O'Brien PE. Preoxygenation is more effective in the 25° head-up position than in the supine position in severely obese patients: a randomized controlled study. *Anesthesiology*. 2005;**102**:1110-5
8. Lane S, Saunders D, Schofield A, Padmanabhan R, Hildreth A, Laws D. A prospective, randomised controlled trial comparing the efficacy of pre-oxygenation in the 20° head-up vs supine position. *Anaesthesia*. 2005;**60**:1064-7
9. Rahiman SN, Keane M. Ramped position: what the "neck"! *Chest*. 2018;**153**:567-8
10. Couture EJ, Provencher S, Somma J, Lellouche F, Marceau S, Bussi eres JS. Effect of position and positive pressure ventilation on functional residual capacity in morbidly obese patients: a randomized trial. *Canadian Journal of Anesthesia*. 2018;**65**:522-8
11. Lee J-H, Jung H-C, Shim J-H, Lee C. Comparison of the rate of successful endotracheal intubation between the "sniffing" and "ramped" positions in patients with an expected difficult intubation: a prospective randomized study. *Korean Journal of Anesthesiology*. 2015;**68**:116
12. Turner JS, Ellender TJ, Okonkwo ER, Stepsis TM, Stevens AC, Sembroski EG, Eddy CS, Perkins AJ, Cooper DD. Feasibility of upright patient positioning and intubation success rates at two academic emergency departments. *American Journal of Emergency Medicine*. 2017;**35**:986-92
13. Reddy RM, Adke M, Patil P, Kosheleva I, Ridley S. Comparison of glottic views and intubation times in the supine and 25 degree back-up positions. *BMC Anesthesiology* 2016;**16**:113
14. Khandelwal N, Khorsand S, Mitchell SH, Joffe AM. Head-elevated patient positioning decreases complications of emergent tracheal intubation in the ward and intensive care unit. *Anesthesia & Analgesia*. 2016;**122**:1101-7
15. Greenland KB, Eley V, Edwards MJ, Allen P, Irwin MG. The origins of the sniffing position and the three axes alignment theory for direct laryngoscopy. *Anaesthesia and Intensive Care*. 2008;**36**:23-7
16. Adnet F, Borron SW, Lapostolle F, Lapandry C. The three axis alignment theory and the "sniffing position": perpetuation of an anatomic myth? *Anesthesiology*. 1999;**91**:1964