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Laryngeal exposure during laryngoscopy is better in the 25° back-up position than in the supine position

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Background. Good visualization of the glottis is important for tracheal intubation. This study evaluated whether the 25° back-up position improves the quality of the laryngeal view during laryngoscopy.

Methods. Laryngoscopy with a curved blade was performed on 40 anaesthetized patients. The patients were randomly assigned to two groups. Laryngeal views were captured with a rigid 0° endoscope. Views were recorded for each patient in Group A (n=20) during laryngoscopies performed with the patient lying first in the supine position and then in the 25° back-up position. Laryngeal views for patients in Group B (n=20) were first captured while the patient was in the 25° back-up position and then while the patient was in the flat supine position. An anaesthetist blinded to the position graded the quality of the images using the percentage of glottic opening (POGO) score.

Results. Comparing the two positions, mean (SD) POGO scores increased significantly from 42.2 (27.4)% in supine position to 66.8 (27.6)% in 25° back-up position ($P<0.0001$).

Conclusions. During laryngoscopy, the laryngeal view, as assessed by POGO scores, improves significantly in the 25° back-up position when compared with the flat supine position.

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Direct laryngoscopy depends upon the forward flexion of the cervival spine and the extension of the head at the atlanto-occipital joint to align the oral, pharyngeal, and laryngeal axes. Studies and reference manuals recommend the 'sniffing' position, or moderate head elevation and atlanto-occipital extension, for tracheal intubation.[1 2] Difficult tracheal intubation with direct laryngoscopy results from the inability to visualize the larynx. Many skeletal and soft tissue factors can contribute to this difficulty.[3–5]

Simple manoeuvres to facilitate tracheal intubation include external laryngeal manipulation, forward cervical flexion, and added use of a stylet.[6 7] There are no studies on the effects of the 25° back-up position on the laryngeal view. The 25° back-up position may change the directional force along the laryngoscope handle and the operator's angle of view down the lumen of the blade.[7] The current study was designed to apply laryngeal imaging and percentage of glottic opening (POGO) scoring to objectively evaluate, in a prospective randomized method with a cross-over design, the effect of 25° back-up position on the quality of laryngeal view compared with supine position.

Methods

The study was approved by the Institutional Review Board of the Kyung Hee University Hospital.

Forty ASA I–II patients, aged 21–75, undergoing routine elective surgery under general anaesthesia were studied between July 2006 and September 2006. Patients with ischaemic heart disease and cerebrovascular disease were excluded. Randomization was performed by placing index cards, with the letter A or B, into 50 sealed envelopes, which were placed in random order. At the time of a patient's enrolment, the next available envelope was placed with the patient's chart. If any problem were to occur with the patient during the procedure, the

anaesthetist would take all appropriate measures to ensure patient safety, and the patient would be excluded from the study. Each patient fasted 8 h before the procedure.

After obtaining written informed consent, midazolam 0.05 mg kg^{-1} i.v. was administered to all the patients immediately before the induction of anaesthesia. Routine monitoring was used. At the time of induction, the envelope was opened and the sequence was thus determined. Each patient in Group A lay supine on the operating table without a pillow under the head and was pre-oxygenated for 3 min. Induction of anaesthesia was achieved with propofol 1.5 mg kg^{-1} i.v. The muscle relaxation was obtained with rocuronium 0.6 mg kg^{-1} i.v. Anaesthesia was maintained with sevoflurane 2–3%. After loss of all four twitches on the train-of-four obtained by ulnar nerve stimulation, laryngoscopy was performed using Macintosh blade size 3. The blade was inserted and lifted up, the 0° rigid endoscope (Olympus Corporation, Hamburg, Germany) was inserted into the oral cavity to the optimal depth to obtain the best view of the glottis. We placed the scope at the midline of the mouth cavity from the incisors and at a depth to get a whole view of the glottic area. The depth of the rigid scope was not the same in every patient. However, the depth was the same at each position in one patient. The laryngeal view was imaged continuously on a monitor of the integrated video system (Olympus Corporation, Tokyo, Japan). The endoscopy angle was measured with an angle finder placed lengthwise on the endoscope.[7] If the endoscope was oriented parallel to the floor, this would represent an endoscopy angle of 0°. If the endoscope was positioned pointing vertically downward and perpendicular to the floor, this would represent an endoscopy angle of 90°. The lengthwise direction of the endoscope was assumed to be equal to the line of sight of the laryngoscopist. After capturing the best laryngeal view, the patient was then placed in the 25° back-up position, which was achieved by breaking the operating table at the hips to prevent patients from sliding off the table, and the same procedure as mentioned earlier was performed (Fig. 1). The laryngoscopist sat on a chair and performed laryngoscopy and captured the view in the flat supine position at the lowest bed height. He stood up for the 25° back-up position to perform laryngoscopy, and the distances from the laryngoscopist's eye or hands to the patient's head were similar in both positions.

Each patient in Group B underwent the same procedure. However, the sequence of positions was reversed.

The captured laryngeal views at the two positions were graded by one anaesthetist using the POGO score. The anaesthetist was blinded to the group and the position associated with each laryngeal view. The primary analysis was done on the change of POGO scores in the back-up position. The POGO score describes how much of the glottic opening is visible; a 100% POGO score includes visualization of the entire glottic opening from the anterior commissure of the vocal cords to the interarytenoid notch (Fig. 2).[8] A POGO score of 0% corresponds with no visualization of laryngeal structures.

Fig 1 Laryngoscopy in the 25° back-up position with an angle finder placed lengthwise on the endoscope. The endoscopy angle (•) is approximately 52°. (Printed with permission from the patient.)

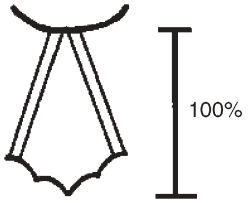

Fig 2 POGO score. A 100% POGO score corresponds to visualization of entire glottic opening from the anterior commissure of vocal cords to the interarytenoid notch between the posterior cartilages.[8] (Reprinted with permission from the publisher, © the Society for Academic Emergency Medicine, 1998.)

Assuming a clinically significant difference in POGO score of 25%, we calculated the appropriate sample size with use of $\alpha=0.1$ and $\beta=0.9$.[9]

Data are presented as mean (range or SD). Data between the two groups were analysed by paired Student's *t*-test using SPSS statistical software (version 10.0). $P<0.05$ was considered statistically significant.

Results

Patient characteristics, changes in POGO scores, and changes in endoscopy angles were similar between the Groups A and B (Table 1). However, POGO scores and endoscopy angles increased in the 25° back-up position in all 40 patients (Table 2). An example of the type of imaging obtained during the study is shown in Figure 3. There were no adverse events associated with the study. There were no occasions when difficulty or complications during the procedure led to withdrawal of a patient from the study.

Discussion

The increased POGO scores indicate that the 25° back-up position may provide better laryngeal view than the flat supine position. This study showed that the mean POGO scores increased from 42.2% in the supine position to 66.8% in the 25° back-up position. A preliminary study suggested that the difference of 25% in POGO scores may be meaningful in terms of an increased number of laryngoscopies needed for intubation and the use of rescue devices.[9] We expect 25° back-up position may be included in, or combined with, the alternative approaches to intubation, such as alternative laryngoscope blades, LMA, intubating stylet, and so on, in the difficult airway algorithm.

It is controversial whether the sniffing position is superior to simple head extension for tracheal intubation. Adnet and colleagues[10] compared laryngeal exposure in the two positions with a curved laryngoscope blade but found no significant difference between the two positions. They proved that the sniffing position does not achieve alignment of the axis of the mouth, the pharyngeal axis, and the laryngeal axis (LA) in awake patients with normal airway anatomy.[11] However, Levitan and others[7] reported that increasing head elevation significantly improves laryngeal exposure during laryngoscopy on fresh human cadavers. Although the sniffing position is widely considered as the standard head position for the performance of orotracheal intubation, head-flat position was used in this study for the free movement of the head.

The anaesthetist must exert axial force on the laryngoscope handle to expose the glottis. The anaesthetist must also apply a perpendicular force to balance the torque on the laryngoscope. Force and torque decreases monoexponentially, despite administration of neuromuscular blocking drugs because of the stress relaxation of pharyngeal tissues that are passively stretched during laryngoscopy.[12] Because there is stress relaxation of the pharyngeal tissues and tongue during laryngoscopy, we randomized the sequence of positioning to exclude any of its effects on the results.

A 45° direction to lift the handle of the laryngoscope in the supine-horizontal position decreases to about 20° in the 25° back-up position (Fig. 4). A change of direction to lift the handle leads to a change of force and torque. Vertical force against gravity will be decreased and horizontal force increased in the back-up position. In the back-up position, a laryngoscopist can push the blade of the laryngoscope forward rather than upward with the same force and get an improved view of the larynx.

Loss of tonic muscular activity because of anaesthesia and paralysis with the head flexed causes posterior displacement of the epiglottis; with the head extended, it causes anterior displacement of the epiglottis, the hyoid, and the thyroid cartilage.[13] Figure 5 shows that the anterior movement of laryngeal structures caused by anaesthesia and head extension displaces the LA, defined as a straight line passing through the centres of the inferior (cricoid cartilage) and superior (base of epiglottis) orifices vertically without modification of the angle. In contrast, the line of vision (LV), defined as a straight line passing through the

Table 1 Patient characteristics and difference in the POGO and endoscopy angle between Groups A and B. Values are number of patients or mean (range or SD). No significant differences were noted

	Group A	Group B
Sex (M/F)	11/9	10/10
Age (yr)	45 (21–74)	46 (21–75)
Weight (kg)	64 (12)	67 (11)
Height (cm)	164 (9)	165 (10)
Difference in POGO (%)	24.7 (13.0)	24.4 (12.4)
Difference in endoscopy angle (°)	19.2 (4.3)	18.5 (3.3)

Table 2 POGO scores and endoscopy angles in the supine position and 25° back-up position; mean (SD) values

	Supine	25° Back-up	*P*-value
POGO (%)	42.2 (27.4)	66.8 (27.6)	<0.0001
Endoscopy angle (°)	39.8 (7.1)	58.6 (5.7)	<0.0001

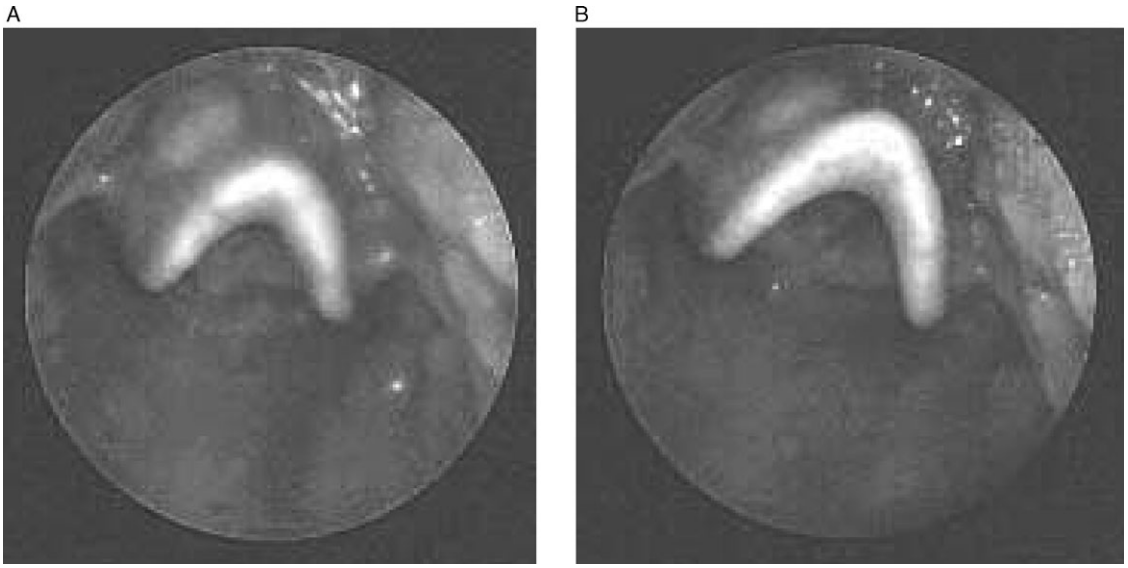

Fig 3 The best laryngeal view of one patient in the flat supine position (A) and the best laryngeal view of the same patient in the 25° back-up position (B).

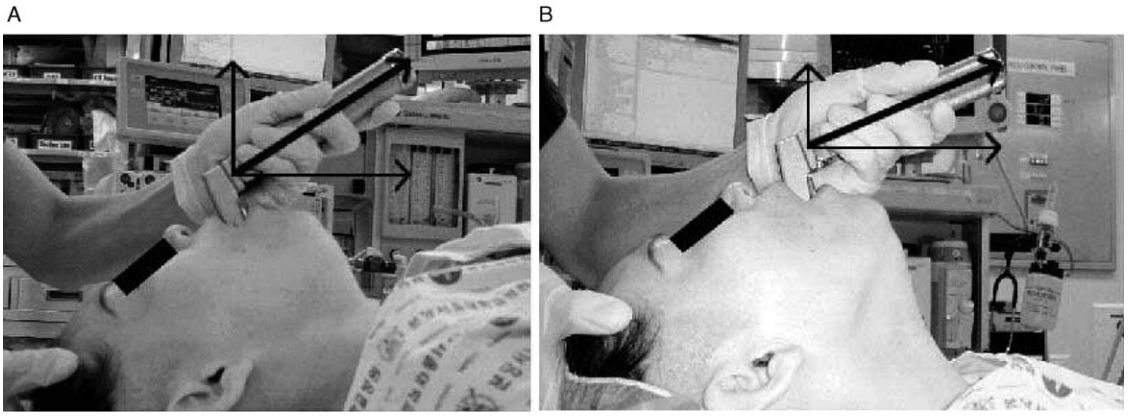

Fig 4 The directions of forces exerted on the laryngoscope handle in the flat supine position (A) and in the 25° back-up position (B). (Printed with permission from the patient.)

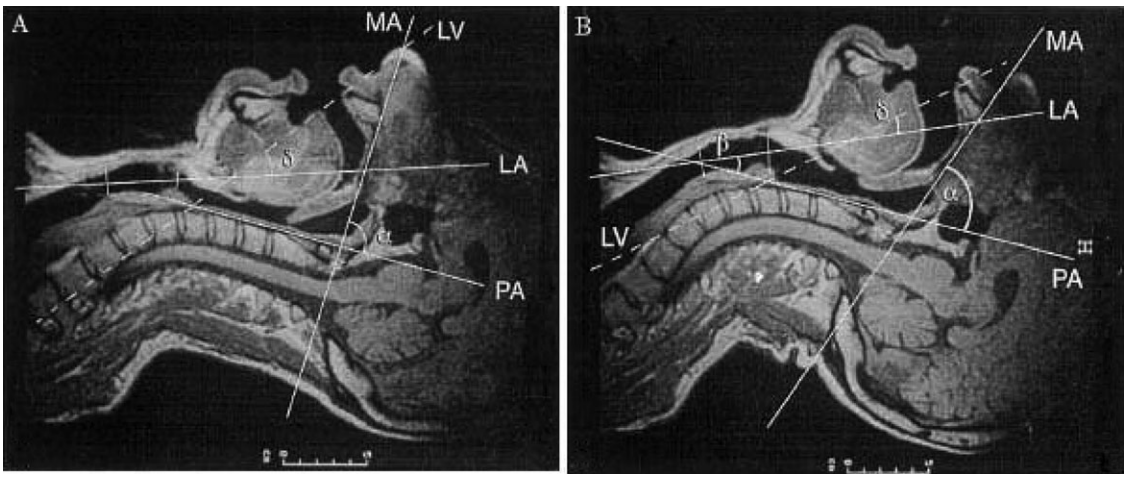

Fig 5 Mouth axis (MA), pharyngeal axis (PA), laryngeal axis (LA), line of vision (LV) in the two head positions; the effect of the 'sniffing' position. The magnetic resonance images are shown. (A) Neutral position; (B) simple head extension. (Reprinted with permission from the publication by Adnet and colleagues.[11])

inferior extremity of the superior incisors and the posterior extremity of the superior portion of the cricoid cartilage is slightly affected by this change and thus, a slight decrease in the angle between LA and LV can be expected.[11] In the 25° back-up position, laryngeal structures move a little more caudally by the gravity than in the supine position and the angle between LA and LV can be further decreased. The gravitational force may pull the laryngeal structures caudally directly and indirectly by pulling whole structure of upper thorax connected to the laryngeal structures. In the paralysed patients, the muscle tone to support the laryngeal structures will be lessened and the effect of gravity will be even more than that seen in awake and unparalysed patients. Thus, the change of effects of gravitational force in the caudal direction cannot be neglected.

This study has several limitations. All laryngoscopies were performed by one laryngoscopist. Although it may produce some bias, it also eliminates variations introduced by having multiple larygoscopists. We studied laryngoscopy with only one blade design. Curved blades are used to lift the epiglottis indirectly exerting upward and forward force on the hyoepiglottic ligament and have the potential to alter laryngeal exposure with minor changes in force and tip placement in the vallecula.[1 7] We performed laryngoscopy with a curved laryngoscope blade because a curved blade is more commonly used. Additionally, it was impossible to blind the laryngoscopist to the position or the sequence in which laryngoscopy was performed. This could have introduced bias in the amount of extension performed by the laryngoscopist. However, bias would be very small because the laryngoscopist tried to get the best laryngeal view in each position. Although maximum head extension and maximum lift with the laryngoscope were used in both positions, measurements of these variables were not achieved objectively in this study. We cannot completely exclude the possibility that maximum head extension may have been different in either position. However, the extent of head elevation was controlled because the lowest portion of every head was in contact with the table in both groups in this study. The increased amount of the endoscopy angle in the 25° back-up position almost reflected the table angle 25°. Therefore, a larger POGO score in the 25° back-up position was not associated with the increased endoscopy angle. However, the 25° back-up position provided better laryngeal view than the flat supine position. Further studies about these measurements are needed.

No patient in this study developed hypotension. However, the cardiovascular stability of the back-up position during induction of anaesthesia should be investigated further.

Use of the POGO scale is difficult to quantify Cormack and Lehane grades III and IV. It is not proven, but is reasonable to assume that a technique which improves the POGO score will be capable of converting Cormack and Lehane grade III or IV views to lower grade.

Levitan and colleagues[7] used an Airway Cam device to get the POGO score. However, we believed that endoscopic views also reflected the view obtained using the Airway Cam device because we used the 0° rigid endoscope that has a view perpendicular to LV and captured the best view while the laryngeal view was imaged continuously on a monitor.

Though the 25° back-up position is unconventional, the laryngoscopist in this study described that the practice including insertion of the blade and intubation was more comfortable in the back-up position than the supine position. Additionally, it eliminated the need for him to lower his head or bend his back or knees to see the larynx because the visual field was improved and the optimal position of the laryngoscopist's eye was moved upward.[14]

In conclusion, this study demonstrated significantly improved POGO scores by performing laryngoscopy in the 25° back-up position instead of the supine position.

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