J Anesth (2010) 24:526–530
DOI 10.1007/s00540-010-0962-x

ORIGINAL ARTICLE

# A comparison of direct laryngoscopic views depending on pillow height

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Received: 10 December 2009 / Accepted: 19 April 2010 / Published online: 8 June 2010


**Abstract**
*Purpose* This study was conducted to determine the optimal pillow height for the best laryngoscopic view.
*Methods* Fifty patients were enrolled and preanesthetic airway evaluations were recorded. After induction of anesthesia, the Macintosh 3 blade was used for direct laryngoscopy without a pillow or with a pillow 3, 6, or 9 cm high in randomized order while the laryngeal view was imaged continuously on a monitor of the integrated video system. The best direct laryngoscopic view was sought for in each condition and graded by one anesthesiologist. The correlations between the preanesthetic airway assessments and the pillow height providing the best laryngoscopic view were analyzed.
*Results* The laryngoscopic view with the 9-cm pillow was significantly superior to that with other pillows and without a pillow ($P < 0.001$). The incidence of difficult laryngoscopy (Cormack and Lehane grade 3) was 16% without a pillow. In these cases, laryngoscopic views were improved with a 9-cm pillow. In five patients with a short neck (<15 cm), better laryngoscopic view was observed with a 3- or 6-cm pillow compared with the 9-cm pillow. Neck length had a significant correlation ($\rho = 0.326$, $P = 0.027$) with the pillow height providing the best laryngoscopic views.
*Conclusion* We recommend the use of a 9-cm pillow during direct laryngoscopy in the sniffing position. In contrast, pillows <9 cm appear to be advantageous in short-necked patients.

**Keywords** Pillow height · Laryngoscopic view · Sniffing position

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## Introduction

The sniffing position has been advocated as a standard for direct laryngoscopy. In this position, the neck is flexed on the chest and the head is extended on the atlanto-occipital joint by elevating the head on a pillow [1, 2]. However, Adnet and colleagues demonstrated that the sniffing position does not achieve alignment of the axes of the mouth, pharynx, and larynx in awake patients [3], and systematic application of the sniffing position offers no appreciable advantage over simple extension for improvement of glottis visualization unless the patient is obese or has reduced neck mobility [4]. The proper positioning of a patient before direct laryngoscopy is a key step. In a randomized study with a crossover design [5], improved laryngeal view was demonstrated by performing laryngoscopy in the 25° head-up position compared with the supine position. In a study of 60 obese patients undergoing bariatric surgery, the ramped position (arranging blankets underneath the patient's upper body and head until horizontal alignment was achieved between the external auditory meatus and the sternal notch) improved laryngeal view when compared with a standard sniffing position [6]. However, there has been no study regarding the optimal pillow height for the best laryngoscopic view in the sniffing position.

We hypothesized that alignment of the three axes would be influenced by pillow height. The purposes of this study were to determine whether the sniffing position provides significant advantages over simple extension of the head on the table during direct laryngoscopy and to seek the optimal pillow height for the best direct laryngoscopic view.

## Methods

After obtaining Institutional Review Board approval and informed written consent, 50 adult patients with American Society of Anesthesiologists (ASA) physical status I–II were enrolled. They were scheduled for gynecologic laparoscopy or endoscopic sinus surgery under general anesthesia. Patients with ischemic heart disease or cerebrovascular disease, loose upper incisors, body mass index (BMI) >40 (kg/m$^2$), or with any history of difficult intubation were excluded. Preanesthetic airway assessments were performed in the sitting position by an attending anesthesiologist who was not subsequently involved in the airway management of the recruited patients. The modified Mallampati classification, thyromental distance, interincisor gap, range of head and neck movement on the sagittal plane, neck length, and occipital prominence were measured as follows: The oropharyngeal view was classified according to the modified Mallampati classification. The straight distance between the styloid process and the sternal notch was measured as the neck length with the head fully extended. Interincisor gap [7] was measured with the mouth fully opened. The range of the head and neck movement was measured as described by Wilson and colleagues [8]. The angle was then classified into two levels: <80° or >80°. The occipital prominence was measured as described by Axelsson et al. [9, 10]. After drawing an imaginary line from the opisthocranion (most posterior point on the surface of the cranial vault defined as the point furthest from nasion disregarding the external protuberance) toward the nasion area with the patient's neck extended, the shortest distance between the opisthocranion and the point perpendicular to the imaginary line at the level of the tragus was measured.

After premedication with midazolam 0.05 mg/kg intravenously, all patients were placed on a surgical bed without a pillow or with the uncompressible pillow of 3, 6, or 9 cm high in random order. Randomization was based on computer-generated codes that were maintained in sealed opaque envelopes. After induction of anesthesia with intravenously administered propofol 1.5 mg/kg, alfentanil 6 μg/kg, and rocuronium 0.6 mg/kg, direct laryngoscopy was performed in the sniffing position on the pillows or without a pillow. All laryngoscopies were performed by an experienced investigator. During the laryngoscopy, the consistent height of a surgical bed (at the same level as the investigator's anterior superior iliac spine) was obtained throughout this study. Using the Macintosh 3 blade, a 0° rigid endoscope (Olympus Corporation, Hamburg, Germany) was inserted into the oral cavity to obtain the best view of the glottis without external laryngeal pressure. The laryngeal view was imaged continuously on a monitor of the integrated video system (Olympus Corporation, Tokyo, Japan). The rigid endoscope was placed at the midline of the oral cavity. After capturing the best obtainable laryngoscopic view for each patient, a mark was made on the rigid endoscope corresponding to the center of the lips, and the endoscope was maintained at the same depth that had been determined to be the best for each patient. In the same way, the intubating position was repeated by using the other pillows or without a pillow, and the best laryngoscopic view was recorded in each condition. Intermittent manual ventilations by a face mask under 100% oxygen and sevoflurane were provided to prevent desaturation.

The captured laryngoscopic views without or with the three different headrests were graded by a different anesthesiologist using the percentage of glottic opening (POGO) score [11] and Cormack and Lehane grade [12]. The POGO score describes how much of the glottic opening is visible [11]. For cases in which the whole glottis could not be seen, the full glottis view was obtained and recorded under external laryngeal pressure. Electrical calipers were used to determine the relative lengths of the glottic openings. The evaluating anesthesiologist was blinded to the headrest used. In the recovery room after surgery, the patients were asked about the presence of sore throat or dysphagia.

Sample sizes were determined based on data from our pilot study obtained from 20 patients [POGO score; standard deviation (SD) = 35%]. Assuming a clinically significant difference in POGO score of 25% [5] between without a pillow and with a pillow providing the best laryngoscopic view, power analysis suggested that a minimum of 42 patients would be required for a $\beta = 0.1$ and $\alpha = 0.05$. To compensate for potential dropouts, we enrolled 50 patients. The laryngoscopic views were classified depending on the degree of glottic visualization under direct laryngoscopy with Cormack and Lehane grade. Thereafter, we divided the Cormack and Lehane grade 2 into 4 grades (2-1 to 2-4): grade 1: when the full view of the glottis was observed; grade 2-1: when more than 3/4 of the whole length of the glottis was observed; grade 2-2: when more than half, but less than three fourths of the whole length of the glottis was observed; grade 2-3: when more than one fourth but less than one half of the whole length of the glottis was observed; grade 2-4: when less than one fourth of the whole length of the glottis was observed; srade 3: none of the glottic opening was seen.

Data are presented as mean values ± SD unless noted otherwise. POGO scores at four headrests were analyzed by repeated measures analysis of variance (ANOVA). Page's trend test [13] was used for analysis of the difference in laryngeal views with the four pillows. The correlation of preanesthetic airway assessments with the pillow height providing the best laryngeal views was analyzed by Spearman's rank order correlation. A $P$ value <0.05 was considered statistically significant.

## Results

Preanesthetic airway assessments are shown in Table 1. Intubations under direct laryngoscopy were successful for all patients. Distribution of laryngoscopic views depending on pillow height is shown in Table 2. The laryngoscopic view of the 9-cm pillow was significantly superior to that with other pillows and without a pillow ($P < 0.001$, Figs. 1, 2).

The incidence of difficult laryngoscopy defined as Cormack and Lehane grade 3 was 16% (8/50 individuals) without a pillow. In these cases, laryngoscopic views were improved with the use of a higher pillow, and the incidence of difficult laryngoscopy was 0% with a 9-cm pillow (Table 2). In five patients, the best laryngoscopic view was obtained with the 3- or 6-cm pillow. These patients all had a shorter neck length than the other patients (Table 3). Neck length was the only preoperative measurement that had a significant correlation with pillow height to provide the best laryngoscopic view ($\rho = 0.326$, $P = 0.027$). There was no complication associated with four laryngoscopies, such as sore throat and dysphagia. The total time for the four laryngoscopies was <90 s for each patient, and none of the patients showed a pulse oximeter reading <95% during the intubation attempts.

**Table 1** Patient characteristics

| Preanesthetic airway assessment ($n = 50$) | Values |
|---|---|
| Age (year) | 40 ± 11 |
| Sex (male/female) | 18/32 |
| Weight (kg) | 61 ± 11 |
| Height (cm) | 163 ± 9 |
| Body mass index (kg/m$^2$) | 22.4 ± 3.0 |
| Mallampati score (1/2/3/4) | 9/23/15/3 |
| Interincisor gap (<35 mm/>35 mm) | 3/47 |
| Thyromental distance (<6 cm/>6 cm) | 12/38 |
| Neck length (cm)[a] | 17.8 ± 1.7 |
| Occipital prominence (cm)[b] | 8.0 ± 1.2 |
| The range of neck motion (>80°/<80°) | 43/7 |

Data are mean ± standard deviation (SD) or number of patients

[a] Neck length = the straight distance between the styloid process and the sternal notch with the head fully extended

[b] Occipital prominence = after drawing an imaginary line from the opisthocranion towards the nasion area, the shortest distance between the opisthocranion and the point perpendicular to the imaginary line at the level of the tragus

## Discussion

This study shows that the sniffing position produced by the 9-cm pillow most likely provided the best laryngoscopic

**Table 2** Distribution of laryngeal views depending on headrest height

| Laryngoscopic view grade[a] | Pillow height ($n = 50$) | | | |
|---|---|---|---|---|
| | 0 cm | 3 cm | 6 cm | 9 cm* |
| 1 | 0 | 0 | 1 | 9 |
| 2-1 | 10 | 17 | 23 | 26[b] |
| 2-2 | 24[b] | 24[b] | 20[b] | 12 |
| 2-3 | 8 | 3 | 2 | 3 |
| 2-4 | 0 | 2 | 2 | 0 |
| 3 | 8 | 4 | 2 | 0 |

The laryngoscopic view with the 9-cm pillow was superior to those of other headrests; *$P < 0.001$, Page's trend test

[a] The laryngoscopic views were classified depending on the degree of glottic visualization under direct laryngoscopy: Grade 1, 100% of the glottis; grade 2-1, 75–99%; grade 2-2, 50–74%; grade 2-3, 25–49%; grade 2-4, 1–24%; grade 3, none of the glottis

[b] Data of the median

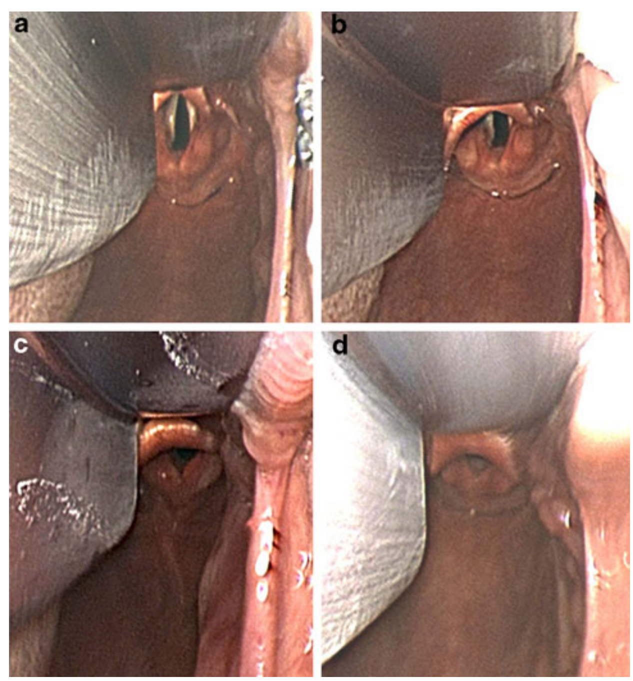


**Fig. 1** Laryngoscopic views in a patient. Views improved with use of a higher pillow. **a** 9-cm pillow, **b** 6-cm pillow, **c** 3-cm pillow, **d** without pillow

view, with the only exception being in patients with a short neck (<15 cm), in which case the 3- or 6-cm pillows provided the best view. This finding is contrary to those by Adnet and colleagues [3, 4], who found that the oral, pharyngeal, and laryngeal axes in eight healthy unanesthetized volunteers were not aligned with the sniffing position (with 7-cm headrest). Although the anatomic axes were not measured under general anesthesia in our study, this discrepancy may be caused primarily by application of the laryngoscopy. With the Macintosh curved blade (MCB), the hyoid was drawn forward and its body tilted downward during laryngoscopy and intubation [14]. Therefore, the use of laryngoscopy may produce a change of the anatomic axes [3]. Moreover, our findings are contrary to those by Adnet and colleagues that the laryngoscopic views were similar in the sniffing position and simple head extension [4]. It is assumed that increasing

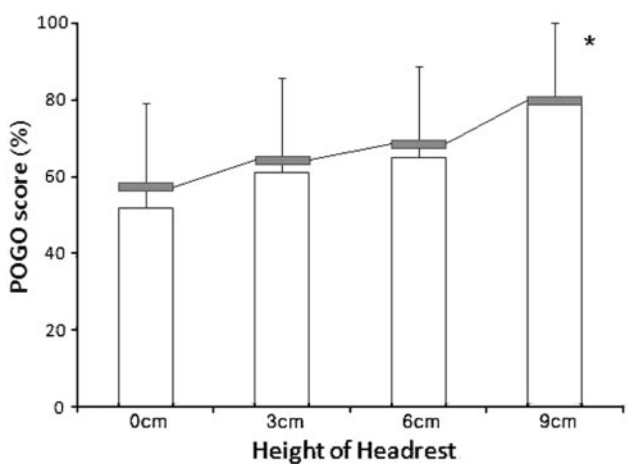


**Fig. 2** Change in percentage of glottic opening (POGO) scores depending on pillow height. Laryngoscopic view with the 9-cm pillow was significantly superior to that of other pillows and without a pillow ($P < 0.001$ by repeated measures analysis of variance). Values are mean ± standard deviation (SD) of POGO score. *Rectangular form lines* are median values at each pillow

pillow height may improve the laryngoscopic view by increasing the occipitoalantoaxial (OAA) angle and enlarging the submandibular space [15]. A radiologic study showed that the sniffing position provides greater OAA extension angle than simple extension of the head and that flexion of the lower cervical spine is needed for maximum extension of the OAA complex [16]. Moreover, the sniffing position increases the submandibular space and facilitates vertical alignment of the mandible, tongue base, and larynx [15]. Interestingly, the laryngoscopic view with the 9-cm pillow was significantly superior to that of the 6-cm pillow. The additional flexion achieved with the 9-cm pillow may support posterior movement of the larynx during laryngoscopy, thus an angle between line of vision and laryngeal axis may be decreased and OAA extension angle may be increased, which needs to be verified with further studies.

Although the images on the monitor, which were used for grading, may not be the same as the direct laryngoscopic view, we tried to align the angle of the rigid endoscope parallel with the axis of the line of vision during direct laryngoscopy. Levitan and colleagues [17] used an Airway Cam device™ to attain POGO score. However, endoscopic views are also believed to reflect views obtained under direct laryngoscopy because the 0° rigid endoscope had a view perpendicular to the line of vision and captured the best view while the laryngeal view was imaged continuously on a monitor [5].

Our study has some limitations. First, it was impossible to completely blind the anesthesiologist to the position or the order of randomization in which direct laryngoscopy was performed. This may have introduced a bias during assessment of the laryngoscopic view and/or during the force exerted on the laryngoscope blade at laryngoscopy. For this reason, the responsible anesthesiologist always tried to get the best laryngoscopic view at maximum head extension and maximum lift with the laryngoscope on each pillow, and the evaluating anesthesiologist was blinded to the pillow used when grading the captured laryngoscopic

**Table 3** Analysis of five cases when better laryngoscopic views were observed with 3- or 6-cm pillows

| Patient | OPC | TD (cm) | IG (cm) | HNM | NL (cm)[a] | OP (cm) | Pillow height of the best laryngoscopic score[b] |
|---|---|---|---|---|---|---|---|
| 1 | 2 | 7 | 5 | <80° | 12 | 9 | 2-3 at 6 cm pillow |
| 2 | 2 | 7.5 | 5 | >80° | 12 | 7.5 | 2-1 at 3 cm pillow |
| 3 | 3 | 6.5 | 3 | >80° | 13 | 6 | 2-1 at 6 cm pillow |
| 4 | 2 | 7.5 | 4.5 | >80° | 14 | 7 | 2-1 at 6 cm pillow |
| 5 | 2 | 7 | 5 | >80° | 14 | 8 | 2-2 at 6 cm pillow |

*OPC* oropharyngeal classification, *TD* thyromental distance, *IG* interincisor gap, *HNM* amplitude of head and neck movement, *NL* neck length, *OP* occipital prominence

[a] This analysis revealed that patients with short neck length (<15 cm) showed poorer laryngoscopic views with the 9-cm pillow

[b] The best laryngoscopic view was obtained with the 3- or 6-cm pillow. Grade 1: 100% of the glottis; grade 2-1: 75–99%; grade 2-2: 50–74%; grade 2-3: 25–49%; grade 2-4: 1–24%; grade 3: none of the glottis

views. Second, we did not apply any pillow higher than 9 cm (such as 12 cm). Based on the finding of our study that 3- or 6-cm pillow provided better laryngoscopic view in short-necked patients, it is thought that the use of any pillow higher than 9 cm provides a poorer laryngoscopic view of the glottis. However, application of a pillow higher than 9 cm may be needed in further studies of taller Western people.

In conclusion, this study demonstrates that the sniffing position provides better laryngoscopic views over simple extension of the head on the table. It is recommended to use a 9-cm pillow during direct laryngoscopy in the sniffing position. Additionally, pillows <9 cm appear to be advantageous in short-necked patients.

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