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Research Article

The effect of different pillow heights on direct laryngoscopic views: A prospective randomised controlled study

Sandip Sinha *, Amitava Layek, Sulagna Bhattacharjee, Avijit Hazra

I.P.G.M.E.R. – Institute of Post Graduate Medical Education and Research, Kolkata, West Bengal, India

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KEYWORDS

Sniff position;
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Abstract *Purpose:* The purpose of this study was to determine the optimal pillow height for the best laryngoscopic view in adult patients scheduled for elective surgery under general anaesthesia.
Methods: A total of fifty adult patients without any anticipated difficult airway and who gave proper informed consent were enrolled for the study. The preanaesthetic airway evaluations were done in all the patients and were recorded. After induction of anaesthesia, the appropriate sized Macintosh blade was used for direct laryngoscopy. The assessment of direct laryngoscopic views was done at head positions without a pillow and with non-compressible pillows of heights 4.5 cm, 9 cm and 13.5 cm, respectively. The views were simultaneously imaged with a flexible fibreoptic bronchoscope attached along the junction between the tongue and the flange of the Macintosh blade, and the position offering the best view was sought for which was graded by one anaesthesiologist.
Results: The laryngoscopic view with the 4.5 cm pillow was significantly superior to that with other pillows and without a pillow ($p < 0.01$). The incidence of difficult laryngoscopy (Cormack and Lehane grade 3) was 18% without a pillow. In these cases, laryngoscopic views were improved using a 4.5 cm pillow.
Conclusion: The use of a 4.5 cm pillow is recommended during direct laryngoscopy in the 'sniff' position for obtaining the best laryngoscopic view.

* Corresponding author. Address: 16/D Rishi Bankim Street, Konnagar, Hooghly, West Bengal 712 235, India. Tel.: +91 9831865165.
E-mail address: dr.sandipsinha72@yahoo.in (S. Sinha).
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1. Introduction

Direct laryngoscopy is used to facilitate tracheal intubation under vision. Successful direct laryngoscopy depends on achieving a line of sight from the maxillary teeth to the larynx [1]. It has been clearly established in several studies that proper positioning of head and neck is one of the most important steps towards laryngoscopy and tracheal intubation which helps in obtaining a good glottic view, thus minimising the rate

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of tracheal injury, duration of the procedure, repeated attempts at laryngoscopy and intubation and ultimately reducing the overall rate of trauma and further complications. Best laryngoscopic views are obtained when oro-pharyngo-laryngeal axes come in a straight line. The 'sniff' 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 pillows [2,3]. The 'sniff' position is usually the best starting position for direct laryngoscopy. In the 'sniff' position, the cervical spine below C5 is relatively straight, there is increasing flexion from C4 to C2, and the head is fully extended (occipito–atlanto–axial complex) [4]. Neck flexion between C2 and C4 is achieved by elevation of the head. No statistical advantage of the 'sniff' position over simple head extension was found in one study, except in the presence of obesity or limited head extension [5]. However, the 'sniff' position facilitated a view of the larynx in 4% of patients in whom this was not possible with simple head extension. The 'sniff' position also improves pharyngeal airway patency in patients with obstructive sleep apnoea [1]. However, Adnet and colleagues demonstrated that the 'sniff' position does not achieve alignment of the axes of the mouth, pharynx and larynx in awake patients [6] and systematic application of the 'sniff' position offers no appreciable advantage over simple extension for improvement of glottic visualisation unless the patient is obese or has reduced neck mobility [5]. The proper positioning of a patient before direct laryngoscopy is a key step. In a randomised study with a crossover design [7], 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 [8]. However, there has been no study regarding the optimal pillow height for the best laryngoscopic view in the 'sniff' position targeting the Indian population. We hypothesised that alignment of the three axes would be influenced by pillow height. The purpose of this study was to seek the optimal pillow height for the best direct laryngoscopic view.

2. Methods

After obtaining Institutional Ethics Committee approval and written informed consent from each of the patients, this prospective, randomised study was conducted in the Department of Anaesthesiology at I.P.G.M.E.R and S.S.K.M Hospital, Kolkata, from 2012 to 2013 in 50 adult patients of either sex, aged between 30 and 60 years with ASA physical status I–II scheduled for urosurgical procedures under general anaesthesia. Patients with uncontrolled hypertension, ischaemic heart disease, cerebrovascular disease, end stage renal disease, uncontrolled diabetes, body mass index (BMI) > 30 kg/m^2, or with any history of difficult airway were excluded. Preanaesthetic airway assessments were performed by an attending anaesthesiologist who was not subsequently involved in the airway management of the recruited patients. The modified Mallampatti classification, thyromental distance, interincisor gap, range of head and neck movement on the sagittal plane, neck length (the straight distance between the styloid process and the sternal notch with the head fully extended) and 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) were measured. The straight distance between the styloid process and the sternal notch was measured as the neck length with the head fully extended. Interincisor gap [9] was measured with the mouth fully opened. The range of the head and neck movement was measured as described by Wilson and colleagues [10]. The angle was then classified into two levels: $< 80°$ or $> 80°$. The occipital prominence was measured as described by Axelsson et al. [11,12].

The patients were premedicated with injection midazolam 0.05 mg/kg intravenously, and all patients were placed on a surgical bed without a pillow or with non-compressible pillows of 4.5, 9, 13.5 cm height in random order. Randomisation was based on computer-generated codes that were maintained in serially numbered, sealed, opaque envelopes. After induction of anaesthesia with intravenously administered propofol 2 mg/kg, fentanyl 2 μg/kg and rocuronium 1 mg/kg, direct laryngoscopy was performed in the 'sniff' position on the pillows or without a pillow. All laryngoscopies were performed by an experienced anaesthesiologist. During laryngoscopy, the consistent height of a surgical bed (at the same level as the investigator's anterior superior iliac spine) was maintained throughout this study. Using the appropriate sized Macintosh blade and a flexible fibreoptic bronchoscope (Karl Storz) attached to the junction between the tongue and the flange with an adhesive tape, direct laryngoscopy was performed to obtain the best view of the glottis without any external laryngeal manipulation. The laryngeal view was imaged continuously on a monitor of the integrated video system (Karl Storz) and recorded. In the same way, the intubating position was repeated by using the 4.5 cm, 9 cm, 13.5 cm pillows or without a pillow, and the best laryngoscopic view was recorded in each position. After this, a 0° rigid endoscope (Karl Storz) was inserted into the oral cavity to obtain the best view of the entire glottis without external laryngeal pressure. The rigid endoscope was placed at the midline of the oral cavity and the best view of the entire glottis was recorded in each patient. Intermittent manual ventilation by face mask with 100% oxygen was provided to prevent desaturation, if at any time during the procedure the patient's oxygen saturation dropped below 95%. The captured laryngoscopic views without or with the three different pillows were graded by a different anaesthesiologist using the percentage of glottic opening (POGO) score [13] and Cormack and Lehane (CL) grade [14]. The POGO score describes how much of the glottic opening is visible [13]. Electronic calipers were used to determine the relative lengths of the glottic openings. The laryngoscopic blade was also checked for the presence of any visible blood. The evaluating anaesthesiologist was blinded to the pillow used. In the post-anaesthesia care unit, after surgery, the patients were asked about the presence of sore throat or dysphagia.

The laryngoscopic views were classified depending on the degree of glottic visualisation under direct laryngoscopy with Cormack and Lehane grade. Thereafter, we divided the Cormack and Lehane grade 2 into 4 sub-grades (2–1 to 2–4)

Table 1 Descriptive statistics of study patient characteristics ($n = 50$).

Parameter	Range	Mean ± SD.
Age (year)	30–60	44.8 ± 9.66
BMI (kg/m^2)	17.8–30	23.7 ± 3.16
IG (cm)	3.4–4.3	3.8 ± 0.23
NT (cm)	30–41	36.0 ± 2.84
TMD (cm)	7.3–9.6	8.7 ± 0.44
NL (cm)	16.7–19.1	17.1 ± 1.25
OP (cm)	6.0–9.5	7.8 ± 1.32

[15]: Grade 1: when the full view of the glottis (100%) was observed; Grade 2–1: when more than three-fourths of the whole length of the glottis (75–99%) was observed; Grade 2–2: when more than half, but less than three-fourths of the whole length of the glottis (50–74%) was observed; Grade 2–3: when more than one-fourth but less than one-half of the whole length of the glottis (25–49%) was observed; Grade 2–4: when less than one-fourth of the whole length of the glottis (1–24%) was observed; Grade 3: none of the glottic opening was seen.

3. Statistical analysis

The sample size was calculated on the basis of the mean POGO score difference expected between the four study groups. It was calculated that 46 subjects would be required per group for a difference of 5 between any two groups to show up as statistically significant. This calculation assumed the standard deviation (SD) of POGO score to be 10, the correlation between POGO scores to be at least 0.3, power to be 80% and type I error probability to be 5%. To compensate for potential drop-outs, we enrolled 50 patients.

Data were summarised by routine descriptive statistics, namely mean and standard deviation for normally distributed numerical variables, and median and interquartile range (i.e. 25th–75th percentile range) for skewed variables. Shapiro–Wilk test goodness-of-fit test was employed for assessing normality. Comparison of Cormack Lehane (CL) grading and POGO scoring across progressively increasing height of the pillow was done by Friedman's analysis of variance (ANOVA) followed by Dunn's test as post hoc test to compare between any two pillow heights. Haemodynamic variables were compared between pre-operative and post-intubation states by Wilcoxon's matched pairs signed rank test. Statistica version 6 [Tulsa, Oklahoma: StatSoft Inc., 2001] and Graph Pad Prism version 5 [San Diego, California: GraphPad Software Inc., 2007] software were used for analysis. A p value < 0.05 was considered as statistically significant.

Table 3 Dunn's multiple comparison test of Cormack Lehane (CL) grade ($n = 50$).

Comparison	Diff in rank sum	p value
No pillow vs. pillow 4.5 cm	103.5	< 0.001
No pillow vs. pillow 9 cm	48.5	< 0.01
No pillow vs. pillow 13.5 cm	−30.0	> 0.05
Pillow 4.5 cm vs. pillow 9 cm	−55.0	< 0.001
Pillow 4.5 cm vs. pillow 13.5 cm	−133.5	< 0.001
Pillow 9 cm vs. pillow 13.5 cm	−78.5	< 0.001

Table 4 Dunn's multiple comparison test of POGO scoring ($n = 50$).

Comparison	Diff in rank sum	p value
No pillow vs. pillow 4.5 cm	−105.00	< 0.001
No pillow vs. pillow 9 cm	−53.000	< 0.001
No pillow vs. pillow 13.5 cm	32.000	> 0.05
Pillow 4.5 cm vs. pillow 9 cm	52.000	< 0.001
Pillow 4.5 cm vs. pillow 13.5 cm	137.00	< 0.001
Pillow 9 cm vs. pillow 13.5 cm	85.000	< 0.001

4. Results

Descriptive statistics of study patient characteristics are shown in Table 1.

Distribution of laryngoscopic views depending on pillow height [Cormack Lehane (CL Grade) and POGO score descriptive statistics] are shown in Table 2.

Dunn's Multiple Comparison Test of Cormack Lehane (CL) Grade is shown in Table 3.

Dunn's Multiple Comparison Test of POGO scoring is shown in Table 4.

Fig. 1 shows the laryngoscopic views in a patient observed without use of pillow (a) and with 4.5 cm (b), 9 cm (c) and 13.5 cm (d) pillow heights, respectively.

The laryngoscopic view of the 4.5 cm pillow was significantly superior to that with other pillows and without a pillow ($p < 0.05$).

A total of 50 adult patients (29 male and 21 female patients) of ASA Grade I & II (22 patients ASA Grade I and 28 patients ASA Grade II) without any anticipated difficult airway were included in our study.

In this cohort of 50 subjects, Body Mass Index (BMI), Inter-incisor gap (IG), Thyromental distance (TMD), Neck thick-

Table 2 Cormack Lehane (CL) Grade and POGO score descriptive statistics ($n = 50$).

Pillow height (cm)	CL grade			POGO score		
	Range	Mean ± SD	Median (IQR)	Range	Mean ± SD	Median (IQR)
Nil	2.10–3.00	2.37 ± 0.31	2.30(2.20–2.30)	0.00–90.00	47.12 ± 25.826	46.00(33–70)
4.5	1.00–2.20	1.34 ± 0.52	1.00(1.00–2.10)	64.00–100.00	93.60 ± 9.626	99.00(88–100)
9	1.00–2.40	2.12 ± 0.296	2.20(2.10–2.20)	25.00–100.00	65.64 ± 19.640	68.00(54–80)
13.5	2.10–3.00	2.42 ± 0.25	2.40(2.30–2.40)	0.00–80.00	30.42 ± 21.233	23.00(18–45)

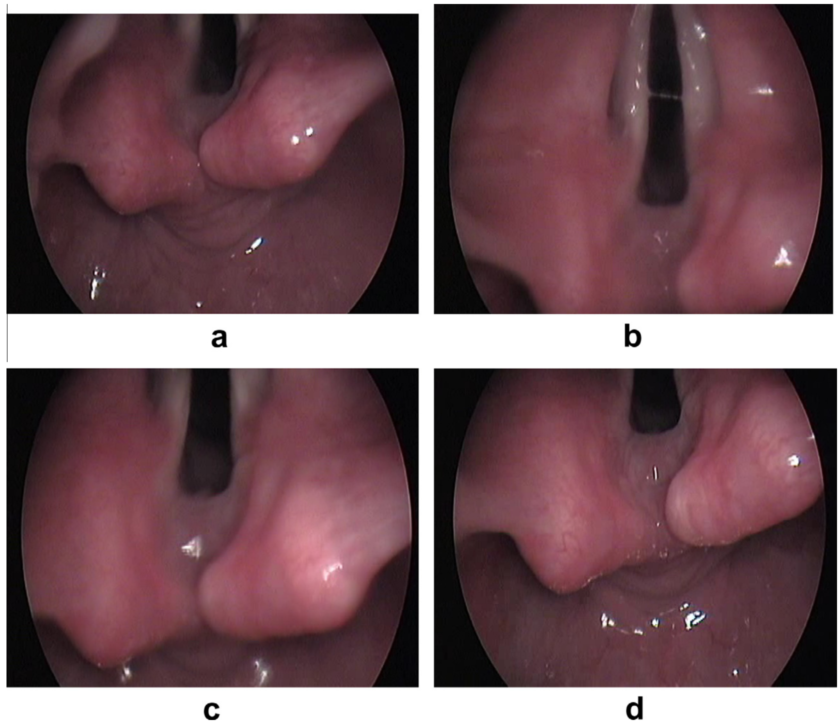

Figure 1 Laryngoscopic views in a patient observed without use of pillow (a) and with 4.5 cm (b), 9 cm (c) and 13.5 cm (d) pillow heights respectively.

ness (NT), Neck length (NL), Occipital Prominence (OP), Heart Rate (HR), Systolic Blood Pressure (SBP), Diastolic Blood Pressure (DBP) and Mean Arterial Pressure (MAP) were found to be normally distributed. Age, CL grade and POGO scoring were not normally distributed.

Buck teeth were present in 10 of the 50 patients; 36 patients had MP Grade 1, 12 patients MP Grade 2 and only three patients had MP Grade 3. The range of neck motion was > 80° in 35 patients and < 80° in 15 patients.

It is seen that mean Cormack Lehane Grade is lower and POGO score is greater in case of 4.5 cm pillow height.

From the above table, it is clear that CL grading at 4.5 cm pillow height is significantly lower than CL grading without pillow and pillow heights of 9.0 cm and 13.5 cm.

For both the above parameters (CL grade and POGO score), it appears that the 4.5 cm pillow height is the best. There is no statistically significant difference between No pillow and pillow of 13.5 cm height.

Intubations under direct laryngoscopy were successful in all patients. The laryngoscopic view of the 4.5 cm pillow was significantly superior to that with other pillows and without a pillow ($p < 0.05$). The incidence of difficult laryngoscopy (Cormack and Lehane grade 3) was 18% (9 of 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% using a 4.5 cm pillow.

There were no complications associated with four laryngoscopies in each patient, 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. As expected the haemodynamic variables, namely HR, SBP, DBP and MAP showed a statistically significant difference between pre-operative and post-intubation values. However, group means were well within clinically acceptable range at both time points and no extreme deviations were observed in any subject.

5. Discussion

This study shows that the 'sniff' position produced by the 4.5-cm pillow provided the best laryngoscopic view. This finding is contrary to those by Adnet and colleagues [5,6], who found that the oral, pharyngeal and laryngeal axes in eight healthy unanaesthetised volunteers were not aligned with the 'sniff' position (with 7-cm headrest). Another study by Schmitt and Mang suggests that head and neck elevation beyond the 'sniff' position may improve laryngoscopic view [5,16]. This discrepancy may be caused primarily by application of the laryngoscopy. With the Macintosh curved blade, the hyoid was drawn forward and its body tilted downward during laryngoscopy and intubation [17]. Therefore, the use of laryngoscopy may produce a change of the anatomic axes [6]. Moreover, our findings are contrary to those by Adnet and colleagues that the laryngoscopic views were similar in the 'sniff' position and simple head extension [5]. It is assumed that increasing pillow height may improve the laryngoscopic view by increasing the occipitoatlantoaxial angle and enlarging the submandibular space [18]. A radiologic study showed that the 'sniff' position provides greater occipitoatlantoaxial extension angle than simple extension of the head and that flexion of the lower cervical spine is needed for maximum extension of the occipitoatlanto-axial complex [19]. Moreover, the 'sniff' position increases the submandibular space and facilitates vertical alignment of the mandible, tongue base and the larynx [19]. The laryngoscopic view with the 4.5-cm pillow was significantly superior to that of the view without pillow. The additional flexion achieved with the 4.5-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 occipitoatlantoaxial extension angle may be increased. We tried to align the angle of the rigid endoscope parallel with the axis of the line of vision during direct laryngoscopy, so that the images on the monitor, which were used for grading, were the same as the direct laryngoscopic view. Levitan and colleagues [20] used an Airway Cam deviceTM to attain POGO score. In our study, we used Telecam DX pal 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 [7].

In conclusion, this study demonstrates that the 'sniff' position using a 4.5-cm pillow provides the best laryngoscopic views when compared with other pillows and that without a pillow. It is recommended to use a 4.5-cm pillow during direct laryngoscopy in the 'sniff' position for obtaining the best view. In future studies, it may be worthwhile to explore in other populations, whether similar conclusion is reached regarding optimal pillow height for the best laryngoscopic view.

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