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Original Research Article

Efficacy of Customized Versus Fixed Height Head Elevation in Sniffing Position for Endotracheal Intubation - A Comparative Study

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Abstract:

Background: The sniffing position is commonly used for optimal intubation during endotracheal procedures, but the precise alignment required can vary. This study aims to assess whether using a customized pillow to align the external auditory meatus (EAM) with the sternal notch improves glottic visualization and eases the intubation process, compared to a fixed-height pillow.

Methods: This comparative, prospective study was approved by the institutional ethics committee and conducted with 450 adult patients (ASA PS I-IV) undergoing elective surgeries. Patients were randomized into two groups: the Fixed Pillow (FP) group, where a standard 4 cm height pillow was used, and the Custom Pillow (CP) group, where additional sheets were placed to align the EAM with the sternal notch. Primary outcomes included Cormack-Lehane (CL) grading of glottic visualization, intubation time, number of attempts, and the need for assistance (e.g., bougie, stylet, external laryngeal manipulation). Data were analyzed using unpaired t-tests and odds ratios, with a significance level of $P < 0.05$.

Results: A total of 450 patients completed the study. The mean pillow height in the CP group was 6.22 ± 0.83 cm. While the difference in CL grading between the groups was not statistically significant, the CP group showed a significantly shorter intubation time (13.52 ± 3.01 seconds) compared to the FP group (15.85 ± 3.14 seconds, $P = 0.01$). Additionally, the CP group had fewer intubation attempts ($P = 0.04$).

Conclusion: Customizing pillow height to achieve horizontal alignment of the EAM with the sternal notch improves intubation efficiency by reducing both time and attempts. This approach may be particularly beneficial for patients with difficult airways.

Keywords: Customized Pillow, Intubation, Glottic Visualization, Laryngoscopy, Sniffing Position, Cormack-Lehane Grading.

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Introduction

Optimal positioning of the head and neck for endotracheal intubation has long been a subject of debate within airway management. Over the past few decades, various theories and modifications to intubation positioning have emerged. The earliest approach to achieving proper positioning involved full extension of the head and neck on a flat surface. This was later modified with the introduction of the sniffing position, which involves placing a pillow under the occiput to raise the head. Today, the sniffing position is considered the most widely accepted and effective technique for intubation.[1] It typically involves a neck flexion of approximately 35° combined with atlanto-occipital joint extension of around 15°.[2] The three-axis alignment theory (TAAT) is often cited as the most anatomically sound explanation for the mechanics behind this positioning,[3] although newer theories are still being explored and have yet to gain widespread acceptance.

A key component of the sniffing position is achieving appropriate head elevation, typically accomplished through the use of a pillow or a head ring. Studies have consistently shown that head elevation improves glottic visualization, which is critical for successful intubation. However, the optimal degree of head elevation remains a point of contention, with studies reporting varying heights for ideal positioning. [4,5–10] Some studies suggest no significant advantage over simple head extension. In recent years, the concept of horizontal alignment between the external auditory meatus (EAM) and the sternal notch has been proposed as an effective marker for appropriate head positioning. This alignment is similar to the ramping technique, which has been shown to improve intubation in obese patients but is not commonly applied to non-obese individuals.

Although the sniffing position remains the gold standard for intubation, the lack of consensus on the ideal degree of head elevation highlights the dynamic and evolving nature of airway management practices.

Aims and Objectives

This study aims to evaluate whether a customized pillow designed to achieve horizontal alignment of the external auditory meatus with the sternal notch improves glottic visualization and eases endotracheal intubation compared to the use of a fixed-height pillow, which is the standard practice. The primary objective is to assess the glottic view using Cormack-Lehane grading, while secondary outcomes include the time taken for intubation, the number of attempts, and the need for additional assistance, such as a bougie, stylet, or external laryngeal manipulation. The study seeks to fill the gap in the current literature regarding the potential benefits of custom pillow use in intubation.

Materials and Methods

Study Design: This comparative cross-sectional study was conducted in the Major Operation Theatre of NMCH, Government Medical College, Kozhikode, over a period of two years from 2019 to 2021.

Inclusion and Exclusion Criteria: The study included patients aged 16 years or older, belonging to ASA physical status I–IV, who were scheduled for elective surgeries requiring tracheal intubation. Patients were excluded if they were pregnant, had a BMI greater than 30, a mouth opening of less than 3 cm, or a thyromental distance shorter than 5.5 cm. Those with an unstable cervical spine, any contraindication to conventional laryngoscopy, or contraindications to the medications used in the study were also excluded.

Sample Size Calculation: Calculated based on a study conducted by Mridul Dhar et al [9]

Sample size was calculated using the formula

$$n = \frac{(Z\alpha + Z\beta)^2 + SD^2}{d^2} \; x\; 2$$

Sample size was found to be 215 in each group. (SD = 0.74, d=0.2). A sample size of 225 was assigned to each group to accommodate any dropouts from the study.

Data Collection Procedure: Data collection was carried out after obtaining institutional ethical and research committee approvals and informed written consent from all participants. Patients were assigned to either the Fixed Pillow (FP) group, using a standard 4 cm head ring, or the Customized Pillow (CP) group, where additional sheets were added to align the external auditory meatus with the sternal notch. Pre-anesthesia assessment included demographic details and airway parameters. Standard monitors were applied, and patients were placed in their allocated sniffing position before being preoxygenated with 100% oxygen for three minutes. Anesthesia was induced with fentanyl, propofol, and succinylcholine, followed by 60 seconds of ventilation. An experienced anesthesiologist performed laryngoscopy, recorded the Cormack–Lehane grade, and measured intubation time from insertion to removal of the laryngoscope blade. Endotracheal tube placement was confirmed using $EtCO_2$ and auscultation, and for multiple attempts, total intubation time was summed. Glottic visualization was documented using the Cormack–Lehane grading system.

Statistical Analysis: Statistical analysis was performed using the SPSS software system, with data presented as numbers, percentages, and mean ± standard deviation where appropriate. Comparisons between groups were made using the unpaired t-test to determine the level of significance, and a P value of less than 0.05 was considered statistically significant.

Results

Demographic Profile of Study Participants

Table 1: Baseline Demographic Characteristics of the Two Groups

Parameter	FP (n=225)	CP (n=225)	p-value
Age (years), Mean ± SD	45.95 ± 14.38	44.60 ± 14.42	0.319
Sex: Male	116 (51.5%)	106 (47.1%)	
Sex: Female	109 (48.4%)	119 (52.9%)	0.396*

Table 1 shows that the demographic parameters (age and gender distribution) were comparable across the two groups with no statistically significant differences.

Table 2: Comparison of Anthropometric Variables

Parameter	FP (Mean ± SD)	CP (Mean ± SD)	p-value
Weight (kg)	61.07 ± 8.48	59.84 ± 6.89	0.094
Height (m)	1.602 ± 0.128	1.589 ± 0.124	0.277
BMI (kg/m²)	23.86 ± 2.66	23.78 ± 2.31	0.752

Table 2 shows that weight, height, and BMI values did not differ significantly between the two groups, indicating comparable anthropometric characteristics.

Table 3: ASA Physical Status Classification

ASA Class	FP (n=225)	CP (n=225)	p-value
ASA I	80	73	
ASA II	108	130	
ASA III	37	22	0.565

Table 3 observes that both groups had similar preoperative ASA physical status classifications, with no statistically significant differences, supporting uniform clinical risk distribution.

Airway Assessment Parameter

Table 4: Mouth Opening, Mallampati, and Thyromental Distance

Parameter	FP (Mean ± SD)	CP (Mean ± SD)	p-value
Mouth Opening (mm)	50.49 ± 4.17	50.79 ± 3.80	0.429
Thyromental Distance (cm)	8.99 ± 0.92	9.08 ± 0.93	0.291
Modified Mallampati Score	2.2 ± 0.56	2.2 ± 0.51	0.944

Table 4 shows that pre-intubation airway assessment parameters such as mouth opening, Mallampati class, and thyromental distance were similar in both groups.

Cormack–Lehane Grade Distribution

Table 5: CL Grading Between FP and CP Groups

CL Grade	FP (n=225)	CP (n=225)	p-value
Grade 1	17	14	
Grade 2	175	191	
Grade 3	33	18	0.184

Table 5 indicates that although FP showed a slightly higher number of difficult laryngoscopies (CL grade 3), the difference was not statistically significant.

Intubation Efficiency - Time and Attempts

Table 6: Comparison of Intubation Performance

Parameter	FP (Mean ± SD)	CP (Mean ± SD)	p-value
Time for Intubation (sec)	15.85 ± 3.14	13.52 ± 3.01	**0.01**
Number of Attempts	1.05 ± 0.22	1.02 ± 0.13	**0.04**

Table 6 shows that intubation was significantly faster and required fewer attempts in the CP (custom pillow) group compared with FP, indicating superior intubation efficiency.

Requirement for External Assistance

Table 7: Use of Assistance during Intubation

Assistance Required	FP (n=225)	CP (n=225)	p-value
None	208	216	
Yes	17	9	0.106

Table 7 observes that although assistance was required less often in the CP group, the difference did not reach statistical significance.

Discussion

Optimal positioning for endotracheal intubation has long been a subject of debate.[11] The sniffing position, originally described by Ivan Magill, remains widely accepted as providing ideal conditions for intubation,[1] and recent interest has focused on revalidating this classical approach. In the present study, head elevation was implemented in both groups: the Fixed Pillow (FP) group used a standard 4 cm pillow, while the Custom Pillow (CP) group received additional pillows to achieve horizontal alignment of the external auditory meatus with the sternal notch, a method supported by previous studies as effectively achieving. [12,13]

Baseline characteristics were comparable between the groups. The mean age was 45.95 ± 14.39 years in the FP group and 44.6 ± 14.42 years in the CP group (p = 0.319). Although the FP group had more male participants, gender distribution did not differ significantly (p = 0.396). Weight (61.07 ± 8.48 kg vs. 59.84 ± 6.89 kg; p = 0.094), height (1.60 ± 0.13 m vs. 1.59 ± 0.12 m; p = 0.277), and BMI (23.86 ± 2.66 vs. 23.78 ± 2.30; p = 0.752) were all comparable. ASA physical status also showed no significant difference (1.81 ± 0.69 vs. 1.77 ± 0.61; p = 0.565). Airway parameters such as mouth opening (50.49 ± 4.17 mm vs. 50.79 ± 3.79 mm; p = 0.429) and thyromental distance (8.99 ± 0.92 cm vs. 9.08 ± 0.93 cm; p = 0.291) were similarly matched, ensuring the absence of confounding variables.

Although higher Cormack–Lehane (CL) grades (>3) occurred more frequently in the FP group, the difference was not statistically significant. Similar findings have been reported in studies comparing head elevation and glottic view. [14-16] The absence of significant variation may be attributed to the elective nature of the cases, the exclusion of obese patients (BMI >30), and the institutional practice of managing anticipated difficult airways with fiber-optic or video laryngoscopy. Variability in difficult airway definitions may also influence such results. [17,18] While patients with higher Mallampati scores (MPC >2) exhibited more CL grade > 3 findings in the FP group, this too lacked statistical significance. Literature suggests that the sniffing position may offer greater benefit in difficult airways or restricted neck mobility,[4] and that ramping may be advantageous in obese individuals,[19] although this was not explored in the present study.

The mean head elevation required to achieve the sniffing position in the CP group was 6.22 ± 0.83 cm, aligning with previously reported ranges of 6–12 cm, [8,20] with 7 cm frequently cited.[6] This corresponds closely with data from an Indian population study.[9] Such variability across populations highlights the potential need for individualized head elevation. Recent studies have proposed modified ramp positions, especially in obese patients,[21] while the Indian Difficult Airway Society recommends a 10 cm elevation,[22] warranting further multicentre validation.

A statistically significant difference was observed in intubation time: 15.85 ± 3.14 seconds in the FP group compared with 13.52 ± 3.01 seconds in the CP group (p = 0.01), consistent with findings from previous studies on conventional and video laryngoscopy. [23,24] The most notable difference was among patients with CL grade 2 views, suggesting more the ergonomic alignment in the customized position. The absence of significant difference in higher CL grades may reflect the small number of such cases in this study.

The number of intubations attempts also differed significantly, with the FP group averaging 1.05 ± 0.22 attempts and the CP group 1.02 ± 0.13 attempts (p = 0.04). This supports existing evidence for the ergonomic advantages of optimized head positioning [25,26] and likely contributed to the differences in intubation time. Although the use of adjuncts such as a bougie or external laryngeal manipulation was slightly lower in the CP group (0.08 ± 0.26 vs. 0.04 ± 0.19), this was not statistically significant (p = 0.106), and the low number of patients with higher CL grades may limit the interpretability of this finding.

Limitations

This study is a comparative cross-sectional design rather than a randomized controlled trial, which may limit its strength of evidence. Additionally, it was conducted at a single centre with a relatively limited sample size, restricting the generalizability of the findings. The study included only elective surgical cases and excluded obese patients, preventing assessment of the impact of customized head elevation in populations where positioning challenges may be more pronounced.

Conclusion

Achieving horizontal alignment of the external auditory meatus with the sternal notch using a customized pillow resulted in a shorter intubation time and required fewer attempts for successful endotracheal intubation.

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