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Comparison of Ease of Intubation and Laryngeal View Obtained Through Inflatable Pillow versus Manual Head Extension – A Randomised Prospective Study

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Abstract

Background: Endotracheal intubation is a crucial procedure in airway management. Achieving an optimal laryngeal view is essential for successful intubation. While manual head extension in the sniffing position is the conventional technique, an inflatable pillow offers an alternative approach that could standardize head positioning, reduce physical strain on the anesthesiologist, and improve glottic visualization. However, limited studies have compared these two techniques in terms of intubation ease and laryngeal view.

Objectives: This study was aimed to compare the effectiveness of an inflatable pillow versus manual head extension in optimizing laryngeal visualization and ease of intubation. The primary parameters evaluated included the Cormack-Lehane (CL) grade, Intubation Difficulty Score (IDS), intubation success rates, and time to intubation.

Methods: A total of 130 adult patients, aged 18-60 years, ASA grade I-II, scheduled for elective surgery requiring endotracheal intubation, were randomly assigned into two groups. Induction of anesthesia in both groups were done in supine position after preoxygenating with 100% oxygen for 3-5 minutes, then patients were premedicated with fentanyl (2 micrograms per kg) and midazolam (0.01mg/kg). After which patients received induction dose of propofol (2mg/kg over 30-40 seconds, with end point being loss of verbal contact with patient. Muscle Relaxation was achieved with Atracurium (0.5mg/kg).Group A underwent intubation with manual head extension, while Group B utilized an inflatable pillow to align the external auditory meatus with the sternal notch. Standard anesthesia protocols were followed. Intubation ease was assessed using the IDS, CL grade, and time to intubation. Statistical analysis was conducted using SPSS v22, with a p-value <0.05 considered significant.

Results: Group B demonstrated a significantly shorter intubation time (30.53 ± 7.65 sec) compared to Group A (36.13 ± 12.25 sec, p=0.038). The head rise was significantly higher in Group B (13.30 ± 1.00 cm) than in Group A (10.00 ± 0.00 cm, p<0.001). CL grade and IDS were significantly better in Group B, indicating improved laryngeal visualization and easier intubation.

Conclusion: The use of an inflatable pillow resulted in a better laryngeal view, reduced intubation difficulty, and shorter intubation time compared to manual head extension. This technique may be beneficial in clinical settings, particularly in patients where manual positioning is challenging. Further research is warranted to explore its applicability in diverse patient populations.

Keywords: Endotracheal Intubation, Airway Management, Laryngeal Visualization, Inflatable Pillow, Manual Head Extension, Cormack-Lehane Grade, Intubation Difficulty Score

Introduction

Endotracheal intubation is a critical procedure in airway management, particularly in anaesthesia, emergency medicine, and intensive care. Achieving an optimal laryngeal view is essential for successful intubation, and various positioning techniques have been employed to enhance visualization of the glottis. The conventional method involves manual head extension using the sniffing position, which aligns the oral, pharyngeal, and laryngeal axes to facilitate endotracheal tube placement. However, this technique may be challenging in patients with cervical spine instability, obesity, or anatomical variations that limit neck extension[1].

An alternative approach involves the use of an inflatable pillow, which provides adjustable head elevation while maintaining patient comfort. Inflatable pillows can potentially standardize head positioning, reduce the physical effort required by the anaesthesiologist, and improve the laryngeal view. Prior studies have demonstrated that passive head elevation can enhance airway alignment, leading to improved intubation conditions[2,3]. However, limited evidence directly compares the ease of intubation and laryngeal view obtained using an inflatable pillow versus manual head extension.

This study aims to evaluate the effectiveness of an inflatable pillow in optimizing laryngeal visualization and ease of intubation compared to the conventional manual head extension technique. The findings could have significant implications for airway management, particularly in patients where manual head positioning is suboptimal. By analysing intubation success rates, time to intubation, and laryngoscopic view grading, this study will contribute to the existing body of knowledge on airway positioning techniques and potentially inform future guidelines for anaesthetic practice[4,5].

Objectives: To compare the laryngeal views obtained through manual head extension and the use of an inflatable pillow. To compare Intubation Difficulty Score (IDS), intubation position, intubation success rates and complications.

This observational study was conducted over a period of six months. A total of 130 adult patients, aged 18-60 years, classified under ASA grade I-II, and scheduled for elective surgery requiring endotracheal intubation, were recruited and divided into two equal groups (Group A and Group B) using a computer-generated randomization technique. Group A underwent intubation following manual head extension, whereas Group B utilized an inflatable pillow for horizontal alignment of the external auditory meatus with the sternal notch before intubation. Standard anaesthesia induction protocols were followed, including preoxygenation with 100% oxygen and the administration of fentanyl, midazolam, propofol, and atracurium for muscle relaxation. Laryngoscopy was performed in both groups, and the Cormack-Lehane (CL) grade was recorded to assess the laryngeal view. Intubation difficulty was evaluated using the Intubation Difficulty Score (IDS). The primary parameters measured included the CL grade, IDS, and the degree of head elevation using a scale. Ethical approval was obtained from the institutional review board, and informed consent was secured from all participants prior to enrolment.

The required sample size was determined using the formula for a two-sample t-test:

$N = [((Z\alpha/2 + Z\beta)^2 \times 2 \times B^2) / d^2]$ - for 2-tailed test

Formula For Total Sample Size:

Maximum Number of Samples = (N*2)

Where, N= Sample Size

$Z\alpha$ = critical value of the Normal distribution at α (confidence level)

$Z\alpha/2$ = critical value of the Normal distribution at $\alpha/2$ (confidence level)

$Z\beta$ = critical value of the Normal distribution at β (power)

B^2 = Variance

d= difference between two means

In our study, assuming a moderate effect size of 0.5 standard deviations, a significance level (α) of 0.05, and a power ($1 - \beta$) of 0.80, along with an expected variability of 1.5 standard deviations. The calculated required sample size was 128 participants for the study. 64 participants per group.

In Group A, positioning was achieved through the placement of a 10 cm incompressible pillow under the patient's head. Laryngoscopy was performed, and the Cormack-Lehane (CL) grade was assessed. In Group B, positioning was achieved through the horizontal alignment of the external auditory meatus with the sternal notch using an inflatable pillow. Laryngoscopy was then performed, and the CL grade was recorded. Throughout both interventions, standard anesthesia monitoring was maintained, and intubation difficulty was assessed using the IDS. In cases of failure to intubate or a drop in oxygen saturation below 94%, appropriate interventions were undertaken as per the institutional protocol for managing difficult airways.

Randomization

Participants were randomly allocated into two groups: the Manual Head Extension group (Group A) and the Inflatable Pillow for AM-S Alignment group (Group B). The following steps were taken to ensure random assignment:

- **Generation of Random Allocation Sequence:** A computer-generated random number table was used to create a random allocation sequence.
- **Assignment of Participants:** Enrollment and allocation of participants were performed by an independent research staff member who was not involved in the intervention or outcome assessment. After obtaining informed consent, participants were

assigned to a group based on the number obtained from the computer-generated sequence.

- **Blinding:** Given the nature of the interventions, blinding of participants and the anesthesiologist performing the interventions was not feasible. However, blinding was maintained during outcome assessment where possible.

Parameters Measured: Modified Mallampati scoring, Cormack-Lehane (CL) grade, Intubation Difficulty Score (IDS) and Head rise using a scale

Ethical approval was obtained from the relevant institutional review board before the study commenced. Informed consent was obtained from all participants prior to their inclusion in the study. Participants were provided with a clear explanation of the study's purpose, procedures, risks, benefits, and their right to withdraw at any time without penalty.

Statistical analysis: Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software and Epi-info version 7.2.1 (CDC Atlanta) software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Normality of the continuous data, was tested by Kolmogorov–Smirnov test and the Shapiro–Wilk test. Independent t test was used as test of significance to identify the mean difference between two quantitative variables. p value of <0.05 was considered as statistically significant. Statistical software: MS Excel, SPSS version 22 (IBM SPSS Statistics, Somers NY, USA) was used to analyze data. [6,7]

Results

Table 1: Profile of subjects

		Group				P value
		Group A		Group B		
		Count	%	Count	%	
Age	18-20 years	1	3.3%	1	3.3%	0.984
	21 to 30 years	12	40.0%	11	36.7%	
	31 to 40 years	11	36.7%	11	36.7%	
	41 to 50 years	5	16.7%	5	16.7%	
	>50 years	1	3.3%	2	6.7%	
Sex	Female	13	43.3%	14	46.7%	0.795
	Male	17	56.7%	16	53.3%	
BMI	18.5 to 24.9 (Normal)	6	20.0%	9	30.0%	0.328
	25 to 29.9 (Overweight)	17	56.7%	18	60.0%	
	>30 (Obese)	7	23.3%	3	10.0%	

Pearson Chi-Square Tests

In the present study, the majority of subjects were in the age group of 21–30 years, constituting 40% in Group A and 36.7% in Group B. The age distribution between the two groups did not show a statistically significant difference (p = 0.984). Regarding gender distribution, 43.3% of subjects in Group A were female, compared to 46.7% in Group B, and 56.7% were male in Group A compared to 53.3% in Group B. The difference in gender distribution was not statistically significant (p = 0.795). In terms of BMI classification, the majority of subjects in both groups were overweight (56.7% in Group A and 60% in Group B), while 20% in Group A and 30% in Group B had a normal BMI. The prevalence of obesity was higher in Group A (23.3%) than in Group B (10%), but the difference was not statistically significant (p = 0.328).

Table 2: Anthropometric measurements comparison between two groups

	Group				P value
	Group A		Group B		
	Mean	SD	Mean	SD	
Height	154.90	3.33	154.80	3.42	0.909
Weight	66.90	8.95	64.37	9.81	0.300
BMI	27.81	2.97	26.78	3.37	0.216

Independent Samples Test

The anthropometric measurements between the two groups were compared. The mean height in Group A was 154.90 ± 3.33 cm, whereas in Group B, it was 154.80 ± 3.42 cm, with no significant difference (p = 0.909). The mean weight in Group A was 66.90 ± 8.95 kg compared to 64.37 ± 9.81 kg in Group B, with no statistically significant difference (p = 0.300). The mean BMI was slightly higher in Group A (27.81 ± 2.97) than in Group B (26.78 ± 3.37), but the difference was not statistically significant (p = 0.216).

Table 3: Comparison of Parameters between two groups

	Group						
	Group A			Group B			P value
	Mean	SD	Median	Mean	SD	Median	
MO	4.48	0.53	4.50	4.53	0.56	4.50	0.723
SPO2	100.00	0.00	100.00	100.00	0.00	100.00	-
IT	36.13	12.25	36	30.53	7.65	30	0.038*
Head Rise	10.00	0.00	10.0	13.30	1.00	13.0	<0.001*

Independent Samples Test

The comparison of parameters between the two groups showed that the mean MO (Mouth Opening) was 4.48 ± 0.53 in Group A and 4.53 ± 0.56 in Group B, with no significant difference (p = 0.723). The mean SPO2 was 100.00 ± 0.00 in both groups. The mean intubation time (IT) was significantly higher in Group A (36.13 ± 12.25 sec) compared to Group B (30.53 ± 7.65 sec), with a statistically significant difference (p = 0.038). The mean head rise was 10.00 ± 0.00 in Group A and 13.30 ± 1.00 in Group B, showing a highly significant difference (p < 0.001).

Table 4: Ease of intubation parameters comparison between two groups

		Group				P value
		Group A		Group B		
		Count	%	Count	%	
Short Neck	No	22	73.3%	22	73.3%	1.000
	Yes	8	26.7%	8	26.7%	
MMP	1	17	56.7%	0	0.0%	-
	2	13	43.3%	0	0.0%	
CL Grade	1.	10	33.3%	14	46.7%	0.043*
	2.	0	0.0%	1	3.3%	
	2A	10	33.3%	14	46.7%	
	2B	7	23.3%	1	3.3%	
	3.	3	10.0%	0	0.0%	
IDS	1	4	13.3%	7	23.3%	0.019*
	2	10	33.3%	18	60.0%	
	3	12	40.0%	5	16.7%	
	4	4	13.3%	0	0.0%	

Pearson Chi-Square Tests

Regarding ease of intubation parameters, short neck was present in 26.7% of subjects in both groups, and there was no statistically significant difference (p = 1.000). The Mallampati Score (MMP) was 1 in 56.7% of subjects in Group A, whereas no subjects in Group B had an MMP score of 1. Similarly, 43.3% of subjects in Group A had an MMP score of 2, while no subjects in Group B had a score of 2. The comparison of CL grade showed that 33.3% of subjects in Group A had a CL grade of 1, compared to 46.7% in Group B, and this difference was statistically significant (p = 0.043). The IDS (Intubation Difficulty Scale) comparison showed that 13.3% of subjects in Group A had an IDS score of 1, while 23.3% of subjects in Group B had the same score. A score of 2 was observed in 33.3% of subjects in Group A and 60% in Group B. A score of 3 was recorded in 40% of subjects in Group A compared to 16.7% in Group B. An IDS score of 4 was present in 13.3% of subjects in Group A, while none had this score in Group B. The difference in IDS scores between the two groups was statistically significant (p = 0.019)

Discussion

The current study aimed to compare the ease of intubation and laryngeal view obtained through the use of an inflatable pillow versus manual head extension in adult subjects undergoing intubation. The results indicate significant differences between the two techniques in certain key parameters related to intubation efficiency and laryngeal view. The demographic distribution, including age, gender, height, weight, and BMI, was comparable between the two groups, as none of these variables showed a statistically significant difference. The majority of participants were in the 21–30 years age group, which is consistent with previous studies on airway management in young adults [8]. The gender distribution was also balanced, minimizing potential bias due to gender-based anatomical differences in airway structures[9]. BMI distribution revealed that most subjects were overweight, with a higher prevalence of obesity in Group A (inflatable pillow). However, the differences were not statistically significant, indicating that BMI did not contribute significantly to differences in intubation ease between the two techniques.

Mouth opening (MO) is a crucial factor in airway management, influencing ease of laryngoscopy and intubation[10]. The study found no significant difference in mean mouth opening between the two groups, suggesting that both techniques provided similar conditions in terms of initial oral accessibility. Additionally, oxygen saturation (SpO2) remained at 100% in both groups, indicating that neither method compromised oxygenation during the procedure, consistent with safe airway management protocols [11].

A key finding was the significantly longer mean intubation time (IT) in the inflatable pillow group (36.13 ± 12.25 sec) compared to the manual head extension group (30.53 ± 7.65 sec, $p = 0.038$). This suggests that the manual head extension technique facilitated a quicker intubation process. Several studies have emphasized that prolonged intubation time can increase the risk of hypoxia, aspiration, and airway trauma [12]. The observed difference might be due to the fact that manual head extension optimally aligns the oral, pharyngeal, and laryngeal axes, whereas the inflatable pillow might require additional adjustments, thereby prolonging intubation.

The head rise was significantly higher in the manual head extension group (13.30 ± 1.00 cm) compared to the inflatable pillow group (10.00 ± 0.00 cm, $p < 0.001$). This difference underscores the effectiveness of manual extension in achieving the sniffing position, which is widely regarded as the optimal head position for direct laryngoscopy [13].

The Cormack-Lehane (CL) grade distribution further supported this observation. A higher proportion of subjects in the manual head extension group achieved a CL grade of 1 (46.7%) compared to the inflatable pillow group (33.3%). This difference was statistically significant ($p = 0.043$), suggesting that manual extension improved laryngeal visibility. Previous literature has demonstrated that a better laryngeal view is associated with easier intubation and reduced likelihood of failed attempts [14].

Mallampati Score (MMP) is a preoperative predictor of difficult intubation, with lower scores indicating easier airway visualization [15]. Notably, 56.7% of subjects in the inflatable pillow group had an MMP score of 1, while none in the manual extension group had this score. Similarly, 43.3% in the inflatable pillow group had an MMP score of 2, whereas none in the manual extension group fell into this category. This discrepancy suggests that although subjects in the inflatable pillow group had potentially favorable airway structures, the intubation process was still more challenging for them. Short neck prevalence was identical in both groups (26.7%), suggesting that anatomical predispositions did not contribute to differences in intubation difficulty between the techniques.

The Intubation Difficulty Scale (IDS) provides an objective measure of intubation complexity, incorporating parameters such as the number of attempts, additional airway maneuvers required, and glottic exposure [16]. The IDS scores differed significantly between the two groups ($p = 0.019$), with a higher proportion of subjects in the manual head extension group achieving lower IDS scores (easier intubation). A score of 1 was observed in 23.3% of subjects in the manual extension group, compared to 13.3% in the inflatable pillow group. Conversely, the proportion of subjects with higher IDS scores (scores of 3 or 4) was greater in the inflatable pillow group. These findings suggest that manual head extension results in a more straightforward intubation process, likely due to better alignment of airway axes and improved laryngeal exposure. This aligns with prior research demonstrating that intubation difficulty increases with suboptimal positioning [17].

The findings of this study have significant clinical implications for airway management in various settings, including emergency medicine, anesthesia, and intensive care. The shorter intubation time and superior laryngeal visibility associated with manual head extension suggest that it should remain the preferred technique for standard intubations, particularly in situations where rapid airway access is necessary. However, the inflatable pillow may still have a role in specific scenarios, such as in patients with cervical spine instability, where excessive neck extension should be avoided [18].

Furthermore, the increased intubation difficulty associated with the inflatable pillow technique highlights the need for additional training and expertise when using this method. Future studies should explore modifications to the inflatable pillow technique to improve its efficiency, such as optimizing inflation levels or combining it with external laryngeal manipulation [19].

Limitations and Future Research

This study has some limitations. First, the sample size was relatively small, which may limit the generalizability of the findings. Second, the study was conducted in a controlled clinical setting with experienced anesthesiologists, and results may differ in emergency or prehospital environments where intubation conditions are more variable. Future research should involve larger, multi-center trials to validate these findings and explore the applicability of the inflatable pillow in different patient populations, including those with difficult airways.

Additionally, the study did not assess subjective factors such as operator comfort and ergonomic considerations, which could influence the choice of intubation technique. Incorporating such factors into future research may provide a more comprehensive understanding of the clinical utility of the two methods.

Conclusion

Overall, the findings suggest that inflatable pillow had better intubation outcomes, with shorter intubation time, improved head rise, and easier intubation as indicated by the IDS and CL grade. These results highlight the potential advantages of the approach or technique used in Group B, which may be beneficial in clinical settings for improving intubation efficiency and ease.

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