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Original Research Article

A STUDY OF CUSTOMISED VERSUS FIXED HEIGHT PILLOW FOR IMPROVING GLOTTIC VISUALIZATION DURING ENDOTRACHEAL INTUBATION IN SNIFFING POSITION BY DIRECT LARYNGOSCOPY

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ABSTRACT

Background: Optimal head elevation is crucial for successful endotracheal intubation using direct laryngoscopy. The sniffing position, achieved by aligning the external auditory meatus with the sternal notch, enhances glottic visualization. Traditionally, a fixed-height pillow is used, but individual anatomical variations may affect its efficacy. Customised pillow height may offer better alignment and improved visualization. This study compares customised versus fixed-height pillows for optimizing glottic view during intubation. This prospective study compared a fixed height pillow (FP) with a customised height support (CP) created by adding sheets to achieve optimal head elevation—defined as horizontal alignment of the external auditory meatus (EAM) with the sternal notch—for endotracheal intubation in the sniffing position. Primary evaluation focused on the success of achieving this alignment, while secondary measures included glottic view by Cormack Lehane grade, time to successful intubation, and the requirement for adjuncts (bougie use, external laryngeal manipulation) or additional intubation attempts.

Materials and Methods: This one-year prospective randomized comparative study was conducted in the Anaesthesiology Department at North Bengal Medical College, Siliguri, with ethical approvals in place. It included 130 adult patients (aged 16–60 years, ASA I and II) from the General Surgery and Orthopaedics departments, undergoing elective surgeries requiring endotracheal intubation.

Results: The demographic and baseline characteristics, including age, weight, height, BMI, and airway parameters, were statistically comparable between the fixed pillow (FP) and customised pillow (CP) groups, ensuring group homogeneity. The Modified Mallampati (MMP) grade distribution was also similar at baseline. Among patients with favourable laryngoscopic views (CL grades 1 and 2), there were no significant differences in MMP grade distribution or intubation time between groups. However, in cases with difficult laryngoscopic views (CL grade ≥3), the customised pillow group had a significantly higher proportion of patients with easier MMP grades (Grade 1 and 2) and a much lower proportion with difficult MMP Grade 3, indicating a notable advantage of the customised pillow in challenging airway scenarios.

Conclusion: This study found that both groups were comparable in baseline characteristics, ensuring differences were due to the pillow strategy. While

glottic exposure and intubation speed were similar in routine cases, the customised pillow improved airway management in difficult views by shifting patients into easier Mallampati classes. Therefore, customised head elevation offers clear benefits in challenging cases without drawbacks in routine ones.
Keywords: Glottic Visualization, Endotracheal Intubation, Sniffing Position, Customized Pillow Height and Direct Laryngoscopy.

INTRODUCTION

Direct laryngoscopy (DL) and endotracheal intubation is one of the most important and basic skills in anaesthetic practice. This requires optimal positioning of head and neck for adequate visualization of glottis and easy negotiation of endotracheal tube through glottic opening. Inadequate positioning may result in delayed or failed intubation attempts because of inability to visualize glottic opening. But proper positioning of head and neck to facilitate intubation has been a matter of endless debate for the past few years. There are different theories explaining the methods for achieving optimal position of head and neck in case of endotracheal intubation.

The position traditionally recommended and taught to all learners for airway management is the "sniffing position" (SP). In 1936, Magill formally described 'sniffing position' as elevation of the occiput with extension of the head at the atlanto-occipital joint.[1] In general this position is accepted as the best position for direct laryngoscopy.[2] Bannister and Macbeth refined positioning of direct laryngoscopy by proposing a need for alignment of the mouth, pharyngeal, and laryngeal axes; that later to be called as 'three axes alignment theory'.[3] The three axes alignment theory is considered to be the most valid explanation for sniffing position, while newer theories have yet to find widespread acceptance.[2,4,5] Then, after more than five decades of formulation and acceptance of Three-axes alignment theory, concerns regarding its correctness were raised by Adnet et al.[6] As a result debate on the usefulness of sniffing position started causing various workers to begin exploring alternative positions for direct laryngoscopy and endotracheal intubation.

In search of a better alternative to sniffing position, many studies have been conducted. Different studies have shown neck flexion or head elevation significantly improves glottis view, although varying amount of head elevation required.[7,8] At the same time, some study shows that there is no distinct advantage of neck flexion or head elevation compared to simple head extension in routine practice.

Greenland et al. described that horizontal alignment of external auditory meatus (EAM) and sternal notch in supine position makes it an optimum position for endotracheal intubation.[9] It is also the goal in 'ramping' that has established role in obese population.[10,11] But ramping is not routine practice for non-obese patient.

This study was conducted to compare the effectiveness of a fixed-height pillow (FP group) versus a customised-height support (CP group, achieved by adding sheets) in attaining optimal head elevation for aligning the external auditory meatus (EAM) with the sternal notch, thereby facilitating endotracheal intubation. The primary objective was to evaluate which method more effectively achieved the desired horizontal alignment. In addition, the study aimed to compare glottic visualization using the Cormack-Lehane grading between the two groups, assess the time taken for successful tracheal intubation, and evaluate the need for additional interventions such as bougie assistance, application of external laryngeal pressure or manipulation, and the number of intubation attempts required in each group.

MATERIALS AND METHODS

Study Design: A prospective randomized comparative study.

Study Setting: This study was conducted under Department of Anaesthesiology in the General Surgery and Orthopaedic operating rooms of North Bengal Medical College.

Place of Study: North Bengal Medical College and Hospital, Siliguri, West Bengal 734012

Period of Study: The study was conducted over a span of one year approximately (May 2019 to April 2020) after getting permission from Institute's Ethics Committee and approval of The West Bengal University of Health Sciences.

Study Population: The participants of study population were belonged to catchment of North Bengal Medical College and Hospital. Adult patients who were admitted in the Departments of General Surgery and Orthopaedics of American Society of Anaesthesiologists (ASA) physical Status I and II, of both sexes, 16 to 60 years, came for elective surgeries requiring endotracheal intubation were eligible for the study.

Inclusion Criteria:

- American Society of Anesthesiologists (ASA) physical Status I and II
- Sex: Male and Female
- Age: 16 years to 60 years
- Type of Surgery: Elective surgeries requiring endotracheal intubation

Exclusion criteria:

- American Society of Anesthesiologists (ASA) physical Status III and IV
- Pregnant women
- Height <140 cm

- Mouth opening <3 cm
- Thyromental distance (TMD) <5.5 cm
- Any airway growth or obstruction, unstable cervical spine and any other contraindication to conventional Macintosh laryngoscopy and intubation of trachea.
- Patient with Cervical spondylosis

Sample size: 130 patients were enrolled for this study.

Statistical Analysis: For statistical analysis, data were initially entered into a Microsoft Excel spreadsheet and then analyzed using SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and GraphPad Prism (version 5). Numerical variables were summarized using means and standard deviations, while Data were entered into Excel and analyzed using SPSS and GraphPad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages. Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

RESULTS

Table 1: Baseline Demographic and Airway Assessment Characteristics of Patients in the Fixed Height Pillow Group (FP) versus Customized Pillow Group (CP)

Parameter	Group FP			Group CP			P Value	Significance
	Mean	Median	SD	Mean	Median	SD		
Age (Years)	40.83	40	10.17	41.22	41	10.26	0.794	Not Significant
Weight (Kg)	60.38	60	7.98	59.63	60	7.96	0.304	Not Significant
Height (m)	1.574	1.58	0.047	1.565	1.56	0.044	0.051	Not Significant
BMI (Kg/m2)	24.26	24.129	2.081	24.311	24.035	2.725	0.68	Not Significant
Mouth Opening (cm)	4.24	4.2	0.48	4.3	4.2	0.48	0.291	Not Significant
Thyromental Distance(cm)	6.763	6.7	0.341	6.802	6.8	0.34	0.514	Not Significant

Table 2: Comparison of Modified Mallampati (MMP) Grade Between Fixed-Height Pillow Group (FP) and Customized Pillow Group (CP)

Parameter		Group FP	Group CP	Total	P Value	Significance
MMP grade	≤2	50(76.92)	46(70.77)	96(73.85)	0.425	Not Significant
	≥3	15(23.08)	19(29.23)	34(26.15)		
Total		65(100)	65(100)	130(100)		

Table 3: Comparison of Cormack-Lehane (CL) Grades Between Fixed-Height Pillow Group (FP) and Customized Pillow Group (CP)

MMP grade			GROUP		Total	p Value	Significance
			GROUP FP	GROUP CP			
MMP 1	CL Grade	1	9(39.13)	2(22.22)	11(34.38)	0.325	Not Significant
		2	14(60.87)	7(77.78)	21(65.63)	0.325	Not Significant
	Total		23(100)	9(100)	32(100)		
MMP 2	CL Grade	1	14(51.85)	16(43.24)	30(46.88)	0.495	Not Significant
		2	9(33.33)	18(48.65)	27(42.19)	0.211	Not Significant
		3	4(14.81)	3(8.11)	7(10.94)	0.412	Not Significant
	Total		27(100)	37(100)	64(100)		
MMP 3	CL Grade	1	0(0)	7(38.89)	7(21.21)	0.001	Significant
		2	1(6.67)	5(27.78)	6(18.18)	0.088	Not Significant
		3	14(93.33)	6(33.33)	20(60.61)	<0.001	Significant
	Total		15(100)	18(100)	33(100)		
MMP 4	CL Grade	2	0(0)	1(100)	1(100)	NA	NA
	Total		0(0)	1(100)	1(100)		

Table 4: Association Between Modified Mallampati (MMP) Grade and Cormack-Lehane (CL) Grade in Group FP and Group CP

MMP grade			GROUP		Total	p Value	Significance
			GROUP FP	GROUP CP			
MMP	CL Grade	1	23(46)	18(39.13)	41(42.71)	0.495	Not Significant
≤2		2	23(46)	25(54.35)	48(50)	0.412	Not Significant
		3	4(8)	3(6.52)	7(7.29)	0.78	Not Significant
	Total		50(100)	46(100)	96(100)		
MMP	CL Grade	1	0(0)	7(36.84)	7(20.59)	0.001	Significant

≥3		2	1(6.67)	6(31.58)	7(20.59)	0.046	Significant
		3	14(93.33)	6(31.58)	20(58.82)	<0.001	Significant
	Total		15(100)	19(100)	34(100)		

Table 5: Comparison of Laryngoscopy to Intubation Time (seconds) Between Fixed Height Pillow (FP) and Customised Pillow (CP) Groups Stratified by Modified Mallampati (MMP) Grade

MMP grade	Time(s)	Mean	Median	Std. Deviation
≤2	Group FP	12.16	12	3.03
	Group CP	12.3	11	3.92
	P-Value	0.426		
	Significance	Not Significant		
≥3	Group FP	20.07	21	4.65
	Group CP	13.79	12	5.08
	P-Value	0.001		
	Significance	Significant		

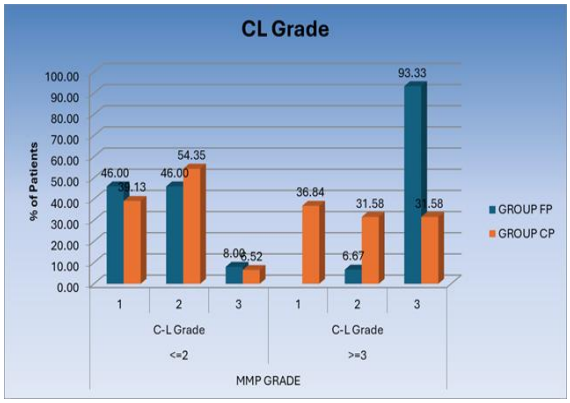

Figure 1: Comparison of Cormack-Lehane (C-L) Grades between Fixed Pillow (FP) and Customized Pillow (CP) Groups across MMP Grades

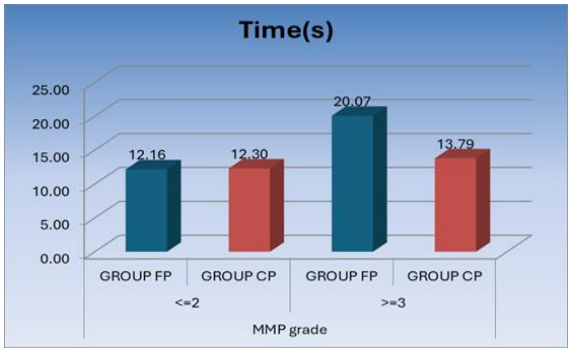

Figure 2: Comparison of Intubation Time between Fixed Pillow (FP) and Customized Pillow (CP) Groups across MMP Grades

The demographic and baseline characteristics between Group FP (Fixed Pillow height) and Group CP (Customised Pillow height) were found to be comparable and statistically non-significant across all evaluated parameters. The mean age was 40.83 ± 10.17 years in Group FP and 41.22 ± 10.26 years in Group CP (p = 0.794). The mean weight was 60.38 ± 7.98 kg in Group FP and 59.63 ± 7.96 kg in Group CP (p = 0.304). The mean height of patients in Group FP was 1.574 ± 0.047 m, while in Group CP it was 1.565 ± 0.044 m (p = 0.051), indicating a borderline but statistically non-significant difference. The BMI was also similar between groups (24.26 ± 2.081 in FP vs. 24.311 ± 2.725 in CP; p = 0.68). Airway assessment parameters such as mouth opening (4.24 ± 0.48 cm in FP vs. 4.3 ± 0.48 cm in CP; p = 0.291) and thyromental distance (6.763 ± 0.341 cm in FP vs. 6.802 ± 0.34 cm in CP; p = 0.514) did not show any significant difference between the two groups.

The distribution of Modified Mallampati Classification (MMP) grades between Group FP (Fixed Pillow) and Group CP (Customised Pillow) showed no statistically significant difference (p = 0.425). In Group FP, 76.92% (n = 50) of patients had MMP grade ≤2, while 23.08% (n = 15) had grade ≥3. In Group CP, 70.77% (n = 46) had grade ≤2, and 29.23% (n = 19) had grade ≥3. When combined, a total of 96 patients (73.85%) had MMP grade ≤2, and 34 patients (26.15%) had grade ≥3 across both groups.

Across patients with favourable laryngoscopic views (CL grades 1 and 2), the distribution of modified Mallampati (MMP) classes was comparable between the fixed height pillow (FP) and customised height pillow (CP) groups. For CL grade 1, 39.1 % of FP patients and 22.2 % of CP patients were MMP class 1, while 60.9 % and 77.8 %, respectively, were MMP class 2 (p = 0.325). A similar, non significant pattern persisted in CL grade 2, where the proportions of MMP classes 1, 2 and 3 did not differ between groups (all p > 0.20).

In contrast, pillow strategy had a clear impact among patients with difficult views (CL grade 3). The CP group showed a significantly higher share of easy MMP class 1 (38.9 % vs 0 %; p = 0.001) and a markedly lower share of difficult MMP class 3 (33.3 % vs 93.3 %; p < 0.001) compared with FP, while MMP class 2 remained similar (p = 0.088). Statistical analysis was not possible for CL grade 4 because only one patient—allotted to CP—fell into this category.

In patients with Cormack-Lehane (CL) grades ≤2, representing relatively easier laryngoscopic views, the distribution of Modified Mallampati (MMP) grades was comparable between the fixed pillow (FP) and customised pillow (CP) groups. MMP Grade 1 was observed in 46% of FP and 39.13% of CP patients (p = 0.495), MMP Grade 2 in 46% and 54.35% respectively (p = 0.412), and MMP Grade 3 in 8% and 6.52% respectively (p = 0.78). None of these differences were statistically significant,

indicating similar airway classification between groups in this subset.

However, in patients with CL grade ≥3, which signifies more difficult airway visualization, significant differences emerged. In the CP group, a higher proportion of patients were classified as MMP Grade 1 (36.84% vs 0%, p = 0.001) and Grade 2 (31.58% vs 6.67%, p = 0.046), while a markedly lower proportion fell under the difficult MMP Grade 3 category (31.58% vs 93.33%, p < 0.001) compared to the FP group.

The mean time required for endotracheal intubation was compared between the fixed pillow (FP) and customised pillow (CP) groups across different Modified Mallampati (MMP) grades. In patients with MMP grade ≤2 (indicating easier airways), the mean intubation time was similar between groups—12.16 seconds in FP and 12.3 seconds in CP. The difference was not statistically significant (p = 0.426), reflecting comparable ease of intubation in this subgroup.

DISCUSSION

Customising head elevation clearly benefited the subset of patients who presented difficult views in our series: when C L grade ≥ 3 the customised pillow (CP) strategy trebled the proportion of easy Mallampati class 1 and slashed the incidence of class 3 compared with a fixed 7 cm block, yet made no difference where the laryngeal view was already favourable. These data mirror the randomised trial by Dhar et al., who found a 28 % rise in C L grade I/II views and a ≈4 s fall in intubation time when pillow height was tailored to external auditory meatus/ sternal notch (EAM SN) alignment compared with a standard pillow.[12] Similar gains were reported with inflatable cushions that permitted on table adjustment to the same landmark: Pachisia et al. showed a doubling of grade I views and a significantly lower Intubation Difficulty Score versus a rigid 7 cm support.[13]

Conversely, studies that kept height fixed illustrate why our fixed pillow arm performed poorly in difficult airways. Sinha et al. demonstrated that a moderate 4.5 cm pad yielded the best glottic exposure, whereas both lower and higher blocks worsened the view,[14] Hong et al. confirmed that over elevation to 8 cm actually degrades alignment and increases operator discomfort.[15] Acharya et al., testing 0, 5 and 10 cm supports, again identified an intermediate (5 cm) height as optimal.[16] Vijayakumar et al. recently extended this observation to Indian patients, showing superior POGO scores and faster intubation with a 4 cm pillow versus 7 cm.[17]

Physiological imaging reinforces the need for individualisation: MRI work by Adnet et al. failed to prove the traditional three axis alignment in the classical sniffing position, implying that "one size fits all" head raise is anatomically unsound.[18] Alternative solutions therefore focus on aligning the EAM and sternum rather than prescribing a centimetre target. The head elevated laryngoscopy position (HELP) of Levitan et al. improves POGO scores in cadaver and volunteer studies by gradually flexing the neck until the EAM SN line is horizontal,[19] while Rao et al. showed the same principle shortens intubation time in obese patients whether achieved with blankets or a table ramp.[20] A recent narrative review summarises this shift towards "position to target" rather than "pillow to measure", recommending bedside individualisation as standard practice.[21]

Taken together, these converging lines of evidence explain our findings: when the laryngeal inlet is already easy to see, extra optimisation is redundant, but in difficult airways even a few centimetres of bespoke adjustment—enough to level the EAM SN line without overshooting—can markedly downgrade Mallampati class, shorten intubation time and, potentially, improve safety.

CONCLUSION

This study concludes that the two study groups were well matched in terms of age, body size, airway dimensions, and baseline Mallampati classification, confirming that any observed differences arose from the pillow strategy rather than patient characteristics. For straightforward laryngoscopic views, glottic exposure and intubation speed were essentially alike with either a fixed-height or customised pillow. However, when the view became difficult, the customised pillow clearly shifted more patients into easier Mallampati classes and reduced the proportion falling into the hardest class, translating into a smoother overall airway management experience. Thus, individualising head elevation offers no disadvantage in routine cases and confers a distinct advantage when glottic visualisation is challenging.

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