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The study of head elevated position for prediction of intubation difficulty using video laryngoscope in adult patients

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Abstract
Background and Aim: Proper positioning of the head and neck is one of the most important steps towards laryngoscopy and tracheal intubation. We aimed to determine the effect of head elevation on the quality of laryngeal view and ease of intubation using video laryngoscopy.
Method: In this prospective observational study, 100 patients who were ASA grade I/II between 18 years and 60 years with anticipated easy intubation were placed on a surgical table with non-compressible pillows under the head till horizontal alignment was achieved between the external auditory meatus and the sternal notch and the pillow height was measured. The Glottic visualization was assessed by using the modified Cormack Lehane classification and the Percentage of glottic opening (POGO) score. Intubation difficulty was assessed by the Intubation Difficulty Scale (IDS).
Results: None of the patients in the study had CL Grade > 2, POGO score <50%, and IDS > 3. The mean pillow height of patients with POGO score 100% was 9.27 ± 1.27 and with POGO score 50% was 10.5 ± 1.20 ($p< 0.001$). Similarly, the mean pillow height of patients with CL Grade I was 9.27 ± 1.23 cm and with CL Grade II was 10.44 ± 1.20 ($p< 0.001$) which was highly significant.
Conclusion: We concluded that alignment of the external auditory meatus and sternal notch in the horizontal plane resulted in better visualisation of the glottis and ease of intubation using a video laryngoscope. A pillow height of approximately 9cm was optimum while intubating.

Keywords: Pillow height, sniffing position, video laryngoscope, intubation

Introduction
Proper positioning of the patient's head and neck appears to be the main determining factor for obtaining a good glottic visualization under direct laryngoscopy. The "sniffing position" causes alignment of laryngeal, pharyngeal and oral axis, causing line of vision to fall on the glottis. In this position, the neck must be flexed on the chest, elevating the head with a cushion under the occiput and extending it at atlanto-occipital joint. However, the sniffing position, although considered the standard of care, needs scientific evaluation [1]. Various other positions used are simple head extension, neutral position, ramping in obese patients, 25 degree back up position and head elevated laryngoscopic position.
Different techniques are used for difficult intubation management such as alternative laryngoscope blades, awake intubation, blind intubation (oral or nasal), fibreoptic intubation, laryngeal mask airway as an intubation conduit, light wand, retrograde intubation and surgical airway access. Video Laryngoscopes facilitate endotracheal intubation by visualization of glottis structures through optical systems especially when difficult intubation is predicted [2]. Keeping this in mind, we conducted a study to observe the effect of head elevation on the quality of laryngeal view and ease of intubation using video laryngoscopy.

Materials and Methods
After institutional ethics committee approval, a prospective observational study was conducted for one year on American Society of Anaesthesiologists (ASA) physical status I/II adult patients of either sex, aged 18 to 60 years posted for elective surgical procedure under general anaesthesia with BMI less than 30 and with no history of difficult airway or anticipated difficult airway on preoperative evaluation. Pre-anaesthetic airway assessment was performed in all patients considering mouth opening, Modified Mallampatti Classification,

range of neck movements, thyromental distance, sternomental distance, neck length, neck circumference and receding mandible (if present) was noted. Written informed consent was obtained. All patients were kept NBM overnight.

On the day of surgery all patients were placed on a surgical table with non-compressible pillows under the head till horizontal alignment was achieved between the external auditory meatus and the sternal notch and the pillow height was measured. Monitors for vital signs were attached and baseline vitals were recorded. I.V line was secured and all patients were pre-medicated with Inj. Glycopyrrolate 0.004mg/kg, Inj. Midazolam 0.02mg/kg, Inj. Fentanyl 2mcg/kg.

After premedication, patients were pre-oxygenated for 5 minutes. Induction was done with Inj. Propofol 2mg/kg and Inj. Rocuronium 0.9mg/kg. A C-MAC video laryngoscope with an appropriate size Macintosh blade was used for tracheal intubation. All the laryngoscopic views were recorded and sent to a senior anaesthesiologist for grading of glottis view who were blind to the study. The study ended here. Anaesthesia was maintained with O2 + N2O + Sevoflurane 1.5 – 2 MAC, supplemented with bolus doses of Inj. Rocuronium 0.2mg/kg. Glottic visualization was assessed by using the modified Cormack Lehane classification.

Intubation difficulty was assessed by the Intubation Difficulty Scale (IDS). This scale is based on the determination of seven parameters, recorded by an independent observer after each intubation.

IDS

Table 1: [19]

Parameter	Score
Number of Attempts > 1	N1
Number of Operators > 1	N2
Number of alternative techniques	N3
Cormack and Lehane Grade	
Grade 1	N4 = 0
Grade 2	N4 = 1
Grade 3	N4 = 2
Grade 4	N4 = 3
Lifting force required	
Normal	N5 = 0
Increased	N5 = 1
Laryngeal Pressure	
Not applied	N6 = 0
Applied	N6 = 1
Vocal Cord Position	
Abduction	N7 = 0
Adduction	N7 = 1
Cords not visualized	N7 = 2
Total IDS = Sum of scores	N1+n2+n3+n4+n5+n6+n7

A score of 0 represents an ideal intubation: one performed by first operator on the first attempt, with use of the first technique and with full visualization of the glottis and little effort. An IDS score between 1 and 5 represents slight difficulty, and IDS score greater than 5 represents moderate to major difficulty. If intubation is impossible, the IDS score is the value attained before abandonment of intubation attempts [19].

The percentage of glottis opening (POGO) score for laryngeal grading represents the linear span from anterior commissure to the interarytenoid notch. A 100% POGO score is a full view of the glottis from the anterior commissure to the interarytenoid notch. A POGO score of 0 means even the interarytenoid notch is not seen.

Observation and results

Continuous variables were presented as means with standard deviations and categorical variables were presented as frequency and percentages. Data was analysed using descriptive statistics. Independent sample t test was used for continuous variables while sensitivity and specificity were given for outcome variables like CL grade, IDS scores and POGO. p value < 0.05 was considered significant.

100 patients undergoing elective surgery between the age group of 18 to 60 years and with anticipated easy intubation were included in the study. 38% were females and 62% were males.

The mean weight among males was 63.29 ± 7.44 kilogram and in females was 55.16 ± 5.77 kilogram with p value of 0.001 which was statistically significant. The mean height in females was 152.92 ± 4.50 centimetres and in males was 165.79 ± 4.91 centimetres with p value of 0.001 which was statistically significant. The mean body mass index among males was 22.99 ± 1.67 kg/m² and in females was 23.54 ± 2.16 kg/m² with p value of 0.18 which was not statistically significant. Thus, making the study population comparable.

The mean length of neck in centimetres in females was 10.47 ± 1.18 and males was 11.27 ± 0.99 with p value of 0.001 which was statistically significant. The mean sternomental distance in females was 13.11 ± 1.01 and in males was 13.76 ± 1.25 with p value of 0.008 which was statistically significant.

Table 2: Predictors of difficult intubation in study population

	Sex	N	Mean	Std. Deviation	Std. Error Mean	P value
Mouth opening cm	F	38	4.67	0.27	0.04	0.379
	M	62	5.59	0.39	0.81	
Neck length cm	F	38	10.47	1.18	0.19	0.001
	M	62	11.24	0.99	0.13	
Neck circumference cm	F	38	33.45	1.66	0.27	0.412
	M	62	33.77	2	0.25	
TM distance cm	F	38	8.28	0.78	0.13	0.062
	M	62	8.54	0.61	0.08	
SM distance cm	F	38	13.11	1.01	0.16	0.008
	M	62	13.76	1.25	0.16	

p value of < 0.05 is statistically significant.

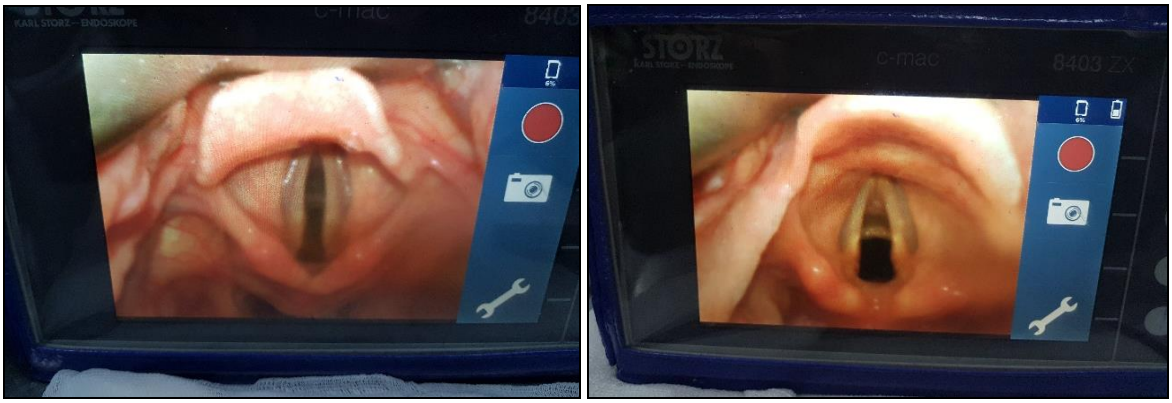

Fig 1: CL Grade I and POGO 100% view of the glottis images taken during the study

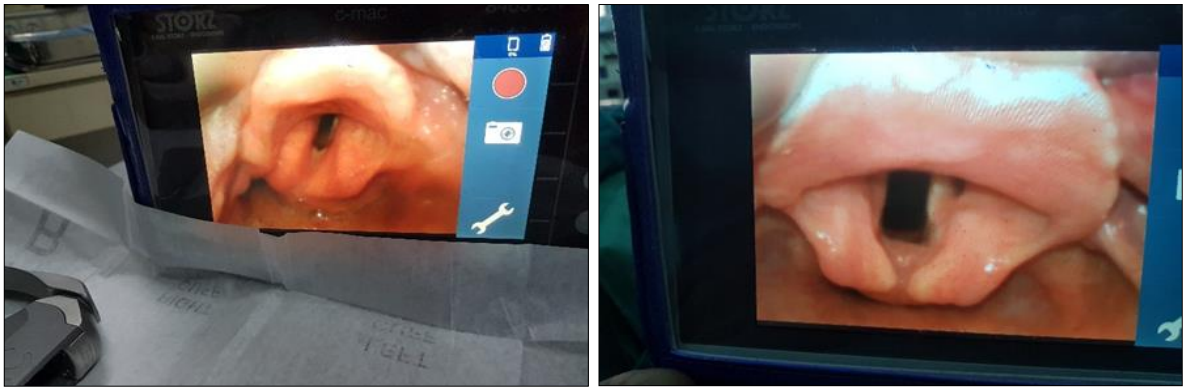

Fig 2: CL Grade II and POGO score 50% images taken during the study

None of the patients in the study had CL Grade > 2 or POGO score less than 50%.

Correlating thyromental distance with CL grade the p value obtained was 0.02 which was statistically significant.

In CL grade I patients 9.27 ± 1.23 cm mean pillow height was needed to align the 3 axes, in CL Grade II patients a higher pillow was required to align the 3 axes ($p < 0.001$).

Comparative evaluation of IDS with CL grade and POGO was done and p value obtained was p = 0.002.

The specificity and sensitivity of both Cl Grade and POGO score was 27.27% and 100% respectively. Both CL grade and POGO score were equally sensitive and specific with intubation difficulty score.

Table 3: Distribution of study population according to scores:

	No. of patients
MPC	
I	56
II	44
III	0
IV	0
CL Grade	
I	82
II	18
III	0
IV	0
POGO	
100%	82
50%	18
0%	0
IDS	
0%	34
1 to 5	66
>5	0

Table 4: Comparative evaluation of CL Grade and POGO score with IDS

IDS	**CL Grade**		**POGO**		**p value**
	I	II	100%	50%	
0	34	0	34	0	0.002
1 to 5	48	18	48	18	

Chi-square value = 9.25

Table 5: Predictors of difficult intubation in head elevated position using video laryngoscope.

Predictors	**IDS 0 Mean with SD**	**IDS 1- 5 Mean with SD**	**p value**
Age	32.94 ± 10.033	35.95 ± 10.656	0.18
BMI	22.62 ± 2.41	23.41 ± 1.77	0.06
Neck circumference	33.97 ± 1.85	33.48 ± 1.89	0.23
Neck length	10.85 ± 1.18	11 ± 1.09	0.54
Mouth opening	34 ± 6.09	66 ± 4.42	0.12
Thyromental distance	8.35 ± 0.734	8.52 ± 0.789	0.32
Sternomental distance	13.35 ± 1.07	13.59 ± 1.27	0.35
Pillow height	9.53 ± 1.44	9.47 ± 1.29	0.83
MPC	**IDS 0 No. of patients**	**IDS 1 – 5 No. of patients**	**p value**
I	22	34	0.29
II	12	32	
CL Grade			
I	34	48	0.002
II	0	18	
POGO			
100%	34	48	0.002
50%	0	18	

P value of < 0.05 is statistically significant.

Discussion

Difficult tracheal intubation is a very frightening situation for all anaesthesiologists. It can be a major source of

mortality and morbidity especially in emergency situations. In our institution, direct laryngoscopy is usually done by keeping a single ring pillow under the head of the patient, with slight head extension. The laryngoscope blade usually used is Macintosh. In the study the C- MAC video laryngoscope having 3 number blade was used for laryngoscopy. The laryngoscopic views were recorded. It provided good visualization of the glottis, not only to the operator but also to all present during the procedure in the operation theatre. This makes it a very good teaching device

The purpose of this study was to determine the effect of head elevation on the quality of laryngeal view and ease of intubation during video laryngoscopy. We elevated the head of the patient till the external auditory meatus and sternal notch were in the same line and intubated the patient using a video laryngoscopy. This position has been proved to align the laryngeal and pharyngeal axis with the oral axis by Greenland *et al*. in 2010 [3]. Who performed a magnetic resonance imaging (MRI) study to evaluate the external auditory meatus–sternal notch relationship as a marker that indicates a proper SP. They found better axes alignment in this SP. Levitan in 2003 performed laryngoscopy on 7 cadavers increasing head elevation and neck flexion and found that POGO score improves significantly [4]. Lee BJ *et al*. in 2007 found that POGO score increased in 25degree back up position as compared to supine position [5]. Schmitt HJ *et al*. in 2002 found that elevation of the head beyond the sniffing position may improve glottis visualisation [6]. However, the three axes alignment theory is still considered to be the correct anatomical explanation by the majority who argue that even if the SP does not bring complete alignment on its own, it brings the axes as close as possible [7].

Among the predictors of intubation, the difference in the mean neck length and the mean sternomental distance between males and females were statistically significant. This was due to the difference in physical characteristics between males and females. The mean thyromental distance in CL Grade I was found to be 8.51 ± 0.65 cm and in CL Grade II was 8.11 ± 0.76 cm with p value of 0.02 which was statistically significant. In correlation with POGO score, the mean thyromental distance for POGO score 100% was 8.52 ± 0.74 cm and for POGO score 50% was 8.17 ± 0.86 cm. But it was not significant when correlated with IDS.

In this study, we did not find any statistically significant predictive value of predictors of difficult intubation namely, age, BMI, neck circumference, neck length, mouth opening, thyromental distance, sternomental distance, pillow height and MPC with the intubation difficulty score. So, the sensitivity and specificity of these parameters to predict difficulty of intubation in head elevated intubation during video laryngoscopy could not be assessed.

K. Venkata *et al*. [8] in 2018 conducted a study in which they compared the sensitivity, specificity, PPV, negative predictive value (NPV), and diagnostic accuracy of TMHT with other bedside tests such as the modified Mallampati score, IIG, TMD, NC, and neck extension individually in predicting difficult laryngoscopy. TMHT had the highest sensitivity (84.62%) and specificity (98.97%), and had the most PPV (88%) and NPV (98.63%) when compared with the modified Mallampati score, IIG, TMD, NC, and neck extension. TMHT was followed by the modified Mallampati score and IIG.

Levitan *et al*. [5], used a video camera to continuously record the change in the laryngeal view while changing the head position from flat to maximum elevation in 7 fresh human cadavers. They found that increasing head elevation and neck flexion significantly improves POGO scores during laryngoscopy on fresh human cadavers.

El Orbany *et al*. [9] conducted a study in which direct laryngoscopy was done in 3 different head height positions. They found that head elevated sniffing position improves glottic exposure and should be considered before direct laryngoscopy in all patients with anticipated difficult intubation which correlates with our study.

The mean pillow height of patients with POGO score 100% was 9.27 ± 1.27 and with POGO score 50% was 10.5 ± 1.20 ($p< 0.001$). Similarly, the mean pillow height of patients with CL Grade I was 9.27 ± 1.23 cm and with CL Grade II was 10.44 ± 1.20 ($p< 0.001$) which was highly significant. [Fig 1, 2, 3, 4] Thus, a pillow height of approximately 9cm was optimum while intubating. Increasing the pillow height decreased the POGO score and increased the CL grade which was obtained.

There were other clinical studies that investigated the ideal height for head elevation during laryngoscopy. Sang-Heon Park *et al*. [10] in 2009 did a study with no pillow or with a pillow height of 3cm, 6 cm and 9 cm in randomised order. They found that the pillow height of 9 cm provided the best laryngeal view than other pillows or no pillow ($p< 0.001$). In our study along with the laryngoscopic views we also assessed the ease of intubation using intubation difficulty score**.**

The comparative evaluation of CL Grade and POGO score with IDS showed a p value of 0.002 which was statistically significant. Both CL grade and POGO score were effective in predicting difficult intubation in IDS. The specificity and sensitivity of both Cl Grade and POGO score is 27.27% and 100% respectively. Both CL grade and POGO score were equally sensitive and specific with intubation difficulty score.

Not a single patient in the study had an IDS of more than 3 making all of them easy to slightly difficult intubation. The laryngeal view did not exceed CL Grade > II or POGO score < 50%.

There were several limitations in our study. The sample size of the study was too small to make a prediction. Patients with anticipated airway difficulties were excluded from the study, so the results of this study cannot be applied to a case of difficult intubation. The ease of the use of the video laryngoscope is subjective and depends on the operator. We used just one video laryngoscope, so the generalization of the results to other types of video laryngoscopes is questionable. The time taken to intubate was not measured which is an important parameter for ease of intubation, and which is not included in the intubation difficulty score.

We concluded that head elevation to a level that achieved alignment of the external auditory meatus and sternal notch in the horizontal plane resulted in better visualisation of the glottis and ease of intubation using a video laryngoscope. Whether this also applies in adults presenting with difficult intubation needs further research.

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