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Comparative Evaluation of Glottic View on Direct Laryngoscopy with or without Head Elevation in Paediatric Population

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Abstract

Introduction: Proper positioning of head and neck is essential for optimal glottic visualisation during direct laryngoscopy (DL). Literature is very scarce on the subject of head posture for laryngoscopy in paediatric population and is not known at which age head elevation should be instituted. Also, we do not know whether the end point of sniffing position(SP) in obese adults can be extrapolated to children or not.

Material & Methods: This prospective crossover study was conducted in 37 paediatric patients belonging to ASA physical health status grade 1 and 2 aged 1 – 12yrs, of either sex scheduled for elective surgery under GA after approval of IRB.A standard anaesthesia protocol was followed. All laryngoscopies were performed by the same laryngoscopist**.** Glottic visualisation during DL was assessed using Cormack and Lehane (CL) grading without external laryngeal manipulation. Inhalational or I/V induction was done as desired by anaesthesiologist. After 2.5min of BMV patient was placed in SP with a pillow (incompressible & height 5 cm) under the head of patient along with simple head extension. Alignment between two points i.e. centre of external auditory meatus (EAM) and sternal notch (H1) was checked. BMV was continued for another 30sec followed by first direct laryngoscopy (DL-1) and CL grading was noted. Thereafter patient was prepared for DL-2 by removing the pillow along with simple head extension. Alignment between centre of EAM and sternal notch(H2) was checked again followed by DL-2. CL grading on DL-2 was noted.

Conclusion: In children aged 1-6yrs, SP and best laryngeal exposure is obtained with simple head extension, without head elevation while in children between 7-12yrs of age it is obtained with head elevation and simple head extension. Also, horizontal alignment of EAM and sternal notch is useful clinical end point for obtaining optimal SP in paediatric patients too.

Keywords: Sniffing position, Head elevation, Head extension, Glottic visualisation

Introduction

The ability of good glottic visualisation during DL is a major determinant of easy tracheal intubation. Proper positioning of head and neck is essential for optimal glottic visualisation during DL. The SP is recommended as the standard head position for optimal glottic exposure[1]. The head should be elevated to such a height that angle of neck flexion over the chest is $35^0$and head extension is 15^0 [2]. The height of head support needed to achieve this degree of neck flexion may vary from one individual to another depending

upon the age, head & neck anatomy and its relationship to the chest diameter of the patient. In majority of the adults, it is possible to achieve this degree of neck flexion with 7-9 cm of headelevation[3]. It has been suggested that horizontal alignment of EAM and sternal notch may be a useful clinical endpoint to ensure a proper SP and subsequently improve glottic visualisation in obese patients and non-obese adults but clinical relevance of this endpoint in paediatric patients is unknown. In children no head elevation is needed[4]because proper neck flexion angle is achieved when patient is supine and only slight head extension at atlanto-occipital joint is needed for axes alignment. Also, slight head extension improves the alignment of line of vision and laryngeal axis. In children <2yrs of age, no advantage of glottic visualisation is obtained from flexion of neck during DL. Older children may require some head elevation to achieve proper SP as their chest diameter is larger than head diameter and laryngeal anatomy approximates adult laryngeal anatomy. The literature is very scarce on the subject of head posture for laryngoscopy in paediatric population and is not precisely known at what age head elevation should be instituted.

Materials & Methods

After approval of the IRB, this prospective crossover study was conducted in 37 paediatric patients of age 1 – 12yrs,of either sex belonging to ASA physical status grade 1 and 2 scheduled for elective surgery under GA. Children enrolled in the study were from various departments which caters to children of various ages. It was ensured that all age group children (i.e. <6yrs and >6yrs) were equally represented in the study population. Children with anticipated difficult airway like limited mouth opening, restricted neck mobility, temporo-mandibular joint ankylosis, congenital anomalies like hydrocephalus or meningo-myelocele, patients undergoing upper airway surgery, with BMI > 95 percentile as per age and sex were excluded. Written informed consent was taken from parents of all children along with detailed pre-anaesthetic check-up and airway examination. Each patient's height, weight, chest diameter (antero-posterior) and head circumference was noted. Children were kept fasting prior to surgery, as per standard ASA recommendations. Premedication was as per pre-anaesthetic requirements. A standard anaesthesia protocol was followed. Monitoring included HR, ECG, SpO2, NIBP, EtCO2. All laryngoscopies were performed by the same laryngoscopist. Laryngoscope with McIntosh blade size no. 1 (for patients aged 1-6yrs) and size no. 2 (for patients aged 6-12yrs). Glottic visualisation during DL was assessed using CL grading without external laryngeal manipulation which was permitted after evaluation in order to facilitate tracheal intubation after DL-2, if required. Easy laryngoscopies were defined as CL grade I or II and difficult as CL grade III and IV. Inhalational or I/V anaesthetic induction was done as desired by anaesthesiologist. For inhalational induction Sevoflurane (6-8 %) or Halothane (2-4%) in Oxygen was used. A peripheral venous line was secured. For I/V induction Fentanyl 1 µgm/kg and Propofol 1.5-2.5 mg /kg were used. After ensuring adequacy of ventilation injection Vecuronium 0.1 mg/kg I/V was given for muscle relaxation. Patient was then mask ventilated with 100% Oxygen with Sevoflurane (2-4%) / Halothane (1-2%). After 2.5min of BMV patient was placed in the SP with a pillow (incompressible & height 5 cm) under the head of patient along with simple head extension. Alignment between two points i.e. centre of EAM and sternal notch (H1) was checked using a horizontal plastic bar

with a spirit level attached in its midst. BMV was continued for another 30sec followed by DL-1 and CL grade was noted, thereafter patient was mask ventilated for 30sec and prepared for DL-2 by removing the pillow kept under the head along with simple head extension. Alignment between centre of EAM and sternal notch (H2) was checked again followed by DL-2, CL grading was noted. After DL-2 patient's airway was secured with an appropriate size ETT or supra - glottic airway device. The following observations were made. The primary outcome being glottic view on DL assessed using CL grading with or without head elevation and secondary outcome was horizontal alignment between centre of EAM and sternal notch (H1 and H2) with or without head elevation.

Statistical Evaluation

Data was summarised and compared using following tests:

1. Paired t test / wilcoxon test
2. Chi square test / Fisher exact test
3. ANOVA test

All tests were performed at 5% level of significance. Hence p value ≤ 0.05 was considered as significant and p value < 0.001 as highly significant.

Results

H1	N	AGE (IN YEARS)		
		Mean	Std. deviation	p-value
No	22	5.00	2.79	<0.001
Yes	15	8.53	2.06	
TOTAL	37	6.43	3.05	

Table1: Comparison of horizontal alignment (H1) of EAM and sternal notch during DL-1 and age of patient

In head elevated position,15/37 patients with mean age of 8.53 ± 2.06 years, there was horizontal alignment of EAM and sternal notch. 22 patients with mean age of 5.00 ± 2.79 years showed no horizontal alignment of EAM and sternal notch. The difference in the ages of patients showing and not showing alignment is statistically highly significant (p < 0.001).

H2	N	Age (In Years)		
		mean	Std deviation	p- value
NO	27	7.37	2.93	0.001
YES	10	3.90	1.59	
TOTAL	37	6.43	3.05	

Table 2: Comparison of horizontal alignment (H2) during DL-2 and age of patient

When patients were put in position for laryngoscopy without any head elevation,27/37 patients with mean age of 7.37 ± 2.937 did not have horizontal alignment of EAM and sternal notch. 10/37 with mean age of 3.90± 1.595 years had horizontal alignment of EAM and sternal notch. The difference in the ages of patients showing alignment and not showing alignment is statistically significant (p =0.001).

CL(DL-2)	CL(DL-1)				TOTAL
	I	II	III	IV	
I	1	6	0	0	7
II	10	6	3	0	19
III	2	7	2	0	11
IV	0	0	0	0	0
TOTAL	13	19	5	0	37

p = 0.092

Table 3: Comparison of glottic view during DL-1(with head elevation) and DL-2 (without head elevation)

Although the above results are statistically insignificant (p = 0.092) but clinically they are significant as majority of the patients showed change in CL grading on removal of head elevation. A marked change in glottic view as well as horizontal alignment of EAM and sternal notch due to effect of head elevation started occurring from the age group of 6yrs onwards therefore

results were re-tabulated into 2 groups i.e. 1-6yrs & 7-12yrs.

CL(DL-2)	CL (DL-1)				TOTAL
	I	II	III	IV	
I	1	6	0	0	7
II	1	3	3	0	7
III	0	1	2	0	3
IV	0	0	0	0	0
TOTAL	2	10	5	0	17

p = 0.212

Table 4: Comparison of glottic view during DL-1 and DL-2 in 1-6yrs age

In this age group (1-6yrs) out of total 17 patients, 9 (6+3) patients showed improvement in theirglottic view with removal of headelevation. above results are statistically insignificant (p = 0.212) but they are clinically significant.

CL (DL-2)	CL (DL-1)				TOTAL
	I	II	III	IV	
I	0	0	0	0	0
II	9	3	0	0	12
III	2	6	0	0	8
IV	0	0	0	0	0
TOTAL	11	9	0	0	20

p = 0.028

Table 5: Comparison of glottic view during DL-1 and DL-2 in 7-12yrs age

In this age group out of total 20 patients, 17 (9+2+6) patients showed worsening of glottic view with removal of head pillow. The above results are statistically significant (0.028).

H2	H1		
	NO	YES	TOTAL
NO	13	14	27
YES	9	1	10
TOTAL	22	15	37

P-value = 0.021

Table 6: Comparison of horizontal alignment during DL- 1and DL-2 The above results are statistically significant (p = 0.021).

p = 0.787

H2	H1		
	NO	YES	TOTAL
NO	6	1	7
YES	9	1	10
TOTAL	15	2	17

Table 7: Comparison of horizontal alignment during DL-1 and DL-2 in 1-6yrs age group

In this age group 9/**17** patients showed improvement in horizontal alignment on removal of head elevation.The above results are statistically insignificant (p = 0.787) but they are clinically significant.

H2	H1		
	NO	YES	TOTAL
NO	7	13	20
YES	0	0	0
TOTAL	7	13	20

p - Value cannot be calculated

Table-8 Comparison of horizontal alignment during DL-1 and DL-2 in 7-12yrs age group

In this age group, 13/20 patients showed worsening of horizontal alignment on removing head elevation.For above results statistical significance cannot be calculated (as value of few entries in the table is 0), but they are clinically significant.

CL (DL-1)	H1		TOTAL
	NO	YES	
I	3	10	13
II	14	5	19
III	5	0	5
IV	0	0	0
TOTAL	22	15	37

p = 0.002

Table 9: Relationship of glottic view and horizontal alignment during DL-1

These results are statistically significant (p = 0.002).

CL (DL-2)	H2		TOTAL
	NO	YES	
I	0	7	7
II	16	19	19
III	11	11	11
IV	0	0	0
TOTAL	27	37	37

p <0.001

Table 10: Relationship of glottic view and horizontal alignment during DL-2

The above results are highly statistically significant (p< 0.001).

Discussion

Experts agree that head posture for laryngoscopy depends upon the age of the child but there is no conclusive study regarding the same.In1936, Sir Ivan Magill recommended placing a pillow below head to raise head and then extending head is required for best laryngeal exposure. This position, called as SP is considered best position for maximal laryngeal exposure[1]. However, many of these recommendations for SP were based on clinical experience and logic and not on actual clinical studies, that's why superiority of SP over other head positions has been questioned and also to avoid confusion a standard definition of SP has been recommended[2]. Now it has been proved that SP does not guarantee adequate exposure in all patients because many other anatomical factors like type and size of laryngoscope blade[5], laryngoscopic lifting force[6], operator's experience[7] and most importantly patient's airway anatomy[8] control final degree of laryngeal visualisation.

Infants and young children have larger head and smaller chest diameter relative to adults, this allows optimal glottic visualisation when head is positioned flat on the bed without head elevation. Park et al[3], found that 3 cm or 6 cm pillow provided better laryngoscopic view in short necked patients. We used non-compressible pillow because head sagging decreases the angle of neck flexion and results in partial SP[9]. We standardised the following in our study : same operator who had performed atleast 100 direct laryngoscopies in paediatric patients performed all laryngoscopies, laryngoscope type and blade size (Mcintosh blade of size 1and 2 for patients aged 1-6yrs and 6-12yrs respectively) and operating table height maintained such that head of the patient was 1 foot below the eye level of laryngoscopist. We assessed glottic view using CLgrading system and classified laryngoscopy as easy (CL grade I or II) or difficult (CL grade III or IV). It is not known whether the anatomical markers (which are the endpoints of correct SP in adults) hold true for paediatric population or not. In our study we found that during DL-1 (laryngoscopy with head pillow), 32/37 patients with mean age of 7.12yrs

had easy laryngoscopy and 5 patients with mean age of 2yrs showed difficult laryngoscpy. During DL-2 we found that ,26/37 patients had easy laryngoscopy with mean age of 5.81yrs and only 11 patients had difficult laryngoscopy with mean age of 7.91yrs. From these statistically significant findings ($p < 0.05$) we can infer that in patients < 6yrs laryngoscopy was easy without head elevation and in patients ≥7yrslaryngoscopy was easy with head elevation. In 1-6yrs of age group, 5/17 patients (30%) had difficult laryngoscopy with head elevation and in 3/5 patients (60%) difficult laryngoscopy was changed to easy by removing the head elevation. In rest of 2 patients CL grade remained unchanged by removing the head elevation. Also, in patients aged 1-6yrs, horizontal alignment of EAM and sternal notch while using head elevation was found only in 2/17 (11%) patients, this number increased to 10/17 (59%) patients when head elevation was removed. From this we can infer that in children aged 1-6yrs head elevation makes the alignment of oral, pharyngeal and laryngeal axes worse resulting in poor glottic view. Though these results are statistically insignificant but they are clinically significant. Statistical insignificance can be attributed to small size of study population. In 7- 12yrs age group none of the patient showed difficult laryngoscopy with head elevation but 8/20 patients (40%), laryngoscopy became difficult on removing the head elevation i.e. glottic view was either good or same with head elevation. Also, in this age group 13/20 (65%) patients showed horizontal alignment of EAM and sternal notch with head elevation, which was lost in all the 13 patients by removing the head elevation. From this we can infer, that in children aged 7-12yrs age better glottic view is obtained on DL with head elevation. These findings are statistically significant ($p = 0.028$). Also, more patients achieve SP with head elevation. However, these findings are statistically insignificant, which may be again due to small sample size. Westhorpe et al[10] in their study on position of larynx found that there is marked descent of all the upper airway structures in neck occurring between birth and 3yrs and there is little change thereafter until puberty. Lateral radiographs of head and neck were taken and in radiographs two straight lines were drawn, one along line of maxilla at borders of teeth, the other passing through centre of laryngeal inlet and tip of uvula. They called angle between these two lines as “intubation angle” and measured this angle in various positions. They concluded that upto 4yrs there is no increase in intubation angle when head is elevated using pillow compared to simple head extension because there are none or few intervertebral joints above larynx to flex, so no advantage is obtained from neck flexion in glottic visualisation. They concluded that from 6yrstill puberty 1^0 or 2^0 of increased angulation and visualisation may be gained by placing head on a low pillow. Our clinical findings are consistent with the findings of Westhorpe R.N., though not based on radiography. Our findings are also consistent with findings of Vialet R et al[11], who by their study of effect of various head position on oral, pharyngeal and laryngeal axes alignment in young children by MRI concluded that only slight head extension leads to axes alignment without need for neck flexion by head elevation. They measured delta angle between laryngeal axis and line of vision based on MRI scans and concluded about axis alignment in various head positions. However crucial clinical endpoint for easy tracheal intubation i.e.extent of glottic visualisation and not the axes alignment remained unanswered in the study. Adnet et al[12], found that SP does not significantly affect the laryngoscopic view in

comparison with simple head extension, during DL when it is systematically used with Mcintosh blade. They found that in presence of obesity or limitation of head extension, SP offers advantage over simple head extension. Simple manoeuvre of head extension against flat surface will inevitably lead to some degree of neck flexion as demonstrated in MRI based study. Our results are in contrast with those of Adnet et al because it was conducted in adults and confounding factors like different operators doing laryngoscopy, non-standardisation of size of the laryngoscopic blade and non-achievement of proper SP before DL. We looked for horizontal alignment of EAM and sternal notch in each patient with or without head elevation and found that during H1(with pillow) only 15/37 patients showed alignment with mean age of 8.53yrs and 22 patients did not show alignment with mean age of 5yrs. During H2 (without pillow) only 10 patients showed alignment with mean age of 3.90yrs and 27 patients did not show alignment with mean age of 7.37yrs. These results are statistically significant ($p<0.05$). On re-tabulation of results into two age groups we found that in children aged 1-6yrs, majority of the patients did not show horizontal alignment between EAM and sternal notch with head elevation. When the pillow was removed most of them showed horizontal alignment between the same with pillow removed. In 7-12yrs age, majority showed horizontal alignment of EAM and sternal notch with head elevation but this alignment was lost on removing the head elevation. From this, we can infer that in children1-6yrs age, SP is achieved without head elevation while in7-12yrs age, SP can be achieved with head elevation. However, these findings are statistically insignificant ($p >0.05$) due to less number of patients enrolled in each age group. Also, we found that all those patients who showed horizontal alignment between EAM and sternal notch with or without pillow had good visualisation of glottis. These findings are statistically significant ($p < 0.05$). Patients who did not show this horizontal alignment had either difficult (32.6%) or easy (67.4%) laryngoscopy. This latter deviation in result (i.e. easy laryngoscopy without any horizontal alignment) could be firstly because of bias in the study as operator was not completely blinded. Secondly, majority (60%) of the patients with such results belonged to the age group 5-8yrs and we used an incompressible pillow of fixed height of 5 cm for all patients. Maybe this height of pillow was either less or more for particular age group. Had we used a pillow with adjustable height in such a manner to bring EAM and sternal notch in a horizontal line, better conclusions could have been drawn. Moreover, we assessed the horizontal alignment between EAM and sternal notch objectively by using a spirit level bar. Had we accurately measured the angle using goniometer, we would have been able to know how far or close we were in achieving the exact horizontal alignment of EAM and sternal notch and its correlation with glottic view.

Conclusion

In children aged 1-6yrs, SP and best laryngeal exposure (CL grade I & II) is obtained with simple head extension, without head elevation while in children between 7-12yrs it is obtained with head elevation (of atleast 5 cm) and simple head extension. Also, horizontal alignment of EAM and sternal notch is useful clinical end point for obtaining optimal SP in paediatric patients too. However as other factors (besides SP) also interplay in controlling the final degree of visualisation of glottis, SP (judged by horizontal alignment of EAM and sternal notch) should be atleast be the starting optimum head position for DL.

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