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Head and Neck Alignment for Optimal Glottic view at Paediatric Laryngoscopy: Comparison of two Anatomical Axes

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ABSTRACT
Background: Suboptimal head-neck alignment in children, with consequent poor glottic visualisation, results in delayed tracheal intubation cascading to peri-intubation sequelae.
Objective: To determine the degree of glottic view achieved in children during direct rigid laryngoscopy for orotracheal intubation with head-neck alignment done keeping the suprasternal notch-auditory meatus (SN-AM) axis versus the sternal angle-auditory meatus (SA-AM) axis, horizontally.
Methods: Following ethical clearance and informed parental consent, 68 children aged 1 – 6 years, of American Society of Anesthesiologists (ASA) class I or II, were randomized into two groups of pre-intubation head-neck alignments: group A used horizontal SN-AM axis, while group B adopted horizontal SA-AM axis, for the alignment. Degree of glottic view achieved, tracheal intubation attempts, external laryngeal backward upward rightward pressure (BURP) manoeuvre and grade were recorded. Glottic view achieved and grade of BURP applied were assessed using the Cormack-Lehane grading and three-point Likert scales respectively; the time to orotracheal intubation (TTOTI), defined as the period from removal of preoxygenating face mask to first capnographic evidence of correct tracheal tube placement, and immediate post-intubation arterial Oxygen saturation (SpO_2) also were recorded.
Results: All 68 children completed the study. The groups were comparable in Cormack-Lehane grades of glottic visualisation, P=0.611, with statistically similar BURP application, P=0.642. The mean TTOTI (26.97±2.58 versus 26.41±2.68) in seconds, and the peri-intubation mean percentage SpO_2 (95.08±1.08 versus 94.85±0.957) showed no significant difference, P=0.383 and 0.346, respectively, with zero occurrence of peri-intubation complications, in the groups.
Conclusion: In children aged 1-6 years, the degree of glottic visualisation achieved at conventional rigid laryngoscopy for endotracheal intubation, is similar between head-neck alignment done by keeping the SN-AM axis in horizontal plane and head-neck alignment done by keeping the SA-AM axis horizontally.

KEYWORDS: Glottic view, Head-neck alignment, Laryngoscopy.

I INTRODUCTION

An optimal laryngeal visualisation is of strategic importance to achieving a swift, smooth and successful tracheal intubation necessary to circumvent the complications of delayed correct tracheal tube placement and those associated with repeated laryngoscopy and tracheal intubation attempts. In their retrospective analysis of 1,828 orotracheal intubations performed in the Emergency Department, Sakles et al[1] highlighted the existence of a direct relationship between the number of attempts at direct rigid laryngoscopy and the incidence of adverse effects, noting an increased incidence with multiple attempts, in contrast with first-pass tracheal intubation which was associated with the least incidence of complications. The authors[1] documented that the incidence of one or more adverse events when tracheal intubation was successful at first, second, third, and at the fourth or more attempts correspondingly was 14.2%, 47.2%, 63.6% and 70.6%, further observing from a multivariate logistic regression analysis that more than one attempt at tracheal intubation was a significant predictor of one or more adverse events.

Young children, especially infants, by possessing reduced functional residual capacity, are prone to rapid desaturation in the event of apnoea;[2] consequently, the ensuing hypoxia and bradyarrhythmia can speedily cascade to death through pathophysiological pathways of hypoxic ischaemic encephalopathy. Although these adverse effects are more common in patients in emergency and critical care settings, their occurrence does not preclude those in elective situations.[3] While failure of oxygenation and lack of ventilation are considered as the direct primary precipitants in the aetiology of hypoxia-trggered pathophysiology, the achievement of a swift, successful tracheal intubation and airway security at first attempt is of critical significance in ensuring an effective prophylaxis against the initiation of hypoxia. Furthermore, with a first-pass tracheal intubation there is circumvention of mask based positive pressure oxygenation/ventilation that carries risk of gastric insufflation, regurgitation, diaphragmatic splinting with worsening of an already decreased functional residual capacity, consequently, leading to hypoxia.[4, 5]

In obese adult patients, the use of the rapid airway management position (RAMP) achieved an optimal head-neck alignment, improved glottic visualisation and ease of tracheal intubation. Greenland et al[6] demonstrated, through magnetic resonance imaging (MRI) aided pilot study, that “ramping” to keep the external auditory meatus of the ear and the suprasternal notch in a horizontal axis, amongst the obese, achieved a better alignment of the oro-pharyngo-laryngeal axis desirable for improved glottic view at orotracheal intubation during direct rigid laryngoscopy, compared to that achieved with head in the neutral position. In 2015, the Difficult Airway Society of the Association of Pediatric Anaesthetists of Great Britain and Ireland (APAGBI), in accordance with the Delphi Consensus,[7] recommended a head-flat, and a head-elevated position for children aged < 2, and ≥ 2 years, respectively, as optimal positioning for improved laryngoscopy.[8] However, no specific reference anatomical landmarks were mentioned in the APAGBI’s guidelines to establish precisely what anatomical axis should define the level of head elevation/non-head elevation optimal for improved laryngoscopy in small children.

Kim et al[9] identified in their report a positive relationship between an optimal head-neck alignment and an improved visualisation of the rima glottidis at laryngoscopy in children aged between 3 and 6 years. The authors[9] documented that aligning the suprasternal notch and external auditory meatus (SN-EAM) horizontally achieved a significantly superior glottic opening in children compared to keeping the head in the neutral position during rigid laryngoscopy. This finding by Kim et al[9] thus unveiled an applicability of definite anatomical points in achieving optimal head-neck alignment for improved glottic view during paediatric direct laryngoscopy. Importantly, the impact of another two-point anatomical axis such as sternal angle (of Louis) and auditory meatus for head-neck alignment on glottic visualisation during paediatric laryngoscopy, in comparison with the use of SN-EAM in horizontal axis for head-neck alignment had not been reported in paediatric population. Hence, this study was designed to determine the degree of glottic view achieved during paediatric direct laryngoscopy for orotracheal intubation, when head-neck alignment is done by keeping horizontally the suprasternal notch-auditory meatus (SN-AM) axis, versus head-neck alignment done by keeping horizontally the sternal angle-auditory meatus (SA-AM) axis.

II MATERIALS AND METHODS

Approval (UPTH/ADM/90/S.11/VOL.XI/1724) was obtained from the Research Ethics Committee of the University of Port Harcourt Teaching Hospital, Port Harcourt, Rivers state, Nigeria, for a prospective, randomized, double-blind comparative study which was conducted from May 2024 to February 2025, in the UPTH, Port Harcourt Nigeria.

A. SAMPLE SIZE DETERMINATION

Sample size (n) was determined using power analysis formula for interventional study:[10]

$$n = \frac{(Z\alpha + Z_{\beta})^2 p(1 - p)}{(d)^2}$$

where,

n = minimum sample size

$Z\alpha$ = one-sided percentage point of the normal distribution corresponding to 100% minus the power; with power of 90% for this study, $Z\alpha = 1.28$

Z_{β} = percentage point of the normal distribution corresponding to one-sided significance level; with a significance level of 5% (i.e. 95% confidence interval), $Z_{\beta} = 1.96$

p1 = proportion of outcome in group which received intervention. In a related study,[11] 85.9% (0.859) improved glottic view was achieved in group which aligned auditory meatus and suprasternal notch on a horizontal axis.

p2 = proportion of outcome in control group. The same study[11] reported improved glottic view of 43.7% (0.437) in the control.

$$p = \text{average proportion} = \frac{p1 + p2}{2} = \frac{0.859 + 0.437}{2} = 0.648$$

d = effect size. For this study, the effect size was 28% (0.28). Substituting,

$$n = \frac{(1.96 + 1.28)^2 \times 0.648(1 - 0.648)}{(0.28)^2} = \frac{(10.4976) \times (0.648 \times 0.352)}{(0.0784)} = 30.54$$

With allowance for 10% attrition, adjusted sample size = 30.54 + 3.05 = 34 per group. Therefore, for the 2 groups, a total of 68 subjects were recruited.

Randomisation and blinding were enabled by recruited Registrar Anaesthetists (Research Assistants). Subjects were randomized into two groups (A and B) by the sequentially numbered opaque sealed envelopes (SNOSE) technique. Each parent/guardian on the morning of surgery, under the supervision of a trained Research Assistant and a Nurse, picked one from a bag which contained 68 envelopes, concealing alphabet A or B in an equal ratio of 34. The envelope picked was excluded from the rest and the patient allocated to the group so designated. Another Registrar Anaesthetist (second Research Assistant), blinded to the outcome of the study, undertook the head-neck alignments in accordance with group specification, as well as assigned a different code for each subject's group against hospital number. The Lead Researcher, who was blinded to the group allocations and head-neck alignments, performed laryngoscopy and recorded the parameters. Data analysis was done by a blinded statistician.

The groups accordingly were, A: group that had head-neck alignment done by keeping the suprasternal notch-auditory meatus (SN-AM) axis horizontally, and B: group which had head-neck alignment done by keeping the sternal angle-auditory meatus (SA-AM) axis horizontally The inclusion criteria comprised children aged 1 – 6 years scheduled to undergo general anaesthesia with direct laryngoscopy and orotracheal intubation for elective surgery, belonging to ASA class I or II, weighing 8 to 22kg, and whose parents gave consent for surgery, anaesthesia and for study, while parental refusal to give consent for surgery, anaesthesia or for study, age < 1 year or > 6 years, weight < 8 or > 22kg, positive history of haemoglobinopathy, asthma, epilepsy, cleft lip and/or palate, torticollis, neck tumours, cranio-facial deformities, thoracic/vertebral anomalies, those diagnosed to have hypertrophic tonsils or oropharyngeal/laryngeal masses, Down syndrome, Pierre Robbin, Goldenhar or Treacher-Collins syndrome, presence of tracheostomy, abnormal head circumference/anatomy (plagiocephaly, microcephaly, megalencephaly), emergency surgery, or scheduled for nasotracheal intubation were excluded. Subjects with unsuccessful tracheal intubation at the second attempt were to be intubated with Glidescope laryngoscope in line with the study protocol.

B. DETAILS OF ANAESTHESIA

A preoperative visit was conducted a day before surgery to establish rapport, clinically assess the patients and verify eligibility for the study based on the inclusion criteria, as well as determine ASA classification. All patients had premedication with oral midazolam 0.5mg/kg mixed with clear glucose-based fluid 30 minutes to general anaesthetic induction. Parents withheld solid food and infant formula 6 hours, breast milk 4 hours, but gave clear fluid up to 2 hours prior to time for surgery, On the morning of surgery, a multi-parameter monitor was attached and a precordial stethoscope strapped to the chest for recording baseline heart rate, breath sound, temperature, non-invasive blood pressure (NIBP), SpO_2, and for continuous monitoring all through the period of surgery. Following the establishment of venous access under sedation with intramuscular glycopyrrolate 0.005mg/kg combined with ketamine 5mg/kg, the children were pre-oxygenated with O_2 at a fresh gas flow rate of 2 – 3 times the minute ventilation for three minutes via Mapleson F breathing system. Prior to laryngoscopy, the second Research Assistant blinded to the study outcome, undertook the head-neck positioning, placing folded linen under the chest and/or head of each subject as necessary, to ensure keeping either the suprasternal notch and the auditory meatus (SN-AM)) or the sternal angle (of Louis) and the auditory meatus (SA-AM) in horizontal axis, in accordance with each child's group allocation. Gauging to ensure correct horizontal axis alignment using the two anatomical axes was done using plum rule. Laryngoscopy and tracheal intubation were performed by the Lead Researcher for homogeneity, utilizing appropriate-size Macintosh blade and styletted tracheal tube, facilitated by intravenous predetermined doses of 2mg/kg propofol, 1µ/kg fentanyl and 2.0mg/kg suxamethonium chloride; anaesthesia maintained with volatile agent (Isoflurane 1 – 1.5% in O_2) and pancuronium 0.5mg/kg. The degree of glottic view achieved, time to orotracheal intubation (TTOTI) defined as the period from removal of preoxygenating face mask to capnographic evidence of correct tracheal tube placement, the number of tracheal intubation attempts, as well as use of external laryngeal manoeuvre with backward, upward, rightward pressure (BURP) were recorded; grade of BURP applied was assessed using a three-point Likert scale:[12] (1 = minimal; 2 = moderate; 3 = maximal). Following successful tracheal intubation and positioning for surgery, adequate analgesia, anaesthesia, necessary akinesia, amnesia,

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airway maintenance, autonomic control, anaesthetic reversal and adequate recovery were ensured in accordance with local standard protocol.

The degree of glottic view achieved at laryngoscopy was assessed using the Cormack-Lehane grading:[13]

Grade 1 = Full view of rima glottidis
Grade 2 = Partial view of rima glottidis
Grade 3 = Only epiglottis seen, none of rima glottidis seen
Grade 4 = Neither epiglottis nor rima glottidis seen

C. DATA COLLECTION AND STATISTICAL ANALYSIS

All data was entered onto Excel spreadsheet and exported to the Statistical Products and Service Solutions (SPSS) version 20.0 (Armonk, NY: IBM Corp.) for statistical analysis, with results presented in tables and figures as appropriate. Descriptive statistics were expressed as mean±standard deviation or number with percentages in brackets. Difference in mean values was analyzed using the student unpaired t-test, while categorical and parametric data were analysed using the chi-square test. Statistical significance was set at a *P*-value less than 0.05.

III RESULTS

Across the two groups of study, the demographic characteristics were comparable: the age (in years) and sex distributions with the corresponding *P*-values of 0.952 and 0.618 were not significantly different. Although there was a male preponderance in the two groups, with a male-to-female ratio of 1.43:1 in group A and 1.83:1 in group B, the mean weights (kg) of the children in the two groups (14.31±3.60 versus 14.63±3.31) were statistically similar, *P*=0.701. The distribution of ASA classifications across the groups (0.595) was also was also comparable **(Table I).**

Table I: Demographic Characteristics and ASA of Subjects in Groups A and B

Demographic Characteristics	GROUP		Total n (%)	χ^2 /t-test	*P*-value
	A	B			
Age (years)					
1.00	6 (42.9)	8 (57.1)	14 (100.0)		
2.00	7 (58.3)	5 (41.7)	12 (100.0)		
3.00	5 (50.0)	5 (50.0)	10 (100.0)	$^{\alpha}$ 1.123	0.952
4.00	5 (55.6)	4 (44.4)	9 (100.0)		
5.00	4 (57.1)	3 (42.9)	7 (100.0)		
6.00	7 (43.8)	9 (56.3)	16 (100.0)		
Sex					
Male	20 (47.6)	22 (52.4)	42 (100.0)	$^{\alpha}$ 0.249	0.618
Female	14 (53.8)	12 (46.2)	26 (100.0)		
M:F	*1.43:1*	*1.83:1*		-	-
Weight (kg)	*14.31±3.60	*14.63±3.31		$^{\beta}$ -0.386	0.701
ASA					
I	25 (52.1)	23 (47.9)	48 (100.0)	$^{\alpha}$ 0.283	0.595
II	9 (45.0)	11 (55.0)	20 (100.0)		

Data are expressed in Number (n), Percentage (%), and Mean±Standard Deviation (Mean±SD)
ASA = America Society of Anaesthesiologists; M:F = Male-to-Female Ratio
$^{\alpha}$ = Chi-Square $^{\beta}$ = t-test; * = Mean±SD

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Adenotonsillectomy, recording a total of 24 (35.294%) was the ranking indication for surgery under endotracheal intubation, followed by urethroplasty [19 (27.941%)], colostomy reversal for ano-rectal malformation [9 (13.235%)] and posterior sagittal ano-rectoplasty [7 (10.294%)] as the second, third and fourth ranking indications; cervical lymph node biopsy and excision biopsy for cystic hygroma, respectively, with the values of 4 (5.882%) and 3 (4.412%) were fifth and sixth, while release of syndactyly [2 (2.941%)] was the least indication **(Figure I).**

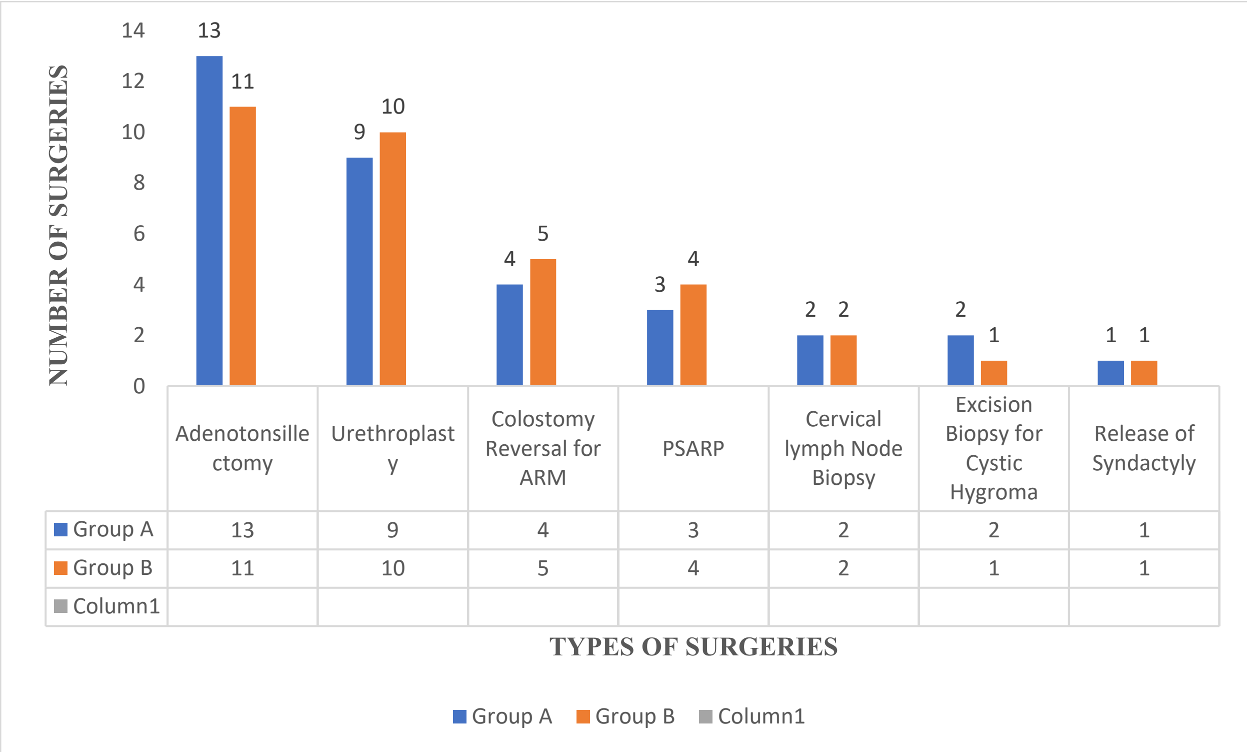

Figure I: Indications for Surgery Under Endotracheal General Anaesthesia Across The GROUPS.

At laryngoscopy, the degree of glottic visualisation was not significantly different between the two groups: respectively, 13 (38.2%) and 21 (61.8%) in group A had Cormack-Lehane grade 1 and grade 2, while the corresponding values were 11 (32.4%) and 23 (67.6%) in group B, P=0.611; there was statistical similarity in the grade and proportion of BURP application, with only 2 (5.9%) in group A and 3 (8.8%) in group B requiring the manoeuvre, *P*= 0.642.The mean time to oro-tracheal intubation (TTOTI in seconds) and peripheral arterial haemoglobin oxygen saturation (SpO_2) in the two groups were as well statistically similar, with the values of 26.97±2.58 versus 26.41±2.68, *P*=0.383, and 95.08±1.08 versus 94.85±0.957, *P*=0.346, respectively, All the subjects were successfully intubated at the first attempt and there was no occurrence of peri-intubation hypoxaemia or oro-pharyngeal trauma in either of the groups. **(Table II).**

Table II: Cormack-Lehane Grading, Burp Application and Grade, Ttoti and Post Intubation Oxygen Saturation (SPO_2)

Parameter	Group A N = 34	Group B N = 34	χ^2 / t-test	*P*-value
Cormack-Lehane Grading				
Grade 1	13 (38.2)	11 (32.4)	$^{\alpha}$ 0.25	0.611
Grade 2	21 (61.8)	23 (67.6)		

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BURP Application and Grade				
Grade 1 (Minimal)				
Yes	2 (5.9)	3 (8.8)	$^{\alpha}$ 0.21	0.642
No	32 (94.1)	31 (91.2)		
Tracheal Intubation Attempts				
1	34 (100.0)	34 (100.0)		-
>1	0 (0.0)	0 (0.0)		
TTOTI (in seconds)	*26.97±2.58	*26.41±2.68	$^{\beta}$0.877	0.383
Post-intubation SpO_2 (%)	*95.08±1.08	*94.85±0.957	$^{\beta}$0.949	0.346
Peri-itubation Complications				
Hypoxaemia (SpO_2 <90%)				
No	34 (100.0)	34 (100.0)		
Yes	0 (0.0)	0 (0.0)		
Oro-pharyngeal Trauma				
No	34 (100.0)	34 (100.0)		
Yes	0 (0.0)	0 (0.0)		

Data are expressed in Number (n), Percentage (%), and Mean±Standard Deviation (Mean±SD)
$^{\alpha}$ = Chi-Square $^{\beta}$ = t-test; * = Mean±SD
BURP = Backward upward rightward pressure; TTOTI = Time to oro-tracheal intubation
SpO_2 = Peripheral arterial haemoglobin oxygen saturation

IV DISCUSSION

In children with comparable demographic characteristics, the degree of glottic visualisation achieved in group B, which had pre-intubation head-neck positioning done with the sternal angle-auditory meatus (SA-AM) axis horizontally aligned, was similar to that achieved in group A, in which head-neck alignment was done by maintaining the suprasternal notch-auditory meatus (SN-AM) axis in horizontal plane; BURP application required in very few subjects was minimal and comparable, all subjects were successfully intubated at first attempt, the TTOTI and immediate post intubation SpO_2 values were statistically similar as well, without occurrence of peri-intubation hypoxaemia or oro-pharyngeal trauma.

Amongst practising Paediatric Anaesthesiologists and airway management professionals, securing a patent and functional airway through tracheal intubation remains the indisputable cornerstone that pivots the successful conduct of anaesthesia, and the delivery of any surgical/non-surgical treatment intervention to a patient. The leading aetiological association of airway-related critical events and perioperative/anaesthesia-related morbi-mortality had been documented in scientific literature.[14] Hasan et al,[14] following a retrospective study of 183 children, documented that respiratory based adverse events [43 (23.5%)], particularly oxygen desaturation, laryngospasm and bronchospasm, were the leading anaesthesia-related complications, further observing that the incidence of Oxygen desaturation, laryngospam and bronchospasm, varied differently across their different age categories, with the corresponding values (%) of 18.7, 9.4 and 3.1 for children aged <1 year, 14.5, 7.3 and 2.2 for children aged 1 – 3 years, and 8.3, 4.2 and 1.0 for those aged 4 – 12 years.

Not only a successful tracheal intubation is to be considered an important goal, but the ease and rapidity of achieving such success as well; in this regard, an improved glottic visualization is the most central factor which serves as a critical determinant of correct tracheal tube placement, according to earlier scientific documentations.[6-9] In this study, the finding that an alignment of the head, relative to the neck, done by keeping in a horizontal plane the SA-AM axis (group B) achieved similar improved degree of glottic view, to that achieved when head-neck alignment was done by keeping in a horizontal plane the SN-AM axis (group A), depicts a parallel effectiveness of the two different axes of alignments in improving glottic visualisation at paediatric laryngoscopy. Inferentially, the SA-AM axis equates to the SN-AM axis in the degree of favourableness achieved, by bringing the anatomical

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alignment of the oro-pharyngo-laryngeal axis, described by Greenland et al,[6] with the eye of the intubator during direct rigid laryngoscopy. In its 4-step (A-B-C-D) algorithm for the management of unanticipated difficult airway, the Difficult Airway Society (DAS) recommended proper head positioning, in plan-A, for the achievement of successful tracheal tube placement, ab initio or following a failed first attempt.[15, 16] On a critical analysis, this recommendation by the DAS identifies an association of difficult tracheal intubation with sub-optimal head-neck alignment, as well as establishes a vice-versa, hence, the consideration of implementing a proper and favourable head repositioning.

Traditionally, rigid direct laryngoscopy is the most primary and frequent first-choice method employed during tracheal intubation globally, in both adults and children, particularly in low- and midde-income nations.[17, 18] Implementing an optimal head-neck alignment preliminary to tracheal intubation is of utmost procedural importance when handling airway management in the paediatric category, particularly in younger children, due to their peculiar anatomical profile. The presence of an endowment of a relatively large head causes cervical flexion in the supine position under anaesthesia; an occipital prominence, a short neck and an antero-cephalad larynx culminate in an unfavourable oro-pharyngo-laryngeal axis alignment, poor glottic view and a difficult tracheal intubation. The challenges of the impact of these alterations in airway morphology on sedated children aged under five years had been reported by Li et al.[19]

A difficult intubation scenario in a child constitutes grave danger to the patient and a nightmare to the attending Anaesthesiologist, due to the associated high risk of pulmonary aspiration of gastric contents, particularly if it is an emergency setting with the patient presenting typically with a "full stomach", Thibodeau et al,[20] following a retrospective review of 79 anaesthetic records of urgent oro-tracheal intubations, performed in the Emergency Department by rapid sequence induction (RSI) technique, reported that pulmonary aspiration occurred in 3 (3.5%) patients (95% confidence interval, 0%, 7.4%). Although this incidence is low, on analysis of the important and detailed information provided in the 4th National Audit Project (NAP4) of the Royal College of Anaesthetists and Difficult Airway Society, Cook et al [21, 22] documented that pulmonary aspiration remained the leading cause of airway-related anaesthetic deaths, most cases possessing identifiable risk factors; according the authors,[22] greater than 50% of airway-related deaths in anaesthesia in the United Kingdom occurred as a consequence of pulmonary aspiration. This adverse pulmonary incident is known to orchestrate the development of a spectrum of pathologies, ranging from pure chemical pneumonitis with transient hypoxaemia (Mendelson's syndrome) and secondary bacterial pneumonia complicating acute lung injury, to grave acute respiratory distress syndrome, all of which have an established aetiological relationship with significant morbidity leading to prolonged hospital stay, increased cost of hospitalization and greater mortality, according to Dunham et al.[23]

In an earlier scientific literature the direct correlation between a higher risk of pulmonary aspiration and poor glottic visualization had been documented.[24] Akbar et al,[24] in their cross-sectional observational study of 87 adults undergoing RSI in the Emergency Department, noted that the patient population with Cormack-Lehane grade I - II views had a lower aspiration pneumonia rate of 12.8% (6/47), compared to the higher rate of 27.5% (11/40) amongst those with Cormack-Lehane grades III - IV, thus depicting a clear association of greater aspiration risk with severity of laryngoscopic view. Inferentially, in patient populations with predisposition to pulmonary aspiration, a pre-intubation head-neck alignment that improves glottic view at laryngoscopy is to be considered a procedural necessity of high aspiration prophylaxis relevance. As observed in this study, there was attainment of comparable level of improved glottic view in the two groups, evidenced by the confinement of Cormack-Lehane grading to I and II, with total exclusion of grades III and IV, revealing further the parallel effectiveness between the two axes of head-neck alignments during conventional rigid paediatric laryngoscopy. From Cormack-Lehane's description of glottic view and its association with the ease/difficulty of tracheal intubation, grades III - IV are categorized as difficult, and grades I - II as easy.[13, 25] Evidentially, while the real significance of optimal head-neck alignment, for improved glottic view, may not be considered critical to the circumvention of pulmonary aspiration in elective anaesthesia settings, the necessity is very obvious for emergency patient care in relation to airway management.

An external laryngeal manoeuvre with backward, upward, rightward pressure (BURP) is usually indicated during direct rigid laryngoscopy, for achieving a conversion from poor to improved glottic visualisation.[26] Through its strategic application the BURP manoeuvre decreased difficult laryngoscopy from 428 (21.1%) to 124 (6.1%) in a study on 2,028 subjects, according to the observation by Yu et al;[26] from the available scientific evidence, BURP is required in scenarios where glottic view is classifiable as grades III – IV, which correlate directly with higher rate of difficult intubation.[26] In this study, the finding that only grade 1 (minimal/light) BURP was required in just 2 (5.9%) and 3 (8.8%) children in groups A and B, respectively, depicts an achievement of favourable glottic visualisation to the exclusion of necessitation of any BURP application in greater than 90% of subjects in either of the groups, considering the fact that Cormack-Lehane grading achieved at laryngoscopy is inversely related to the grade of BURP necessitated. In a previous prospective, randomized, double blind study, Aggo et al[27] similarly documented an observation of the complete exclusion of necessitation of any form of BURP application in the groups, when comparing the impact of horizontally maintaining the sternal angle of Louis-external auditory meatus (SAL-EAM) axis versus keeping the suprasternal notch-external auditory meatus (SN-EAM) axis in horizontal plane, for their subjects' head-neck alignments, during direct rigid laryngoscopy in adults undergoing elective oro-tracheal intubation under general anaesthesia.

The ASA Task force on the Management of Difficult Airway, in its 2003 updated report, re-defined difficult tracheal intubation simply as any correct tracheal tube placement requiring multiple attempts.[28] In this study, there was a zero occurrence of difficult intubation in the two groups of children evidenced by the achievement of 100% first attempt success, attributable to improved glottic view enabled by optimal head-neck alignments. In the context of RSI practice, two goals are to be deemed cardinal by the Anaesthesiologist or airway management professional, globally: a) smooth, successful tracheal intubation at first attempt, and b) rapidity in successful tracheal intubation enabling the exclusion of occurrence peri-intubation sequelae, particularly pulmonary aspiration. In this regard, the achievement of the second goal is a function invariably dependent on the achievement of the first. Consequently, during the implementation of any RSI protocol, a failure to achieve tracheal intubation at the first attempt defeats the primary objective, and disqualifies the general anaesthetic induction process from being described as rapid sequence. The importance of achieving a first-pass success in tracheal tube placement, especially in the care of patients in the Emergency Department or in critical care units had been published scientifically.[29, 30]

In a retrospective analysis of multicentre data, Goto et al[29] observed that in 1,151 rescue intubations the success rate on the first attempt declined as the number of preceding failed attempts increased, with the corresponding values of 81%, 71%, and 67%, after the first, second and third failed attempts. Importantly, Chen et al,[30] following their retrospective univariate and multivariate analysis of outcomes of neonatal tracheal intubations, using data from the NEAR4NEOS, reported the finding of 62.5% first intubation attempt success out of 360 intubation courses, with 538 attempts identified, concluding that increasing operator seniority and lower airway grades were associated with increased first attempt intubation success rates. Similarly, studying the first intubation attempt success rates of endotracheal intubation by comparing the rapid airway management protocol ("Ramped") versus supine positioning in 267 patients, Chanthawatthanarak et al[31] observed that while the overall first intubation success rate was 82.4%, the rate was higher in the ramped group relative to the supine group (86.7% versus 78.0%, P=0.066); though the difference was not statistically, they identified that improved glottic view grade I – II (AOR 3.256; 95% CI: 1.088, 9.741) was independently associated with first-pass success. Combining the findings by Goto et al[29] and Chanthawatthanarak et al,[31] there is consensus that improved glottic visualisation is the most important denominator to achieving first-pass success in tracheal intubation, and that agrees with the findings in this study. Inferentially, therefore, to achieve excellent first-attempt tracheal intubation success rates, the implementation of an optimal pre-intubation head-neck alignment, which improves glottic visualization, is to be considered a pre-requisite. For practising paediatric Anaesthesiologists or airway management professionals, also it far saner, and for the patient safer to adopt such head-neck alignment prior to the very first attempt, than relegate it to a place to be considered after a failed initial tracheal intubation attempt, in both elective and emergent patient care settings.

A characterizing principal feature of rapid first-pass tracheal tube placement is its associated short TTOTI. Given the imperativeness of the avoidance of peri-intubation hypoxaemia, all direct rigid laryngoscopies for tracheal intubation must be time-sensitive. According to the 2020 American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency cardiovascular Care,[32] continuous waveform capnography is the gold standard for confirming correct tracheal tube placement. Using peri-intubation capnography for confirmation, there was an observation of statistical similarity in the mean TTOTI in seconds (26.97±2.58 versus 26.41±2.68, P=0.383), in the groups of this study; this finding agrees with the mean duration of 27 seconds reported in scientific literature, as the time taken to achieve successful intubation in neonates.[33]

Again, in the 6th edition of the Neonatal Resuscitation Program (NRP), limiting tracheal intubation attempts in infants, especially neonates, to 30 seconds is recommended for the avoidance of significant oxygen desaturation and bradycardia.[34] As part of their peculiar anatomical profiles, young children have decreased functional residual capacity (FRC), and this is further negatively impacted by supine position, because a cephalad displacement of intra-abdominal viscera occurs with consequent diaphragmatic splinting that aggravates an already decreased FRC.[35, 36] In addition, there is vagotonia, arising from an innate autonomic dysequilibrium characterized by a higher parasympathetic nervous system activity, relative to the sympathetic, according the empirical finding by Harteveld et al.[37] As a consequence of these anatomical peculiarties, they demonstrate a tendency to rapid desaturation in the event of apnoea, as well as development of bradycardia in response to hypoxia. In this regard, setting the goal of a first-pass tracheal intubation with rapidity, limiting the TTOTI to 30 seconds is judicious, and is achievable through optimal head-neck alignment resulting in improved glottic visualisation, as evidenced, in this study, by post-intubation mean percentage SpO_2 values of 95.08±1.08 versus 94.85±0.957 in group A versus group B, as well as by 100% absence of occurrence of peri-intubation hypoxaemia.

None of the 68 subjects had an oral/pharyngeal/laryngeal trauma in association with laryngoscopy in this study, a finding conveying a direct positive association of ease of correct tracheal tube placement with improved glottic view. Multiple laryngoscopic attempts warranted by difficult tracheal intubation are known to entail significant sequelae; the procedural difficulty resulting in an anatomical damage triggers a pathophysiological response cascading to grave morbidity, or even mortality: trauma to airway structures evokes reactionary oedema leading to poor airflow mechanics/airway obstruction and consequent hypoxia, while an accompanying autonomic upheaval predisposes to the occurrence of arrhythmia and haemodynamic derangements. Going by the Hagen-Poiseuille's equation,[38] flow (Q) through a tubular structure is directly proportional to the fourth power of the radius (r); mathematically, any change in the radius impacts the flow in a dimension equal to the fourth power of the change, in the direction of the change. In clinical setting, therefore, a decrease in the radius of the airway by as little as 2mm, caused by reactionary oedema from multiple tracheal intubation attempts, will result in a 16-fold decrease in air-flow mechanics. For younger children, this entails a significant implication due to their narrow airways. Besides the decreased oxygenation and impaired ventilation of carbondioxide, the increased work of breathing needed to overcome an increased resistance to airflow leads to respiratory muscle fatigue, with consequent respiratory failure.[39] This failure occurs because children in the younger age category, due to an innate immaturity of the neuromuscular junction in their skeletal muscles, lack the requisite resilience in functionality for effectively handling such burden of respiratory pathophysiology.

In an earlier scientific report, Sakles et al[1] had highlighted the existence of a direct relationship between the number of attempts at direct rigid laryngoscopy and the incidence of adverse effects, documenting an association of increased incidence with multiple attempts, in contrast with first-pass tracheal intubation which was associated with the least incidence of complications. Similarly, Singh et al[40] following a retrospective review of data on 7,708 neonatal tracheal intubations in the delivery room and neonatal intensive care unit (NICU), obtained from the National Emergency Airway Registry for Neonates (NEAR4NEOS) in 17 academic centres, documented an independent association of increasing tracheal intubation attempts with increased risk of adverse intubation-related events. As a note, therefore, ensuring an optimal head-neck alignment in children, enabling an improved glottic view that enhances a smooth, rapid and successful tracheal intubation should be established as an ethical necessity, especially in low- and middle-income countries where high-tech intubating gadgets are less likely to be available, for the achievement of safe paediatric anaesthesia outcomes.

V CONCLUSION

Pre-intubation head-neck positioning done by ensuring horizontal aligning of the SA-AM axis, statistically equated with aligning the SN-AM axis horizontally, evidenced by the achievement of comparable degree of improved glottic visualisation, first-pass tracheal intubation in all subjects, remarkably short TTOTI, very minimal requirement of external laryngeal manoeuvre with BURP, and zero occurrence of peri-intubation hypoxaemia/trauma, during paediatric direct rigid laryngoscopy.

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AUTHORS' ROLES:

[1*]Initial study conception, study design, final intellectual content development, manuscript preparation, and corresponding author.
[2]Data acquisition, initial intellectual content development, integrity appraisal, final version approval and critical reviewing author.

REFERENCES

1. Sakles JC, Chiu S, Mosier J, Walker C, Stolz U. The importance of first-pass success when performing orotracheal intubation in the emergency department. Acad Emerg Med, 2013;20(1):71-78. doi: 10.1111/acem.12055.
2. Patel R, Lenczyk M, Hannallah HS, McGill WA. Age and the onset of desaturation in apnoeic children. Can J Anaesth. 1994;41(9):771-774 doi:10.1007/BF03011582.
3. Carroll CL, Spinella PC, Corsi JM, Stoltz P, Zucker AR. Emergent endotracheal intubations in children: be careful if it's late when you intubate. Peidatr Crit Care Med. 2010;11(3):343-348 doi:10.1097/PCC.0b013e3181c51426
4. Doerges V, Sauer C, Ocker H, Wenzel V, Schmucker P. Smaller tidal volumes during cardiopulmonary resuscitation: comparison of adult and paediatric self-inflatable bags with three different ventilatory devices. Resuscitation. 1999;43(1):31-37. doi: 10.1016/s0300-9572(99)00117-3.
5. Berg MD, Idris AH, Berg RA. Severe ventilatory compromise due to gastric distention during pediatric cardiopulmonary resuscitation. Resuscitation. 1998 Jan;36(1):71-73. doi: 10.1016/s0300-9572(97)00077-4.
6. Greenland KB, Edwards MJ, Hutton NJ. External auditory meatus-sternal notch relationship in adults in the sniffing position: a magnetic resonance imaging study. Br J Anaesth 2010;104:268-269. https://doi.org/10.1093/bja/aep390
7. Lee YK, Shin ES, Shim JY et al. Developing a scoring guide for the Appraisal of Guidelines for Research and Evaluation II instrument in Korea: a modified Delphi consensus process. J Korean Med Sci 2013; 28: 190-194.
8. Black AE, Flynn PE, Smith HL, Thomas ML, Wilkinson KA, Association of Pediatric Anaesthetists of Great B, et al. Development of a guideline for the management of the unanticipated difficult airway in pediatric practice. Paediatr Anaesth 2015;25:346-362
9. Kim E-H, Ji S-H, Song I-K, Lee J-H, Kim J-T, Kim H-S. Am J Emerg Med. 2017;35(6): c928-929 https://doi.org/10.1016/j.ajem.2017.01.048
10. Katz DL, Jekel JF, Elmore JG, Wild DMG, Lucan SC. Sample size calculation for epidemiological studies. In: Jekel JF Editor. Jekel's Epidemiology, Biostatistics, Preventive Medicine and Public Health. 4th edition. Philadelphia. Saunders, Elsevier Inc. 2014; p. 155-undefined
11. Chun EH, Chung MH, Kim JE, Kim JM, Lee HS, Son JM, et al. Effects of head-elevated position on tracheal intubation using a McGrath MAC videolaryngoscope in patients with a simulated difficult airway: a prospective randomized cross-over study. BMC Anesthesiology 2022;22:166-176. https://doi.org/ 10.1186/s12871-022-01706-5
12. Rensis L. *A* Technique for the Measurement of Attitudes. Archives of Psychology1932; 140: 1–55
13. Cormack RS, Lehane J. Difficult tracheal intubation in obstetrics. Anaesthesia. 1984; 39(11):1105-1111 doi: 10.1111/j.1365-2044.1984.tb08932.x.
14. Hasan MR, Sharmin T, Rickta D, Sharmin R, Gosh P. Complications of Anesthesia in Children: An Observational Study.EAS J Anesthesiol Crit Care.2025;7(4):60-66. doi: 10.36349/easjacc.2025.v07i04.001
15. Henderson JJ, propat MT, Latto IP, Pearce AC. Difficult Airway Society Guidelines for management of the unanticipated difficult intubation. Anaesthesia. 2004;59(7):675-694
16. Traylor BA, McCutchan A. Unanticipated Difficult Intubation in an Adult Patient. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.
17. Fiadjoe JE, Nishisaki A, Jagannathan N, Hunyadi AI, Greeberg RS, Reynolds PI. Airway management complications in children with Difficult tracheal intubation from the Pediatric Difficult Intubation (PeDI) registry: a prospective cohort analysis. Lancet Respir Med. 2016;4(1):37-48. doi: 10.1016/S2213-2600(15)00508-1
18. Collins SR. Direct and Indirect Laryngoscopy: Equipment and Techniques. Respiratory Care. 2014;59(6):850-864. doi: 10.4187/respcare.03033
19. Li H, Jia X, Ye H, Liang J-W, Zhao W-L, Cui P, et al. Impact of lateral positioning on upper airway morphology in sedated children under five. World J Pediatr. 2025;21:587-596. doi: 10.1007/s12519-025-00910-w

20. Thibodeau LG, verdile VP, Bartfield JM, Incidence of aspiration after urgent intubation. Am J Emerg Med.1997;15(6):562-565 doi: 10.1016/s0735-6757(97)90157-1.
21. Cook TM, MacDoughall-Davies SR. Complications and failure of airway management. Br J Anaesth. 2012;109(1):i68-i85. doi: 10.1093/bja/aes393.
22. Cook TM, Woodall N, Frerk C; Fourth National Audit Project. Major complications of airway management in the UK: results of the Fourth National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: anaesthesia. Br J Anaesth. 2011;106(5):617-631. doi: 10.1093/bja/aer058.
23. Dunham CM, Barraco RD, Clark DE, Daley BJ, Davis FE. Gibbs MA, et al. EAST Practice Management Guidelines Work Group. Guidelines for emergency tracheal ntubation immediately after traumatic injury. J Trauma. 2003;55(1):162-169. doi: 10.1097/01.ta.0000083335.93868.2c.
24. Akbar A, Ali Z, Hanif S, Ullah I, Akhtar A, Ullar TR, et al. Risk Factors Associated with Aspiration During Rapid sequence Induction. JHWCR [Internet]. 2026;4(3):e1202 doi: 10.61919/h82sh690
25. Yemam D, Melese E, Ashebir Z. Comparison of modified Malampati classification with Cormack and Lehane grading in predicting difficult laryngoscopy among elective surgical patients who took general anesthesia in Werabie comprehensive specialized hospital – cross sectional study. Ethiopia, 2021. Ann Med Surg. 2022;24(79):103912. doi: 10.1016/j.amsu.2022.103912
26. Yu T, Wu R, Longhini F, Wang B, Wang M, Yang F, et al. The “BURP” maneuver improves the glottic view during laryngoscopy but remains a difficult procedure. J Int Med Res. 2020;48(5). doi: 10.1177/0300060520925325
27. Aggo AT, Hart F. Impact of two different head and neck alignment planes on glottic visualization at laryngoscopy in adults. Int J Adv Med. 2025;12:278-284. doi: 10.18203/2349-3933.ijam20251076
28. Apfelbaum JL, Hagberg CA, Connis RT, Abdelmalak BB, Agarkar M, Dutton RP, et al. American Society of Anesthesiologists Practice Guidelines for Management of the Difficult Airway. Anesthesiology. 2022;136(1):31-81. doi: 10.1097/ALN.0000000000004002
29. Goto T, Gibo K, Hagiwara Y, Okubo M, Brown DFM, Brown CA, et al. Factors associated with first-pass success in pediatric intubation in the Emergency Department. West J Emerg Med. 2016;17(2):129-134. doi: 10.5811/westjem.2016.1.28685
30. Chen DY, Devsam B, Sett A, Perkins EJ, Johnson MD, Tingay DG. Factors that determine first intubation attempt success in high-risk neonates. Pediatr Res. 2023;95(3):729-735. doi: 10.1038/s41390-023-02831-8
31. Chanthawatthanarak S, Tangpaisarn T, Kotruchin P, Phungoen P, Lenghong K, Apiratwarakul K. First-pass Success Rates of Endotracheal Intubation Using Ramped versus Supine Positioning in the Emergency Department. Med Assoc Thai. 2020;103(6):51-57.
32. Panchal AR, Bartos JA, Cabanas JG, Donnino MW, Drennan IR, Hirsch KG, et al. Adult Basic and Advanced Life Support Writing Group. Part 3: Adult Basic and Advanced Life Support: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. Circulation. 2020;142(16_Suppl_2):S366-S468. doi: 10.1161/CIR.0000000000000916
33. Jobe AH. Intubating infants: How long does it take? J Pediatr. 2004;145(1):PA3. doi: 10.1016/j.peds.2004.06.011
34. Perlman JM, Wyllie J, Kattwinkel J, Atkins DL, Chameides L, Goldsmith JP, et al. Part II: Neonatal resuscitation: 2010 International Consensus on Cardiopulmonary resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation. 2010;122(2):S516-538. doi: 10.1161/CIRCULATIONAHA.110.971127
35. Marciniak B. growth and development. In: Cote CJ, Lerman J, Todres ID, editors. A Practice of Anaesthesia for Infants and Children. 4th ed. Philadelphia, PA: Saunders Elsevier;2009. p7-21
36. Bhammar DM, Wilhite DP, Olojo T, Alagappan K, Jones K, Liu Y-L, et al. Effects of Obesity and Sex on Supine Functional Residual Capacity and ExpiratoryFlow Limitation in Children. Pediatr Pulmonol. 2025;60(4):e71061. doi: 10.1002/ppul.71061
37. Harteveld LM, Nederend I, Ten Harkel ADJ, Schutte NM, de Rooij SR, Vrijkotte TGM. et al. Maturation of the Cardiac Autonomic Nervous System Activity in Children and Adol escents. J Am Heart Assoc. 2021;10(4):e017405. doi: 10.1161/JAHA.120.017405.

38. Hagen-Poiseuille equation. In: Gooch J.W. (eds) Encyclopedic Dictionary of polymers. 2007; Springer, New York, NY. Available from: https://doi.org/10.1007/978-0-387-30160-0_5664 Accessed March 11, 2026
39. Bhammar DM, Jones HN, lang JE.Inspiratory Muscle Rehabilitation Training in pediatrics: What Is the Evidence? Can Respir J. 2022;2022:5680311. doi: 10.1155/2022/5680311
40. Singh N, Sawyer T, Johnson LC, Herrick HM, Moussa A, Zenge J, et al. National Emergency Airway Registry for Neonates (NEAR4NEOS). Impact of multiple intubation attempts on adverse tracheal intubation associated events in neonates: a report from the NEAR4NEOS. J Perinatol. 2022;42(9):1221-1227. doi: 10.1038/s41372-022-01484-5.