Section: Anaesthesiology

Original Research Article

EVALUATION OF AIRWAY PARAMETERS FOR ANTICIPATING DIFFICULT AIRWAY IN CHILDREN– A CROSS-SECTIONAL STUDY

Bashith Puthukkudi[1], Aysha Nubla[2], Radha K R[3], Radhika K P[4]

[1]Assistant Professor, Department of Anaesthesiology, Dr Moopen's Medical College, Wayanad, Kerala, India
[2]Assistant Professor, Department of Anaesthesiology, KMCT Medical College, Kozhikode, Kerala, India
[3]Professor& Head, Department of Anaesthesiology, Govt. Medical College, Kozhikode, Kerala, India
[4]Professor, Department of Anaesthesiology, Govt. Medical College, Kozhikode, Kerala, India

Received : *26/11/2024*
Received in revised form : *13/01/2025*
Accepted : *29/01/2025*

Keywords:
Difficult airway, Pediatric airway, Sternomental distance, Ratio of height to thyromental distance.

Corresponding Author:
Dr. Bashith Puthukkudi,
Email: bshthputhukkudi460@gmail.com

DOI: 10.47009/jamp.2025.7.1.55

Source of Support: Nil,
Conflict of Interest: None declared

Int J Acad Med Pharm
2025; 7 (1); 282-286

Abstract

Background: Airway related problems are still the most common cause of anesthesia related morbidity and mortality in children. Failure to establish a definite airway in minimal time can increase the chances of complications in pediatric population. There has been lack of adequate study in formulating a score or index for predicting difficult airway in children. The objective is to evaluate multiple airway parameters in children and to assess whether they help in anticipating difficult bag and mask ventilation, difficult Laryngoscopy and difficult Intubation. **Materials and Methods:** An observational study was designed to evaluate whether the airway parameters has any significance in anticipating difficult Bag and Mask ventilation, larngoscopy or Intubation in children. 230 children aged 3 to 6 years, belonging to ASA class 1 and 2 were the study subjects. A written informed consent obtained from parents/guardians of each children. Desired airway parameters were measured. Children were connected to standard monitoring devices and an intravenous cannula secured. After preoxygenation with 100% oxygen, intravenous induction was done with fentanyl (2 µg/kg body weight), propofol (2mg/kg), and muscle relaxation by Succinylcholine (1.5 mg/kg). An experienced anaesthesiologist then performs laryngoscopy with appropriately sized Macintosh blade and Cormack–Lehane grade assessed. Ease of intubation was assessed using Intubation difficulty scale (IDS). Statistical software SPSS version 24.0 was used for the analysis of the data. Chi-square test was used to measure association between qualitative variables, t- test and ANOVA to measure association between quantitative variables. Confidence interval of 95% was used in all statistical tests and a p value < 0.05 was considered statistically significant. **Result:** Body weight of children showed a statistically significant association with difficult bag and mask ventilation and intubation but not with difficult laryngoscopy. Neck circumference of children showed a statistically significant association with difficult Bag and mask ventilation but not with difficult laryngoscopy or intubation. Ratio of height to thyromental distance (RHTMD) as well as TMD alone showed a statistically significant association with difficult bag and mask ventilation, laryngoscopy and intubation. Inter incisor gap (IIG) and Sternomental distance (SMD) showed a statistically significant association with difficult bag and mask ventilation and intubation, but not with difficult laryngoscopy. Lower lip to chin distance did not show a significant association with difficult bag and mask ventilation, laryngoscopy and intubation. RHTMD was the best airway parameter for predicting difficult airway in children. **Conclusion:** The airway parameters assessed namely inter incisor gap, lower lip to chin distance, neck circumference, thyromental distance, sternomental distance and ratio of height to thyromental distance, had a statistically significant role in anticipating difficult airway in children. Ratio of height to thyromental distance was the best airway parameter for anticipating difficult airway in children.

ISSN (O): 2687-5365; ISSN (P): 2753-6556

INTRODUCTION

Difficult airway in pediatric patients is a really challenging and stressful situation for an anaesthesiologist. Studies showed inadequate ventilation as a common cause for anaesthesia related deaths in pediatric patients.[1] Rose and cohen (1994) made an airway assessment that helps in identifying more than 98% of difficult airway.[2] But still unlike adults, no fixed classification exist which would help in determination of pediatric patients at risk of difficult bag and mask ventilation or intubation.

Difficult airway can be anticipated or unanticipated. Anticipated factors include congenital syndromes or acquired factors like Tempero-mandibular joint dysfunction or neck contractures. A common feature of many of these syndromes is micrognathia leading to difficult laryngoscopic visualisation of glottic structures.[3,4] Mallampatti classification does not accurately predict a poor view of glottis during direct laryngoscopy in paediatric population.[5]

Some prefer COPUR scale for evaluation of paediatric airway. This scale rates-chin size, inter dental opening, previous intubation/Obstructive sleep apnoea, uvula visualisation, estimated range of motion of neck on a 4 point scale.[6]

Study is conducted for evaluating airway parameters and to find out whether they have any statistical significance in predicting difficult airway in pediatric population.

The objectives of the study were to evaluate the following airway parameters in pediatric population and to find out whether they help in anticipating 1. Difficult Bag and Mask ventilation, 2. Difficult Laryngoscopy, and 3. Difficult Intubation.

MATERIALS AND METHODS

This Observational cross-sectional study was conducted in Pediatric surgery operation theatre, ENT operation theatre Government Medical college, Kozhikode from March 2020 to December 2021. A total of 230 children undergoing elective surgery under general anaesthesia belonging to ASA (American society of Anaesthesiologists) class 1 or 2 were selected for the study. Pediatric patients between age 3 and 6 years and ASA (American society of Anaesthesiologist) class 1 or 2 undergoing elective surgery under General anaesthesia were included in the study, while Children with congenital upper airway malformations, Swellings in head and neck regions, Scars in head and neck regions, any dressings in head and neck region and refusal from the side of parents were excluded. After obtaining approval from Institutional research committee and Institutional ethics committee of government medical college Kozhikode, a written informed consent was obtained from parents /guardians of each children included in the study. A detailed pre- anaesthetic checkup done. This includes history of snoring, mouth breathing, recurrent respiratory tract infections, reactive airway disease, hoarse voice and any prior surgery to head and neck region. General and systemic examination of the children also performed. The following parameters are measured

- Inter incisor gap(cm)
- Lower lip to chin distance(cm)
- Neck circumference(cm)
- Thyromental distance(cm)
- Sternomental distance(cm)
- Ratio of height to thyromental distance(cm)
- These children were assessed on table for
- Difficult Bag and Mask ventilation
- Difficult Laryngoscopy
- Difficult Intubation

Ease of Bag and Mask ventilation was assessed using difficult Bag and Mask ventilation score [1,2

- **Grade1-** ventilated by mask
- **Grade2-** ventilated by mask with oral airway or adjuvants (with or without muscle relaxant)
- **Grade 3-** difficult ventilation (inadequate, unstable or requiring 2 providers)- (with or without muscle relaxant)
- **Grade4-** Unable to mask ventilate with or without muscle relaxant

Succinyl choline 1.5mg/kg was given to all patients with difficult Bag and Mask ventilation grade1, 2 or 3 and Bag and Mask ventilation, assessed for 2 minutes using controlled ventilation.

In case Bag and Mask ventilation was not possible after muscle relaxation or spo2 falls below 92%, airway were secured with intubation using an un cuffed oral endo tracheal tube of appropriate size

Laryngoscopy was carried out using appropriate size Mc intosh blade and assessed by Cormack and Lehane (C andL) grading[1]

- **Grade 1 -** Full exposure of glottis (anterior + posterior commissure visualised)
- **Grade 2 -** Anterior commissure not visualised
- **Grade 3 -** Only epiglottis visualised
- **Grade 4 -** No glottis structures visualised

Total IDS (intubation difficulty score) = sum of scores N1 to N7 [Table 1]

- IDS score =0 easy intubation
- IDS score >0 to ≤5 slightly difficult
- IDS score >5 moderate to major difficulty

In case of impossible intubation, intubation difficulty scale (IDS) takes the value attained before abandonment of intubation attempts.

Children were attached to standard monitoring devices- electrocardiogram, pulse Oximetry (SpO2), and non invasive blood pressure, and an intravenous cannula of appropriate bore size secured. All the patients were pre oxygenated with 100% oxygen for 3 minutes with a close-fitting mask in sniffing position. Difficulty of bag and mask ventilation was assessed by difficult bag and mask ventilation score by an experienced anaesthesiologist (minimum 2 years post specialisation experience). Intravenous induction was done with fentanyl (2 µg/kg body weight), propofol (2 mg/kg body weight), and muscle relaxation by Succinyl choline (1.5 mg/kg

ISSN (O): 2687-5365; ISSN (P): 2753-6556

bodyweight). Patients ventilated for 60 seconds for adequate muscle relaxation. Then, an experienced anaesthesiologist performs laryngoscopy with appropriately sized Macintosh blade and the Cormack– Lehane grade was assessed. Ease of intubation was assessed using Intubation difficulty scale (IDS).

The Statistical software -SPSS version 24.0 was used for the analysis of the data and Microsoft word and Excel have been used to generate graphs and tables. Descriptive and inferential statistical analysis has been carried out in the present study. Results on continuous measurements were presented on Mean & SD (Min-Max) and results on categorical measurements were presented in Number (%). Significance is assessed at 5 % level of significance.Chi-square test (2 tailed) was used to measure association between qualitative variables. Independent sample t- test and ANOVA were used to measure association between quantitative (scale) variables. A confidence interval of 95% was used in all statistical tests and p value < 0.05 was considered as statistically significant.

RESULTS

A total of 230 children belonging to ASA class 1 and 2, aged 3 to 6 years, were included in the study and all completed the study. Of the 230 subjects, 120 (52.17%) were males and 110(47.82%) were females. [Table 2] shows the linear regression analysis results of patient anatomical parameter and BMV score, C&L grading and IDS.

Table 1: IDS scale.

Parameter	Score
Number of attempts >1	N1
Number of operators >1	N2
Number of alternative techniques	N3
Cormack-Lehane grade 1	N4
Lifting force required • Normal • Increased	N5 N5=0 N5=1
Laryngeal pressure • Not applied • Applied	N6 N6=0 N6=1
Vocal cord mobility • Abduction • Adduction	N7 N7=0 N7=1

Table 2: Correlation of BMV score, C& L grade and IDS with anatomical parameters

Parameter	BMV score		C & L grade		IDS	
	Mean ± SD	P-value	Mean ± SD	P-value	Mean ± SD	P-value
Age	1.091 ± 0.317	0.028	1.082 ± 0.275	0.241	0.234 ± 0.581	0.132
Weight	1.091 ± 0.318	0.024	1.081 ± 0.018	0.145	0.235 ± 0.038	0.01
Height	1.091 ± 0.317	<0.001	1.082 ± 0.275	<0.001	0.235 ± 0.581	<0.001
Neck circumference	1.091 ± 0.317	0.031	1.082 ± 0.275	0.221	0.234 ± 0.581	0.599
RHTMD	1.091 ± 0.317	<0.001	1.082 ± 0.275	<0.001	0.234 ± 0.581	<0.001
Inter Incisor Gap (IIG)	1.091 ± 0.318	<0.001	1.083 ± 0.276	0.178	0.235 ± 0.582	<0.001
Lip to Chin distance	1.086 ± 0.32	0.698	1.075 ± 0.264	0.511	0.213 ± 0.576	0.353
Thyromental distance (TMD)	1.091 ± 0.317	<0.001	1.082 ± 0.275	0.02	0.234 ± 0.581	<0.001
Sternomental distance (SMD)	1.091 ± 0.317	<0.001	1.082 ± 0.275	0.64	0.234 ± 0.581	0.017

Age, weight, height, neck circumference, RHTMD, IIG, YMD and SMD showed a statistically significant association in predicting BMV score with p value of <0.05, and hence has an association with difficult bag and mask ventilation in children.

Height, RHTMD and TMD showed a statistically significant association in predicting C&L grading with p value of <0.05, and hence has an association with difficult laryngoscopy.

Weight, Height, RHTMD, IIG, TMD and SMD showed a significant association with IDS (p values of <0.05) and thus had an association with difficult intubation.

[Figure 1] shows the correlation of RHTMD, IIG, TMD and SMD with BMV score, C7L grading and IDS.

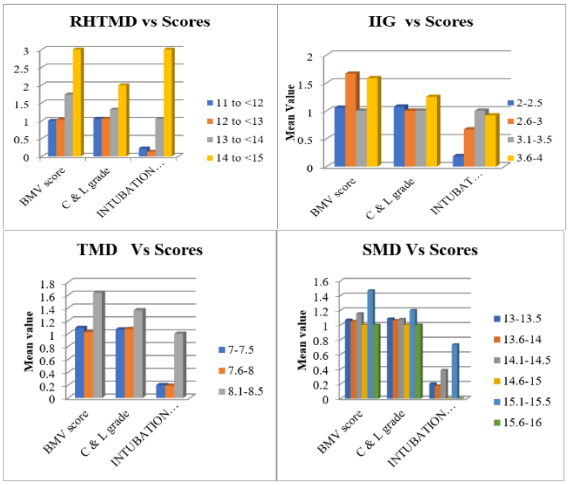

Figure 1: Comparison of RHTMD, IIG, TMD and SMD with scores

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Lower lip to chin distance in children did not show a significant association with BMV score, C and L grading and IDS (p values of 0.698, 0.511 and 0.353 respectively) and thus lower lip to chin distance values was not associated with difficult bag and mask ventilation, difficult laryngoscopy and difficult intubation in children.

DISCUSSION

Difficult airway is defined as "The clinical situation in which a conventionally trained anaesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation or both. Difficult airway can be anticipated or unanticipated.

Airway related problems are still the most common cause of anesthesia related morbidity and mortality in children. Unlike adults, there is no definitive grading system to predict difficult airway in children, which further increases the chance of un-anticipated difficult airway.

Rose and Cohen (1994) conducted a study with the aim of describing methods, risk factors, and outcomes of airway management in all patients (obstetrics excluded) attended by anaesthesiologists over 27 months.[7] Pre operatively, anaesthetists recorded patient factors and assessed four airway characteristics. Methods of tracheal intubation and ease of direct laryngoscopy following general anaesthesia (easy/awkward/difficult) were noted. They could determine factors predictive of poor outcome and the value of the pre-operative airway examination in more than 98% of the cases.

A study conducted by Aggarwal et al,[8] observed statistically significant relationship between airway parameters measured and their role in prediction difficult bag and mask ventilation, laryngoscopy and intubation. They assessed the usefulness of inter incisor gap (IIG), oropharyngeal view with mouth wide open (without tongue protrusion), modified mallampatti class (MMP), relationship of maxillary and mandibular incisor during normal jaw closure, neck circumference (NC), thyromental distance (TMD), sternomental distance (SMD), ratio of height to thyromental distance as preoperative predictors of difficult mask ventilation, laryngoscopy and intubation. 100 patients between age 1 to 5 years were studied. They observed that best oropharyngeal view is a better tool for airway assessment in children than modified Mallampatti class.

Madan Mohan Maddali et al,[9] studied 199 children, below 5 years of age, undergoing elective cardiac catheterization. Pre – anaesthetic airway assessment was done by modified mallampati grading, lower lip to chin distance (LCD), tragus to mouth angle (TMA), thyromental distance (TMD), neck circumference (NC), and the ratio of height to thyromental distance (RHTMD). They observed that lower lip to chin distance, thyromental distance, neck circumference and ratio of height to thyromental distance have good negative predictive values and all can be used as screening tools during pre anesthetic airway evaluation for predicting difficult laryngoscopy views in children.

A single- blinded comparative observational study conducted by Suvarna kaniyil et al,[10] observed 300 adult patients of either gender scheduled to receive general anaesthesia. ratio of height to thyromental distance as a single best preoperative test for predicting difficult laryngoscopy, a combination of tests has higher sensitivity and specificity with better discriminative power. Therefore indices should be used in combination in pre operative airway assessement.

Swarup Ray et al,[11] evaluated ratio of height to thyromental distance (RHTMD) and ratio of height to sternomental distance (RHSMD) as predictors of laryngoscopic grade in children aged 1-12 years scheduled for elective surgery under general anaesthesia. Following induction of anaesthesia and full muscle relaxation, laryngoscopy was performed and Cormack-Lehane view with cook's modification was noted. Receiver operating characteristic (ROC) curve analysis using RHTMD and RHSMD was performed for predicting poor laryngoscopic view. Results a total of 138 children with mean age of 6.6 +/- 3.4, RHTMD of 17.7 +/- 2.1 and RHSMD of 10.0 +/-1.0 were included. No grade 3 or 4 laryngoscopic views obtained. Study concludes that RHTMD is a better predictor of restricted view compared to RHSMD.

In our study, 230 children aged 3 to 6 years, belonging to ASA class 1 and 2 were studied for evaluating the airway parameters and to find out their significance in predicting difficult bag and mask ventilation, laryngoscopy and intubation. 120 (52.17%) were males and 110(47.82%) were females. On analysis of the collected data using appropriate statistical tools, the following results were obtained.

Weight showed a statistically significant association with difficult bag and mask ventilation (p value of 0.024) and difficult intubation (p value of 0.010) but no statistically significant association with difficult laryngoscopy (p value of 0.145) in children.

Neck circumference of children showed a statistically significant association with difficult Bag and mask ventilation (p value of 0.031) but no statistically significant association with difficult laryngoscopy or intubation (p values of 0.221 and 0.599 respectively).

Ratio of height to thyromental distance (RHTMD) in children showed a statistically significant association with difficult bag and mask ventilation, laryngoscopy and intubation (p value of 0.000 in all 3 variables).

Inter incisor gap (IIG) in children showed a statistically significant association with difficult bag and mask ventilation (p value of 0.000) and difficult intubation (p value of 0.000) However it does not show a significant association (p value= 0.178) with difficult laryngoscopy.

Lower lip to chin distance in children did not show a significant association with difficult bag and mask ventilation, laryngoscopy and intubation in children (p values of 0.698, 0.511 and 0.353 respectively)

ISSN (O): 2687-5365; ISSN (P): 2753-6556

Thyromental distance (TMD) in children shows a significant association with difficult bag and mask ventilation, laryngoscopy and intubation (p values of 0.000, 0.002 and 0.000 respectively).

Sterno mental distance (SMD) in children showed a statistically significant association with difficult bag and mask ventilation and intubation (p values of 0.000 and 0.017 respectively) but no significant association with difficult laryngoscopy (p value of 0.640)

The results obtained from our study were similar to those obtained in study by Aggarwal et al,[8] and Madan Mohan Maddali et al.[9] From our study we could also conclude that the ratio of height to thyromental distance is the single best airway parameter for predicting difficult airway in children, which is similar to the result obtained in the study done by Suvarna kaniyil et al.[10]

Limitations of the Study

The small sample size precludes us from reaching a definite conclusion. Further studies with large sample size are necessary to establish a statistically significant association. Only ASA class 1 and 2 patients are included in the study.

CONCLUSION

It is concluded from the study that all the airway parameters assessed namely inter incisor gap, lower lip to chin distance, neck circumference, thyromental distance, sternomental distance and ratio of height to thyromental distance, had a statistically significant role in anticipating difficult airway in children. We could also conclude that the ratio of height to thyromental distance was the best airway parameter for anticipating difficult airway in children.

REFERENCES

1. Morray JP, Geiduschek JM, Caplan RA, Posner KL, Gild WM, et al. (1993) A comparison of pediatric and adult anesthesia closed malpractice claims. Anesthesiology78: 461-467.
2. Rasid MK(2007)Airway management made easy. (2ndedn), Hyderabad, India: Paras. (6):32-34.
3. Todes ID(2001) The pediatric airway. In: Cote CJ, Todes ID, Godsouzian NG, Ryan JF, Editors; A practice of anesthesia for infants and children. (3rd edn) Philadelphia, USA; WBsaunders:39:398-402.
4. Wheeler M (2000) The difficult pediatric airway. In: Hagberg CA, editors: Handbook of difficult airway management. (1stedn) Philadelphia, USA: Churchill Livingstone 11:180-183.
5. Rabb MF, Szmuk P (2007) The difficult pediatric airway. In: Hagberg carin A, editor: Benumof's airway management: principles and practice. (2ndedn) Philadelphia, USA:Mosby 34:342-350.
6. Lane G (2005) Intubation Techniques. Operative Techniques in Otolaryngology 16:166-170.
7. Sumer SS, Cham SC, Raipure AM, Dhumane PG. Evaluation of difficult airway in pediatric population ranging from 5-12 years age group. Int J Med Rev. 2019;7(5):411-421.
8. Aggarwal A, Sharma KR, Verma UC (2012).Evaluation of "Difficult Airway Predictorsin Pediatric Population" As a clinical Investigation. J Anesth Clin Res 3: 256.doi:10.4172/2155-6148.1000256
9. AnnCard Anaesth..doi:10.4103/aca.ACA_47_18.Preoperative predictors of poor laryngoscope views in pediatric population undergoing cardiac catheterization. 2018Oct-Dec; 21(4): 376-381.
10. Kaniyil S, Anandan K, Thomas S. Ratio of height to thyromental distance as a predictor of difficult laryngoscopy: A prospective observational study. J Anaesthesiol ClinPharmacol2018;34:485-9
11. Swarup R, Jasvinder K, Shwethapriya R. Ratio of height to thyromental distance and ratio of height to sternomental distance as predictors of laryngoscopic grade in children. Journal of Anaesthesiology Clinical Pharmacology. 34(1):68-72

ISSN (O): 2687-5365; ISSN (P): 2753-6556