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## Current practices of cuffed endotracheal tubes in pediatric anesthesia: Indian perspective

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### Abstract

**Purpose:** To understand the current practices regarding the use of cuffed endotracheal tubes in paediatric anaesthesia amongst Indian anaesthesiologists.

**Methods:** We formulated a questionnaire intended to assess the use of cuffed endotracheal tubes in pediatric age-group by pediatric and general anaesthetists in India. The questionnaire was also designed to evaluate practices related to the use of cuffed endotracheal tube in pediatric age group, such as the medium used for inflation of the cuff and whether or not cuff pressure monitoring was done during surgery. The self-structured questionnaire had 23 questions, and they were widely shared amongst anaesthetists practicing in India.

**Results and Conclusion:** We found that more number of cuffed ETT has been seen to be used by the practitioners who are in the age group of 25 to 40 years. More number of cuffed ETT has been used by female practitioners for paediatric anaesthesia. Strong association has been observed between years of practice of preference of practitioners for the type of ETT, with practitioners with less than 10 years post PG experience preferring cuffed ETT while those with post PG experience of > 20 years preferring uncuffed ETT. We also concluded that majority practitioners prefer uncuffed ETT in neonates and in children between 1 month to 2 years of age, while most of them prefer cuffed ETT in children above 2 years of age. We also concluded that even though use of cuffed endotracheal tubes in pediatric patients is on a rise, the percentage of anaesthesiologists who monitor intraoperative cuff pressure is very low, thus compromising the safety.

**Keywords:** Pediatric, cuffed endotracheal tube, cuff pressure

### Introduction

Since more than 50 years, the traditional teaching and practice has been to use uncuffed endotracheal tubes for the tracheal intubation in neonates, infants and children below 8 years of age. These guidelines were based on a study conducted in 1953, on cadaveric larynx. The reason for not using cuffed endotracheal tube in pediatric age group was the belief that the pediatric larynx is funnel shaped, with the narrowest part being the sub-glottic area. A cuff was believed to exert pressure on the mucosal capillaries leading to necrosis, subglottic edema, trauma and post-operative airway problems. However, with recent technology such as MRI studies and bronchoscopic studies in live patients, our understanding of the basic anatomy of pediatric airway has undergone modifications. The pediatric larynx is no longer believed to be funnel shaped, rather it is now stated to be cylindrical, just like in adults. Because of these changes in our understanding of the anatomy, in recent times, cuffed endotracheal tubes are being increasingly used for pediatric intubations for surgeries. The literature also supports use of cuffed endotracheal tubes due to certain definite advantages such as reduced theater contamination with anesthetic gas, decreased ETT exchanges, increased capnographic accuracy, and decreased risk of microaspiration and respiratory adverse events<sup>[1, 2]</sup> without increasing the risk of any airway morbidity. Since 2004, a high-volume, low-pressure CET specifically designed for children has been made available (MicroCuff®, Kimberly-Clark, unomedical SDN, Kedah, Malaysia), which has been found to effectively seal the trachea at very low pressures (<15 cmH<sub>2</sub>O) and since then, there have been substantial data which support their use<sup>[3, 4]</sup>.

Yet, whether cuffed endotracheal tube or uncuffed endotracheal tube is better for pediatric intubation is still a matter of debate<sup>[1]</sup>.

We conducted this study to find out the prevalent practices amongst anaesthesiologists in general, and pediatric anaesthesiologists in particular, in India, regarding the use of cuffed or

uncuffed endotracheal tubes for pediatric anesthesia. Secondly, when a cuffed endotracheal tube is used in a pediatric patient, it is very important to monitor the cuff pressure so as to reduce the risk of post-operative airway complications arising from excessive pressure of the cuff on the tracheal mucosal capillaries and their necrosis and resulting edema. In this study, we tried to assess how many anaesthesiologists who use cuffed endotracheal tubes in pediatric age group actually monitor the cuff pressures.

**Materials and Methods**

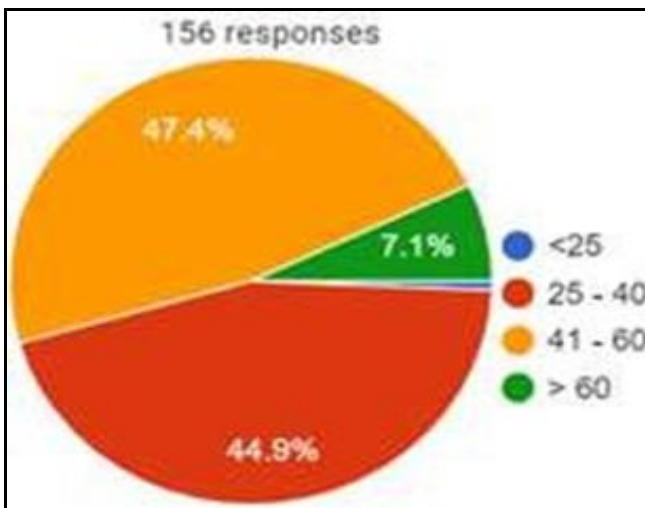
After a thorough search on e-libraries such as PubMed, and after conducting a thorough review of literature using similar published research articles, review articles and practical guidelines, we formulated a questionnaire intended to assess the use of cuffed endotracheal tubes in pediatric age-group by pediatric and general anaesthetics in India. The questionnaire was also designed to evaluate practices related to the use of

cuffed endotracheal tube in pediatric age group, such as the medium used for inflation of the cuff and whether or not cuff pressure monitoring was done during surgery.

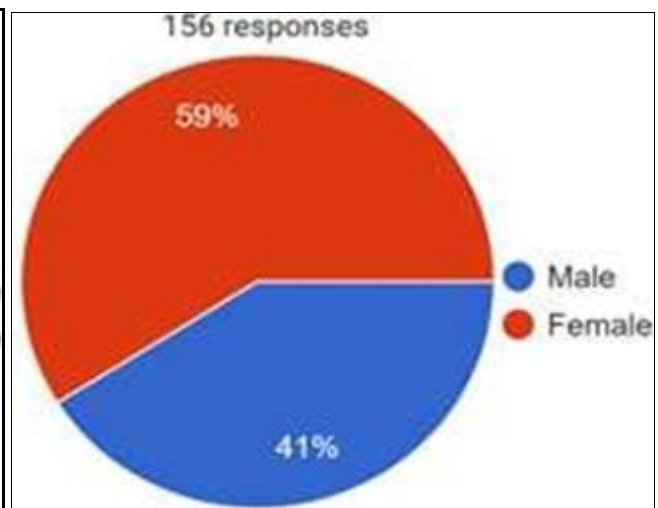
The self-structured questionnaire had 23 questions, and they were widely shared amongst anaesthetists practicing in India through social media, such as Facebook groups, Whatsapp groups and direct messages, over a period of three months. A brief message regarding the nature of the survey and why we were conducting this particular survey accompanied the questionnaire. Voluntary participation by anaesthetists by clicking the link and answering the questionnaire was considered as implied consent.

On clicking the link, the anaesthetists were directed to a Google form that contained the questionnaire. After a few demographic questions, the survey was in the form of some multiple choice questions and some short answer questions. The results thus obtained were directly tabulated in an excel sheet and given for statistical analysis.

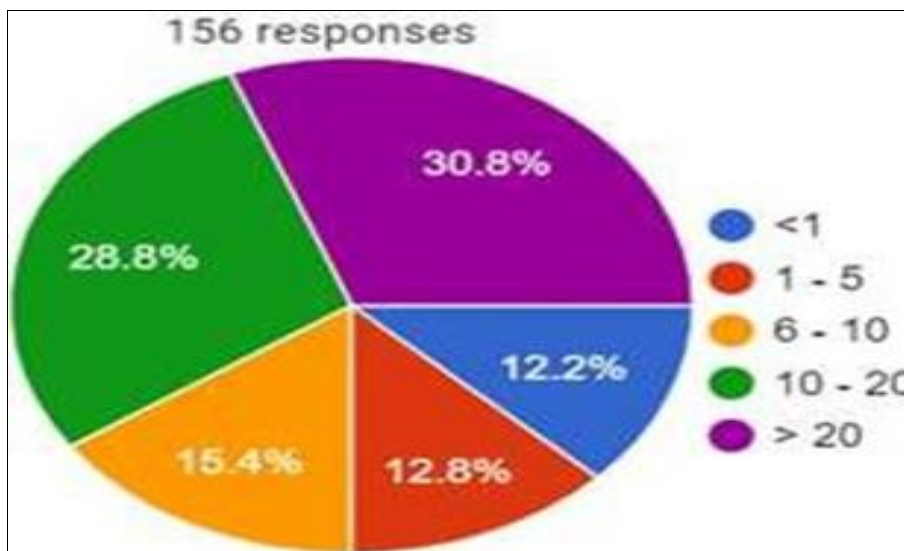
**Observations and results**



**Fig 1:** Age (In years)



**Fig 2:** Sex



**Fig 3:** Years of practice post PG

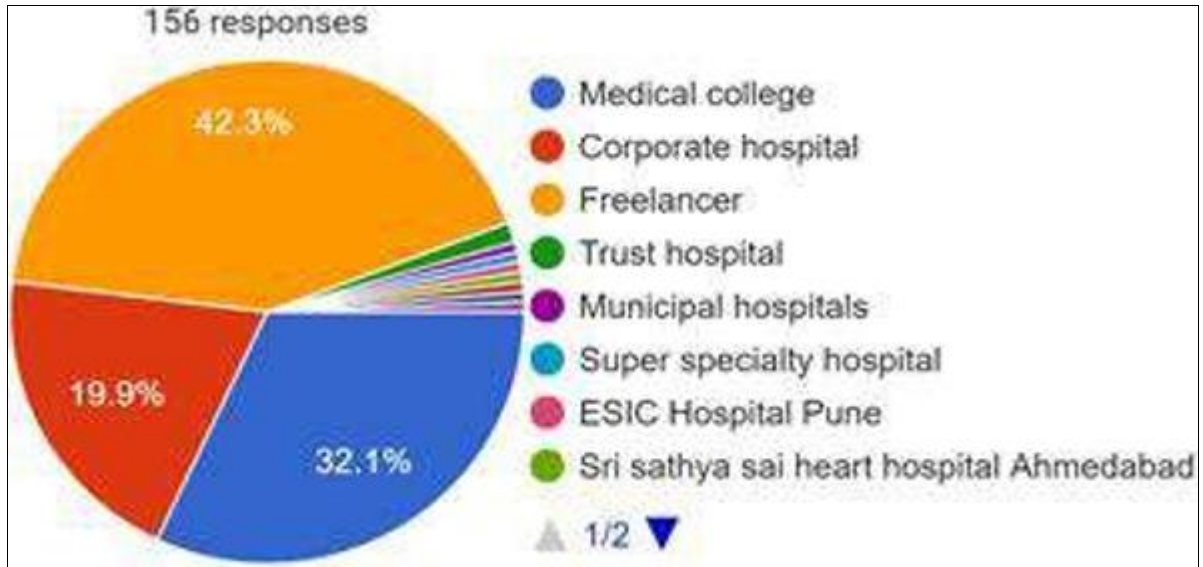


Fig 4: Working place

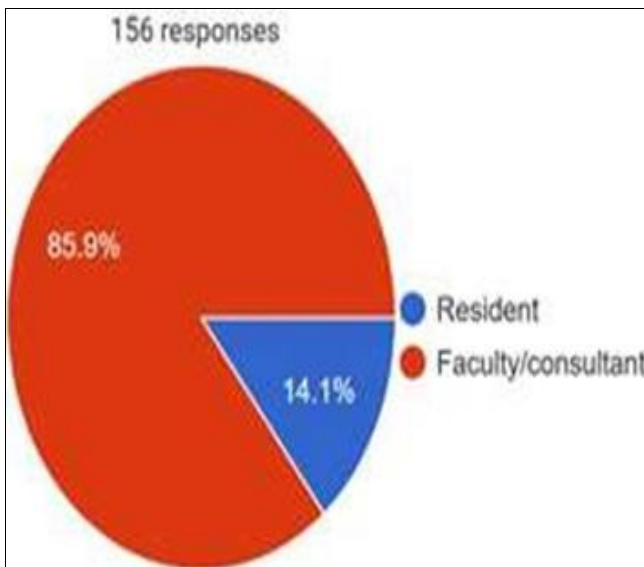


Fig 5: Designation

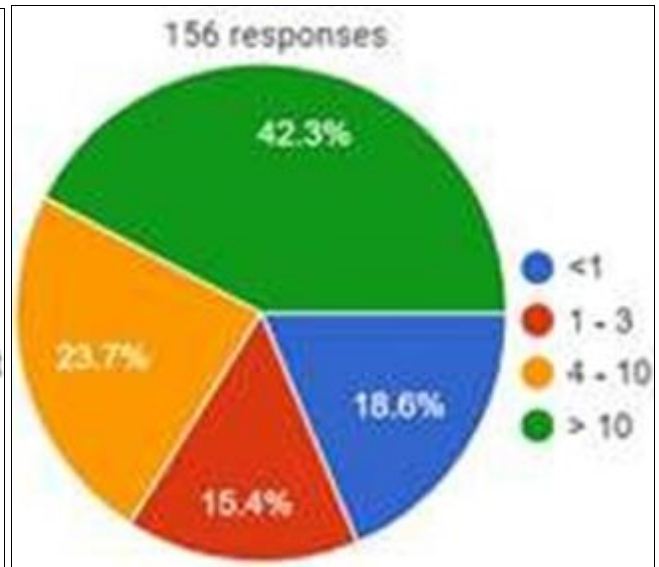


Fig 6: Number of years of experience in pediatric anesthesia post PG

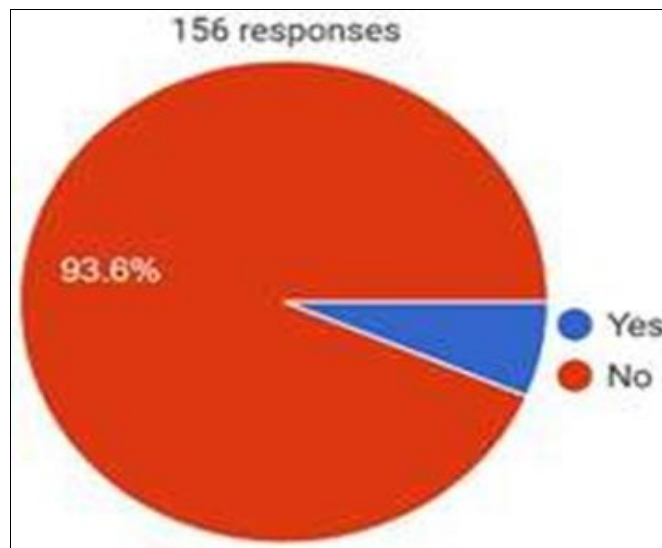


Fig 7: Are you an exclusive pediatric anaesthesiologists?

**ETT type used among children patients**

More number of cuffed ETT has been used in the age

group of 2 to 8 years children however more number of uncuffed ETT has been used up-to 2 years aged children.

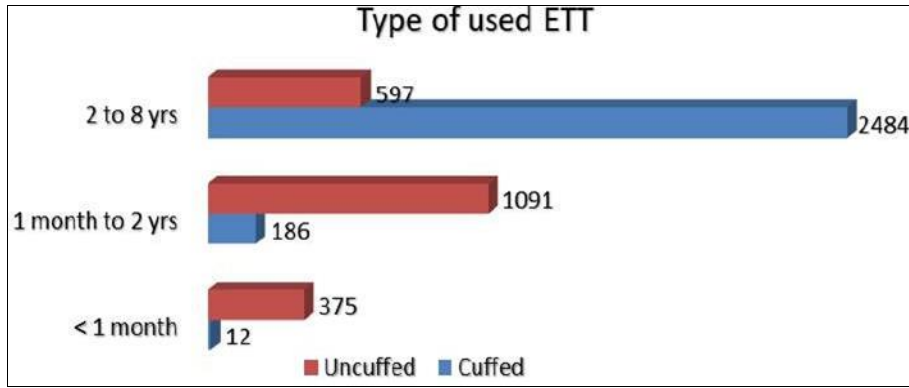


Fig 8: Association between age-group of children and type of ETT has been checked with chi-square test at 5% level of significance

Table 1: Strong association has been observed between age-group of children and type of ETT ( $p < 0.00001$ )

Age-group of children	Type of ETT used			Association test		
	Cuffed	Uncuffed	Total	Chi-square	p value	significance
< 1 month	12 (0.45)	375 (18.18)	387 (8.16)	2092.43	<0.00001	Significant
1 month to 2yrs	186 (6.94)	1091 (52.88)	1277 (26.91)			
2 to 8yrs	2484 (92.62)	597 (28.94)	3081 (64.93)			

Table 2: Average number of pediatric cases between 2 – 8 years per month

<5	18
5-10	16
11-15	9
16-20	5
21-100	15
>100	5

Table 3: Average number of pediatric cases below two years (Excluding neonates) per month

0	6
<5	21
5 – 10	16
11 – 15	1
16 – 20	2
>20	12

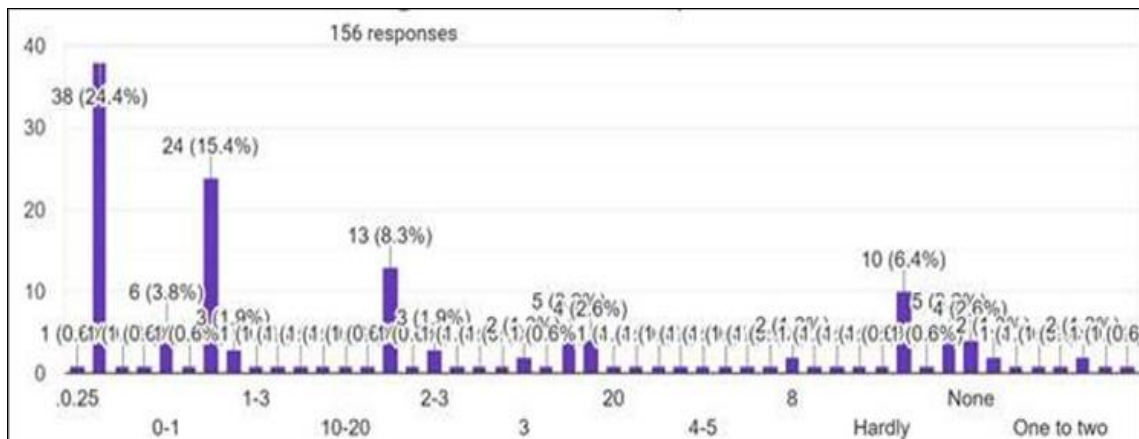


Fig 9: Average number of neonates per month

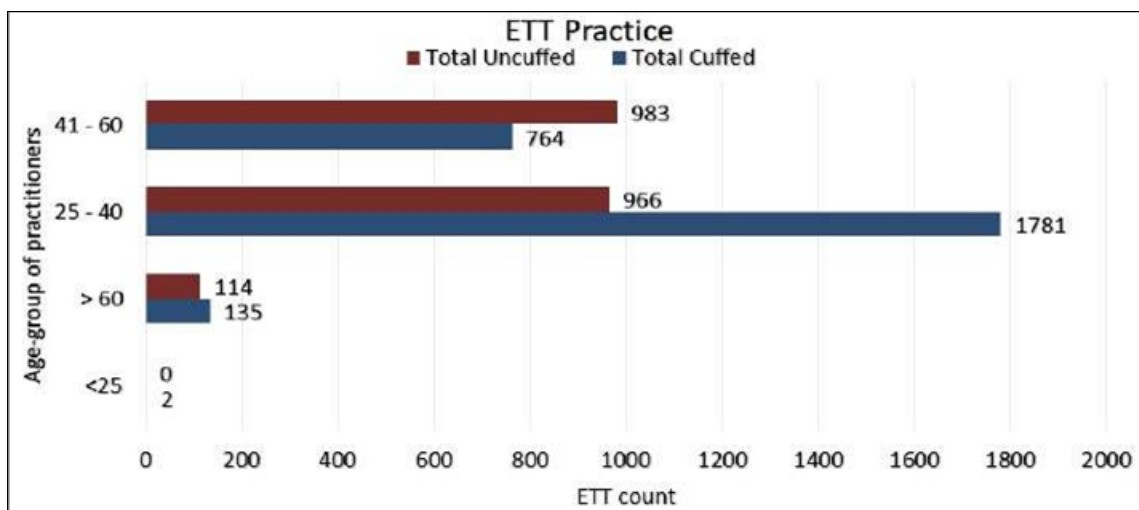
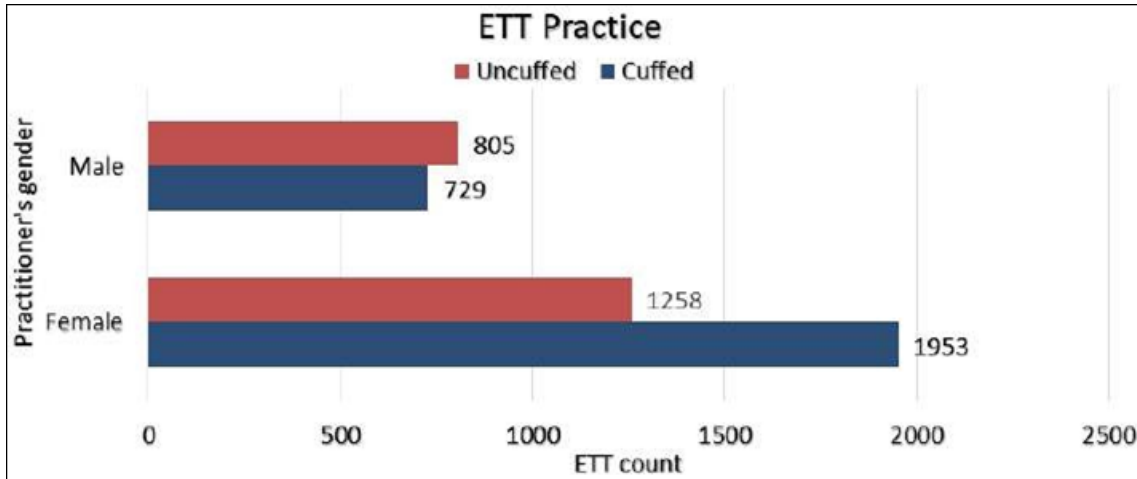


Fig 10: ETT type used by practitioners with respect to their age

**Table 4:** ETT type used by practitioners with respect to their age

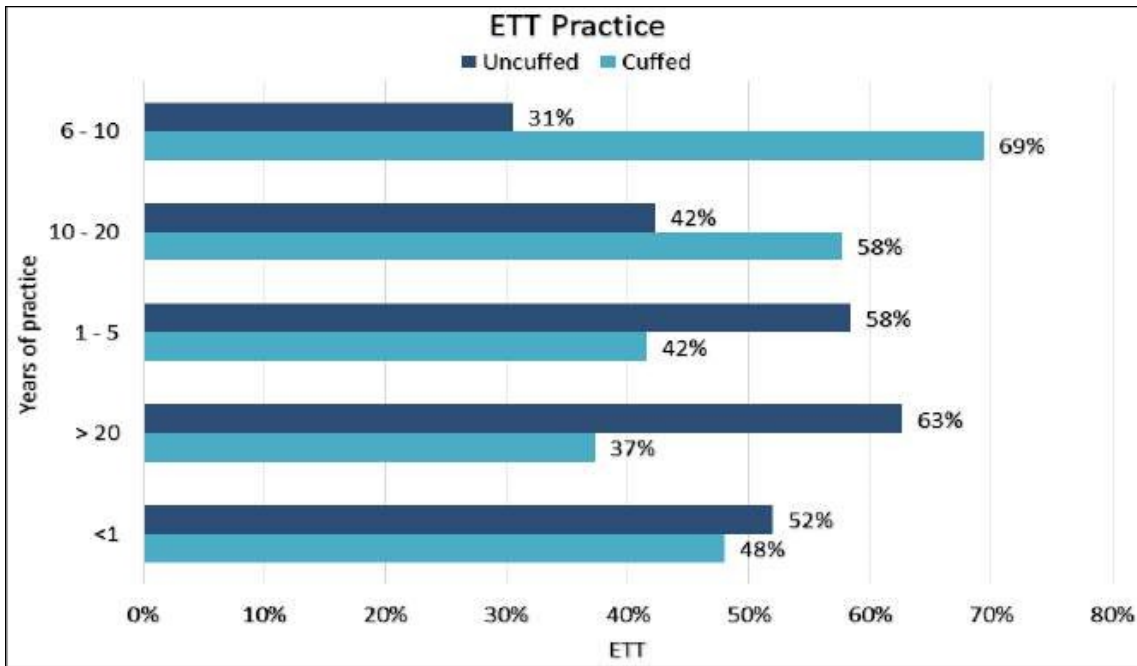
Age-group of practitioners	Cuffed ETT				Uncuffed ETT				Grand total	Association test	
	Neonates	1 month to 2yrs	2 to 8yrs	Total	Neonates	1 month to 2yrs	2 to 8yrs	Total		Chi-square	p-value
<25	0 (00)	0 (00)	2 (100)	2 (100)	0 (00)	0 (00)	0 (00)	0 (00)	2	194.09	=0.0000
> 60	11 (10)	10 (07)	123 (91)	135 (54)	11 (10)	45 (39)	58 (51)	114 (46)	249		
25 - 40	191 (20)	116 (07)	1664 (93)	1781 (65)	191 (20)	642 (66)	133 (14)	966 (35)	2747		
41 - 60	173 (18)	60 (08)	695 (91)	764 (44)	173 (18)	404 (41)	406 (41)	983 (56)	1747		
Grand Total	375 (18)	186 (07)	2484 (93)	2682 (57)	375 (18)	1091 (53)	597 (29)	2063 (43)	4745		



**Fig 11:** ETT type used by practitioners with respect to their gender

**Table 5:** ETT type used by practitioners with respect to their gender

Gender of practitioners	Cuffed ETT				Uncuffed ETT				Grand total	Association test	
	Neonates	1 month to 2yrs	2 to 8yrs	Total	Neonates	1 month to 2yrs	2 to 8yrs	Total		Chi-square	p-value
Female	2 (0)	126 (6)	1825 (93)	1953 (61)	236 (19)	752 (60)	270 (21)	1258 (39)	3211	194.09	< 0.0000 1
Male	10 (1)	60 (8)	659 (90)	729 (48)	139 (17)	339 (42)	327 (41)	805 (52)	1534		
Total	12	186	2484	2682	375	1091	597	2063	4745		



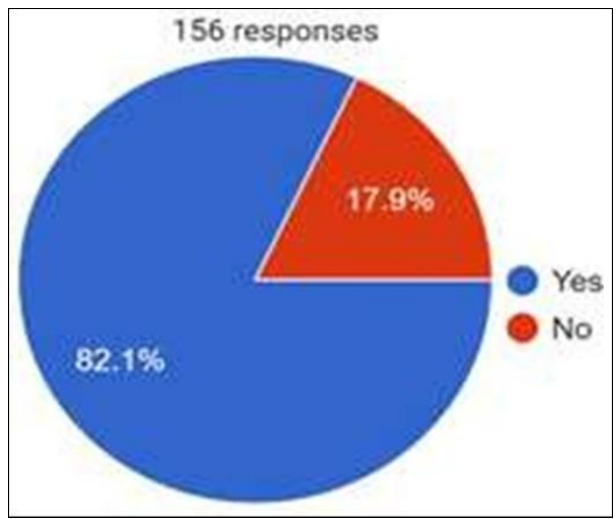
**Fig 12:** ETT type used by practitioners with respect to their years of practice

**Table 6:** ETT type used by practitioners with respect to their years of practice

Years of practice	Cuffed ETT				Uncuffed ETT				Grand total	Association test	
	Neonates	1 month to 2yrs	2 to 8yrs	Total	Neonates	1 month to 2yrs	2 to 8yrs	Total		Chi-square	p-value
<1	1 (1)	7 (4)	148 (95)	156	40 (24)	75 (44)	54 (32)	169	325	347.94	< 0.0000 1
> 20	7 (2)	27 (6)	400 (92)	434	86 (12)	248 (34)	396 (54)	730	1164		

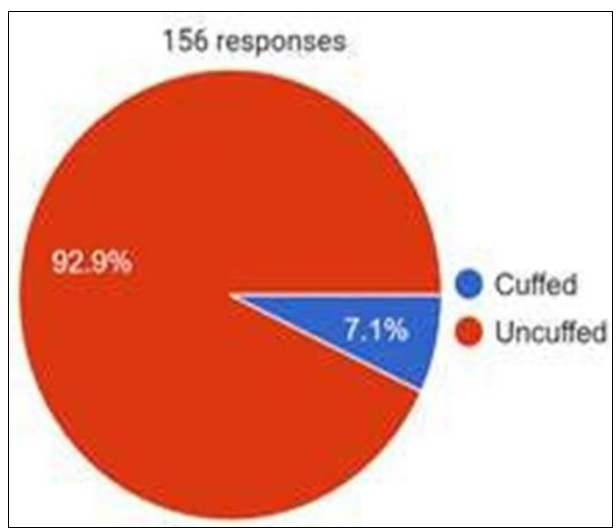
1 -5	0(0)	4 (4)	85 (96)	89	17 (14)	49 (39)	59 (47)	125	214
10 - 20	4 (1)	13 (2)	521 (97)	538	92 (23)	244 (62)	58 (15)	394	932
6-10	0 (0)	135 (9)	1330 (91)	1465	140 (22)	475 (74)	30 (5)	645	2110
Total	12	186	2484	2682	375	1091	597	2063	4745

**Availability of cuffed ETT at workplace**



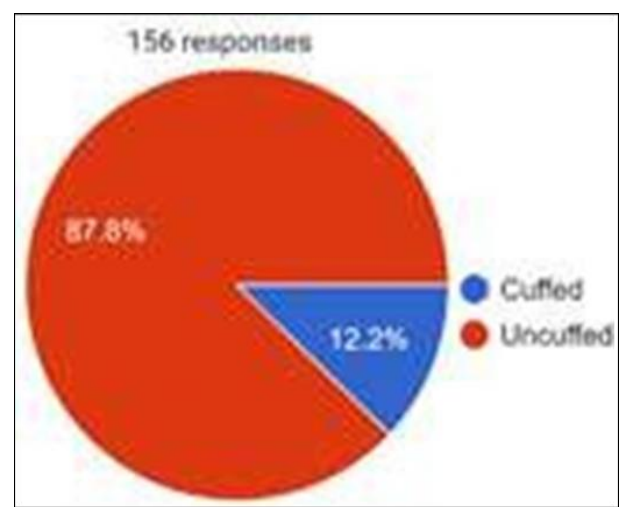
**Fig 13:** Are cuffed ETT available at your workplace?

**Endotracheal tube preference in neonates**



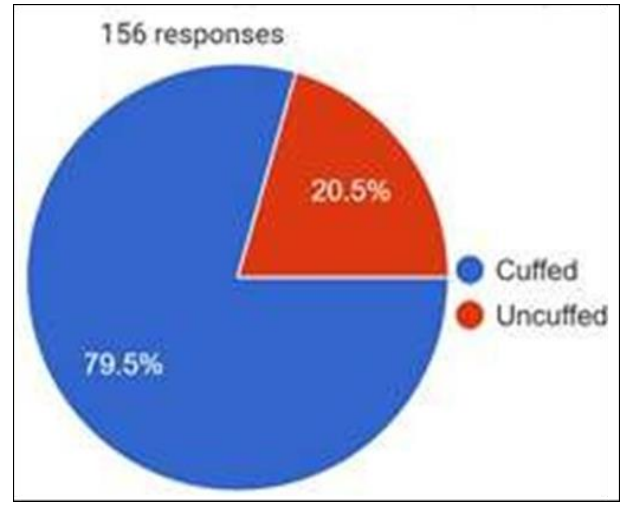
**Fig 14:** Which type of endotracheal tube do you prefer in neonates

**Endotracheal tube preference in children between one month to two years**



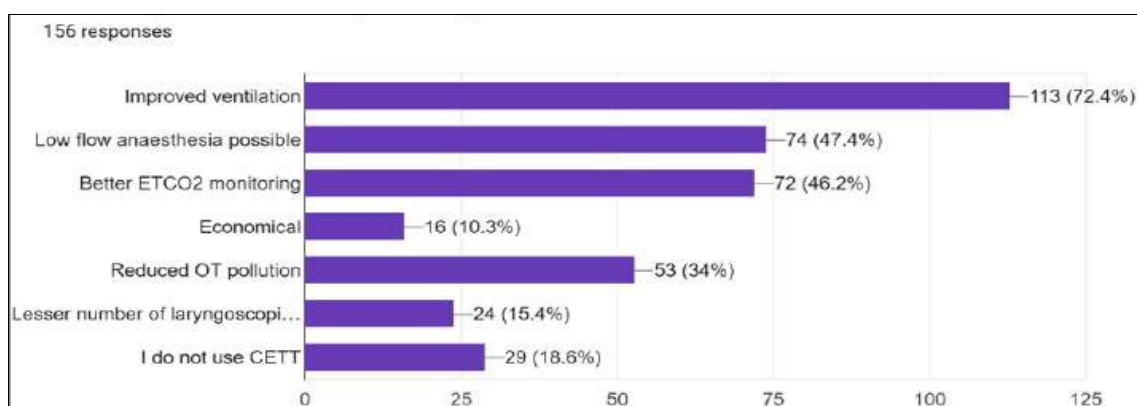
**Fig 15:** Which type of endotracheal tube do you prefer in children between one month to two years?

**Endotracheal tube preference in in pediatric patients >2 to 8 years**



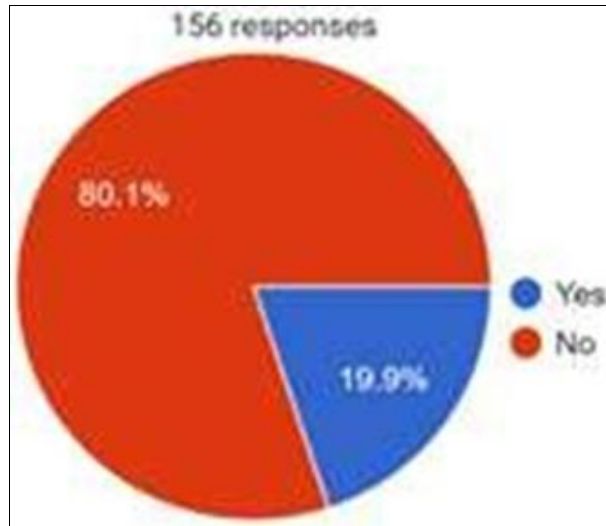
**Fig 16:** Which type of ETT do you prefer in pediatric patients >2 to 8 years

**Reasons for preferring to use CETT's**



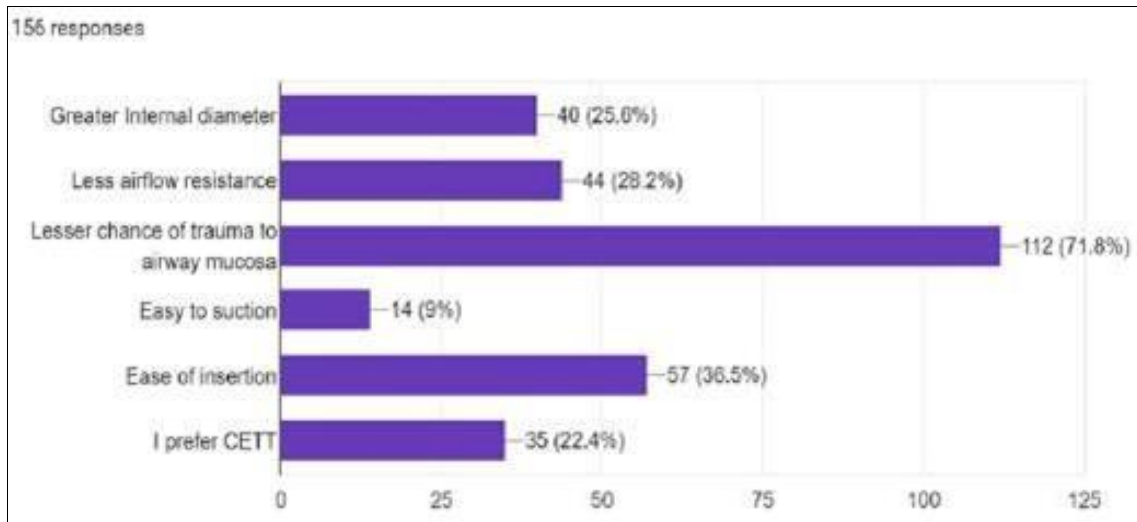
**Fig 17:** What for preferring to use CETT's

**Any complication witnessed using a cuffed ETT that could have been prevented using an Uncuffed ETT**



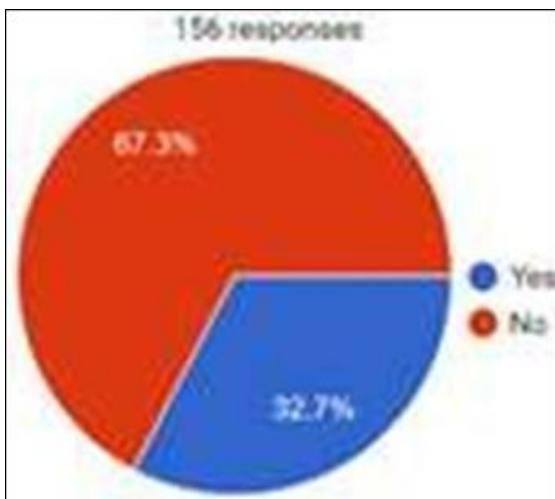
**Fig 18:** Have you witnessed any complication using a Cuffed ETT that could have been prevented using an Uncuffed ETT?

**Reasons for preferring an Uncuffed ETT**



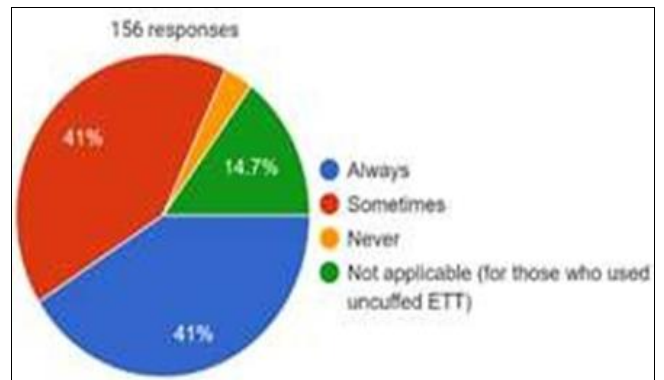
**Fig 19:** What are your reason for preferring an Uncuffed ETT?

**Any complication witnessed using Uncuffed ETT that could have been prevented with a cuffed ETT**



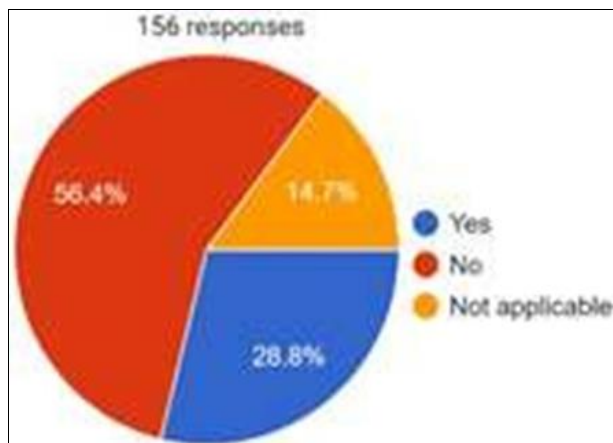
**Fig 20:** Have you witnessed any compaction using Uncuffed ETT that could have been prevented with a cuffed ETT?

**Frequency of inflation of ETT cuff**



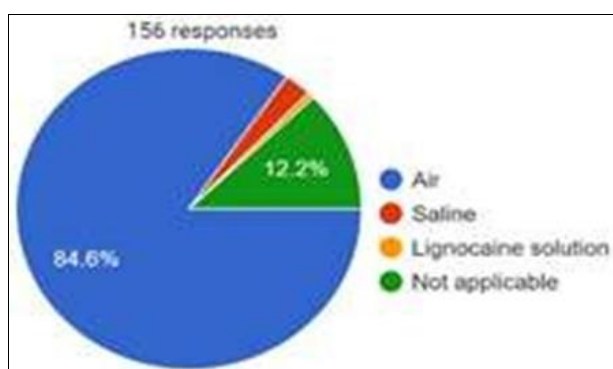
**Fig 21:** If you use cuffed ETT, how often do you inflate the cuff?

**Whether or not intracuff pressure is monitored while using cuffed ETT**



**Fig 22:** If you see cuffed ETT, do you monitor the intacuff pressure

### Method of inflation of ETT cuff



**Fig 23:** IF you use a cuffed tube, what do you use to inflate the cuff?

In our study, 47.4% anaesthetists were in the age range of 40 – 60 years, 44.9% in the range of 25 to 39 years, 7.1% above 60 years, while the remaining minority in the age group of less than 25 years.

Regarding ETT type used by practitioners with respect to their age 57% practitioners are using cuffed ETT and 43% are using non cuffed ETT. More number of cuffed ETT has been seen to be used by the practitioners who are in the age group of 25 to 40 years. Strong association has been observed between age-group of practitioners and type of ETT ( $p < 0.00001$ ).

In our study, 41% respondents were males, while 59% were females.

Regarding ETT type used by practitioners with respect to their gender, among female practitioners, 61% use cuffed ETT and 39% use uncuffed ETT for pediatric anaesthesia. Among male practitioners, 48% use cuffed ETT and 52% use uncuffed ETT for pediatric anaesthesia. More number of cuffed ETT has been used by female practitioners for pediatric anaesthesia. Strong association has been observed between gender of practitioners and type of ETT ( $p < 0.00001$ ).

Amongst the respondents, 12.2% had a post post-graduation experience of less than 1 year, 12.8% had 1 to 5 years, 15.4% between 6 to 10 years, 28.8% between 10 to 20 years and 30.8%, the maximum, above 30 years.

In the study conducted by Motiani <sup>[3]</sup> *et al*, titled Current practice and attitudes regarding the perioperative use of cuffed tracheal tubes for pediatric

and neonatal tracheal intubation: A survey-based evaluation among Indian anesthesiologists, the total response rate was 55% (99/180) and after excluding the responses of postgraduates, 96 responses were evaluated. The use of pediatric cuffed ETT was similar among institutions. Only 35.5% of the respondents routinely used cuffed tubes regularly.

Regarding ETT type used by practitioners with respect to their years of practice, maximum inclination towards using cuffed ETT in pediatric patients is seen amongst practitioners with 6 to 10 years of post PG experience - 69% use cuffed ETT and 31% use uncuffed ETT. On the contrary, those with experience of more than 20 years post PG show an inclination towards using uncuffed ETT rather than cuffed ETT in pediatric anaesthesia – 63% use uncuffed ETT while 37% use cuffed ETT. Strong association has been observed between years of practice of preference of practitioners for the type of ETT ( $p < 0.00001$ ).

Regarding the place of work, maximum, 42.3% were freelancer anaesthetists; 32.1% worked in a hospital attached to a medical college; 19.9% worked in corporate hospitals, and the rest were minority working in other places like trust hospitals and municipal hospitals.

Amongst the respondents, 85.9% were faculty or consultants while 14.1% were resident doctors.

Amongst the respondents, 42.3% had more than 10 years of experience in pediatric anaesthesia after post-graduation; 23.7% had 4 – 10 years of post PG experience in pediatric anaesthesia, 15.4% between 1 to 3 years and 18.6% had less than 1 year of experience in anaesthesia after post- graduation.

Of the respondents, only 6.4% were exclusive pediatric anaesthesiologists.

Among the respondents workplaces, pediatric cuffed ETT were available with 82.1% while it was not available with 17.9%.

When asked about ETT preference in neonates, 92.9% preferred uncuffed ETT in neonates as against only 7.1% who preferred using cuffed ETT in neonates. Between 1 month to 2 years, 87.8% preferred using uncuffed ETT while 12.2% preferred using cuffed ETT. Between 2 to 8 years of age, 79.5% preferred using cuffed ETT while 20.5% preferred using uncuffed ETT.

### The reasons for preferring to use cuffed ETT in pediatric anaesthesia were

- Improved ventilation – 72.4%
- Low flow anaesthesia possible – 47.4%
- Better ET<sub>CO2</sub> monitoring – 46.2%
- Reduced OT pollution – 34%
- Lesser number of laryngoscopies needed to change size of tube – 15.4%
- Economical – 10.3%

Rest 18.6% did not prefer cuffed ETT in pediatric patients. Recent advances in the knowledge of pediatric airway anatomy have countered the previous beliefs which favored uncuffed ETTs, and this has further laid impetus on the benefits of CETs in children <sup>[8]</sup>. They have been shown to be safe for use even in small neonates <sup>[9]</sup>.

When asked whether any complication was witnessed while using cuffed ETT that could have been prevented by using uncuffed ETT, 80.1% said no. The remaining 19.9% claimed to have witnessed the following complications of cuffed ETT

1. Difficulty with size during nasal intubation
2. Difficulty in tube insertion
3. Laryngeal trauma and edema
4. Sore throat
5. Post extubation laryngospasm
6. Hoarseness of voice



7. Microaspiration
8. Vocal cord injury
9. Tracheal trauma and narrowing
10. Subglottic stenosis
11. Stridor

Of these, laryngeal oedema, laryngospasm and sore throat were the most common in that order.

In a study conducted by N A Chambers, A Ramgolam<sup>[10]</sup>, titled Cuffed vs. uncuffed tracheal tubes in children: a randomised controlled trial comparing leak, tidal volume and complications, they compared tidal volume and leakage around cuffed and uncuffed tracheal tubes in children who required standardised mechanical ventilation of their lungs in the operating theatre. During volume-controlled ventilation, leakage was significantly less with cuffed tracheal tubes than with uncuffed tracheal tubes; in ml.kg<sup>-1</sup>, median (IQR [range]) 0.20 (0.13-0.39 [0.04-0.60]) vs. 0.82 (0.58-1.38 [0.24-4.85]), respectively,  $p < 0.001$ . With pressure-controlled ventilation, leakage was less with cuffed tracheal tubes and stayed unchanged over a 30-min period, whereas with uncuffed tracheal tubes, leakage was higher and increased further over the 30-min period. Tidal volumes were higher in the cuffed group and increased over time, but in the uncuffed group were lower and decreased over time. In a study, Michel de Wit<sup>[11]</sup>, Linda M Peelen *et al.*, retrospectively studied all children aged 0-7 years in which the trachea was intubated between September 28, 2006 and August 26, 2016 in a pediatric university hospital. Logistic regression analysis was performed to estimate the association between tube design (Cuffed vs uncuffed) and the incidence of acute postoperative respiratory complications (Stridor, wheezing, or dyspnea; desaturations  $\leq 90\%$ ) in need of intervention (Epinephrine, dexamethasone, nebulizers, supplementary oxygen, or reintubation), adjusting for potential confounders. After adjusting for confounders, there was no difference in acute postoperative respiratory complications between cuffed tubes and uncuffed tubes.

**Amongst the anaesthesiologists, the reasons for preferring Uncuffed ETT over cuffed ETT in paediatrics patients were as follows:**

- Lesser chance of trauma to airway mucosa – 71.8%
- Ease of insertion – 36.5%
- Less airflow resistance – 28.2%
- Greater internal diameter – 25.6%
- Preference for CETT – 22.4%
- Ease of suctioning – 9%

When asked whether any complication was witnessed while using uncuffed ETT that could have been prevented by using cuffed ETT, 67.3% said no. The remaining 32.7% claimed to have witnessed the following complications of uncuffed ETT

- Aspiration
- In ENT surgeries, due to shared airway, the uncuffed ETT gets displaced easily as compared to the uncuffed ETT.
- Leak around the tube
- Upper airway irritation due to secretions
- Difficult to ventilate because of loss of volume,

needed high flow

- Tube Dislodgement, Accidental extubation. Sometimes when the patient is being weaned off the tube slips out of trachea due to tongue movement of the child
- Accidental extubation, aspiration, migration of tube
- Aspiration of saliva causing coughing and laryngospasm post extubation
- Many tube changes needed or throat packing needed.
- Lot of leakage occurring with uncuffed tube requiring either packing the throat or changing tube to higher size thus requiring second laryngoscopy.
- Leak around tube leading to expired tidal volume significantly lower than the inspired tidal volume
- TEE probe while removing many of my residents pulled the UCET tube. May be could have prevented if CETT was used
- Leak, so couldn't ventilate post OP properly in post OP period, as tidal volume not achieved.
- Aspiration pneumonitis
- Vomiting
- Aspiration in a patient with gastric outlet obstruction
- Endobronchial intubation

When questioned about frequency of inflation of cuff in cuffed endotracheal tube, 41% stated that they always inflate, 41% sometimes inflate, while 3.3% said that they never inflate the cuff. The question was not applicable to 14.7% who use only uncuffed endotracheal tubes.

When using cuffed endotracheal tube, measurement of cuff pressure is extremely important. The gold standard for cuff pressure monitoring has been the intermittent manual manometer, and guidelines have since recommended that cuff pressure should be maintained at 20–30 cm H<sub>2</sub>O<sup>[6]</sup>. There is preponderance of evidence that tracheal tube cuffs are improperly inflated when manometers are not used<sup>5</sup>.

When questioned whether or not intracuff pressure monitoring was done while using cuffed endotracheal tube, only 28.8% responded yes while 56.4% responded no. The question was not applicable to 14.7% who use only uncuffed endotracheal tubes.

Arinze Duke George Nwosu, Edmund Ndudi Ossai<sup>5</sup> *et al* conducted a study titled 'Knowledge and practice of tracheal tube cuff pressure monitoring: a multicenter survey of anaesthesia and critical care providers in a developing country'. This was a multicenter cross-sectional study conducted from March 18 to April 30, 2021. The first part (A) was conducted at 4 tertiary referral hospitals in Nigeria by means of a self-administered questionnaire on the various cadre of anaesthesia and critical care providers. The second part (B) was a nationwide telephone survey of anaesthesia faculty fellows affiliated to 13 tertiary hospitals in Nigeria, selected by stratified random sampling. They found that only 3.1% (6/196) of the care providers admitted having ever used a tracheal cuff manometer, while 31.1% knew the recommended tracheal cuff pressure.

In the study conducted by Motiani<sup>[3]</sup> *et al*, titled Current practice and attitudes regarding the perioperative use of cuffed tracheal tubes for pediatric and neonatal tracheal intubation: A survey-based evaluation among Indian anesthesiologists, the common reasons for non-usage of cuffed tubes included fear of higher resistance to flow and risk of subglottic injury. Those anesthesiologists who were performing higher pediatric cases were more inclined to use a cuffed ETT. Endotracheal cuff pressure was monitored routinely by 40% of the respondents who used cuffed tube. In a study conducted by P E Flynn, A E Black, V Mitchell<sup>[7]</sup> *et al.*, titled The use of cuffed tracheal tubes for paediatric tracheal intubation, a survey of specialist practice

in the United Kingdom, a questionnaire was e-mailed to the paediatric intensive care unit and anaesthetic department clinical leads in all UK specialist paediatric hospitals with a paediatric intensive care unit (n = 30). Information was requested on the use of tracheal tubes across all paediatric age groups, as well as the reasons for non-use and the incidence of complications attributed to cuffed tubes. A total of 20 paediatric intensive care unit and 15 anaesthetic questionnaires were returned, equating to a response rate of 67% and 50%, respectively. Only 5% of the paediatric intensive care unit and 7% of the anaesthetic respondents routinely use a cuffed tube in children under the age of 8 yr. The commonest reason cited in both groups for non-cuff use was that there is minimal benefit to be gained over using an uncuffed tracheal tube. The most frequent specific indication for use of a cuffed tube was a reduced lung compliance (60% respondents both groups). In all, 45% of the paediatric intensive care unit respondents and 100% of the anaesthetists reported that they did not routinely monitor the intracuff pressure when using a cuffed tube.

Regarding method of inflation of endotracheal tube cuff, 84.6% use air, 2.6% use saline while 0.6% use Lignocaine solution.

Use of cuffed endotracheal tubes in pediatric age group has always been a matter of debate. Use of cuffed endotracheal tube is not as widespread as it should have been owing to fear regarding postoperative stridor, laryngeal oedema, coughing and airway irritation. However, cuffed tubes have been shown to be safe and the incidence of such postoperative complications between two groups is not significant. Yet, while using cuffed endotracheal tube, inflation of the cuff, and measurement of the intracuff pressure are two very vital steps.

### Conclusion

In our study, we concluded that more number of cuffed ETT has been seen to be used by the practitioners who are in the age group of 25 to 40 years. More number of cuffed ETT has been used by female practitioners for pediatric anaesthesia. Strong association has been observed between years of practice of preference of practitioners for the type of ETT, with practitioners with less than 10 years post PG experience preferring cuffed ETT while those with post PG experience of > 20 years preferring uncuffed ETT. We also concluded that majority practitioners prefer uncuffed ETT in neonates and in children between 1 month to 2 years of age, while most of them prefer cuffed ETT in children above 2 years of age. We also concluded that even though use of cuffed endotracheal tubes in pediatric patients is on a rise, the percentage of anaesthesiologists who monitor intraoperative cuff pressure is very low, thus compromising the safety.

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