

Original article

Comparison of Postoperative Respiratory Complications using Cuffed ETT vs Un-cuffed ETT in Pediatric Surgeries

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ABSTRACT

Background: Modern cuffed endotracheal tubes may improve airway sealing without increasing airway injury, but comparative evidence from pediatric surgical populations in Pakistan is limited. **Objective:** To compare postoperative respiratory complications between cuffed and uncuffed endotracheal tubes in children undergoing elective surgery. **Methods:** This prospective comparative observational study included 150 children aged 0–7 years undergoing elective surgery under general anesthesia at Mayo Hospital, Lahore, from January to April 2026. Participants were classified according to the endotracheal tube selected in routine care (75 cuffed and 75 uncuffed). Stridor, wheezing, dyspnea, oxygen desaturation and any respiratory complication were assessed during the first hour after extubation. Fisher's exact test and risk ratios (RRs) with 95% confidence intervals (CIs) were used. **Results:** Any respiratory complication occurred in 24/75 (32.0%) children with cuffed tubes and 29/75 (38.7%) with uncuffed tubes (RR 0.83, 95% CI 0.54–1.28; $p=0.495$). Event rates were lower with cuffed tubes for stridor (6.7% vs 16.0%), wheezing (8.0% vs 20.0%), dyspnea (2.7% vs 9.3%) and desaturation (5.3% vs 14.7%). Only the unadjusted wheezing comparison excluded the null on the RR confidence interval (RR 0.40, 95% CI 0.16–0.98), while Fisher's exact $p=0.058$. **Conclusion:** No statistically conclusive difference in the composite outcome was detected. The direction of the estimates favored cuffed tubes, but clinically important benefit or harm cannot be excluded. **Keywords:** Pediatric anesthesia, Cuffed endotracheal tube, Uncuffed endotracheal tube, Respiratory complications, Stridor, Oxygen desaturation

EDITORIAL INFORMATION

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INTRODUCTION

Perioperative respiratory adverse events remain an important source of preventable morbidity during pediatric anesthesia. Children have high oxygen consumption, limited functional residual capacity and relatively small airways; consequently, obstruction, bronchospasm, laryngospasm and oxygen desaturation may develop rapidly and require immediate treatment. Large prospective studies have shown that respiratory events constitute a substantial proportion of severe perioperative incidents, with younger age, respiratory symptoms, higher physical-status classification, airway instrumentation and provider experience influencing risk (1–4). These vulnerabilities make the selection and management of an airway device a clinically important component of pediatric anesthetic care.

For many years, uncuffed endotracheal tubes (ETTs) were preferred in infants and young children because the cricoid region was considered the narrowest and a sealing cuff was thought to increase mucosal pressure and post-extubation injury. Imaging and anatomical studies have since refined this model of the pediatric larynx, while redesigned high-volume, low-pressure cuffs have allowed a seal to be achieved below the vulnerable subglottic region (5–7). Appropriate tube size, insertion depth and intracuff pressure remain essential because an oversized tube or excessive pressure can impair mucosal perfusion, whereas an inadequate seal can cause gas leakage, unreliable ventilation, environmental contamination and aspiration risk (8–11).

Modern cuffed tubes offer potential operational advantages. They can reduce leakage, improve measurement of tidal volume and end-tidal gases, limit anesthetic-gas loss and reduce tube exchange when the initial size is unsuitable. In a large multicenter randomized trial involving young children, cuffed tubes markedly reduced tube exchange without increasing post-extubation stridor (12). Earlier comparative work similarly showed more reliable tube sizing with cuffed devices (13). Meta-analyses and systematic reviews have generally found fewer exchanges and no clear increase in post-extubation airway morbidity, although certainty is constrained by heterogeneity in tube design, age, cuff-pressure practice and outcome definitions (14–16). Evidence in neonates remains particularly limited (17).

Safety depends on technique rather than the presence of a cuff alone. Objective cuff-pressure monitoring is preferable because palpation and other subjective inflation methods frequently produce pressures outside the desired range (18–21). Pediatric studies have also demonstrated that tube size and patient dimensions affect intracuff pressure, and that excessive or insufficient inflation can occur even during routine practice (22–24). Post-extubation symptoms are additionally shaped by repeated laryngoscopy, duration of intubation, airway surgery, respiratory infection, anesthetic technique and clinician experience (2,4,25). Therefore, observational comparisons must be interpreted in the context of possible confounding by the clinical factors that influence tube selection.

Despite increasing international acceptance of cuffed ETTs, locally generated comparative evidence from pediatric surgical practice in Pakistan remains limited. Differences in equipment availability, cuff-pressure monitoring and case mix may affect how international findings translate to local care. This study aimed to compare the incidence of postoperative respiratory complications—stridor, wheezing, dyspnea, oxygen desaturation and the composite occurrence of any respiratory complication—between children managed with cuffed and uncuffed ETTs during elective surgery under general anesthesia.

MATERIALS AND METHODS

A prospective comparative observational study was conducted at Mayo Hospital, Lahore, Pakistan, from January to April 2026. Using purposive sampling, 150 children aged 0–7 years with American Society of Anesthesiologists physical status I or II who underwent elective surgery under general anesthesia with tracheal intubation, were extubated in the operating room and remained in the post-anesthesia care unit (PACU) were included. Children with congenital airway abnormalities, tracheostomy, obstructive or restrictive respiratory disease, emergency intubation or planned postoperative ventilation were excluded. Tube type was selected by the attending anesthesiologist as part of routine care; no study-specific intervention or random allocation occurred. Seventy-five children received a cuffed ETT and 75 received an uncuffed ETT.

Demographic characteristics, anesthetic technique and postoperative respiratory events were recorded on a structured form. The primary outcome was documentation of any respiratory complication during the first hour after extubation in the PACU. Prespecified component outcomes were stridor, wheezing, dyspnea and oxygen desaturation, identified by direct clinical observation and routine monitoring by the anesthesia team. Frequencies and percentages were calculated. Between-group comparisons used two-sided Fisher's exact tests because several outcome cells were sparse. Unadjusted risk ratios (RRs), absolute risk differences and 95% confidence intervals (CIs) were calculated from the reported group counts. A p value <0.05 was considered statistically significant. Analyses were performed using IBM SPSS Statistics version 27.0. It was conducted in accordance with the ethical principles of the Declaration of Helsinki and the requirements of the Ethical Review Committee of the Faculty of Allied Health Sciences, The University of Lahore (Ref. No.: DRC/DHPT001/11/25). Written informed consent was obtained from all participants before enrolment. Participation was voluntary, confidentiality and anonymity were maintained throughout the study, and participants could withdraw without penalty at any stage of data collection.

RESULTS

All 150 enrolled children were included in the reported analysis, with 75 in each ETT group. The overall cohort comprised 76 (50.7%) boys and 74 (49.3%) girls. Seventy-three (48.7%) children were aged 0–3 years, 40 (26.7%) were aged 4–5 years and 37 (24.7%) were aged 6–7 years. Forty-seven (31.3%) were classified as ASA I and 103 (68.7%) as ASA II. Intravenous induction was used in 59 (39.3%),

inhalational induction in 51 (34.0%) and combined induction in 40 (26.7%). Anesthesia was maintained with sevoflurane or isoflurane in 99 (66.0%), intravenous agents in 21 (14.0%) and a combined technique in 30 (20.0%) children (Table 1).

Table 1. Demographics of Participants

Characteristic	Category	Total, n (%)
Age, years	0–3	73 (48.7)
	4–5	40 (26.7)
	6–7	37 (24.7)
Sex	Male	76 (50.7)
	Female	74 (49.3)
ASA physical status	I	47 (31.3)
	II	103 (68.7)
Induction	Intravenous	59 (39.3)
	Inhalational	51 (34.0)
	Combined	40 (26.7)
Maintenance	Sevoflurane/isoflurane	99 (66.0)
	Intravenous	21 (14.0)
	Combined	30 (20.0)
ETT type	Cuffed	75 (50.0)
	Uncuffed	75 (50.0)

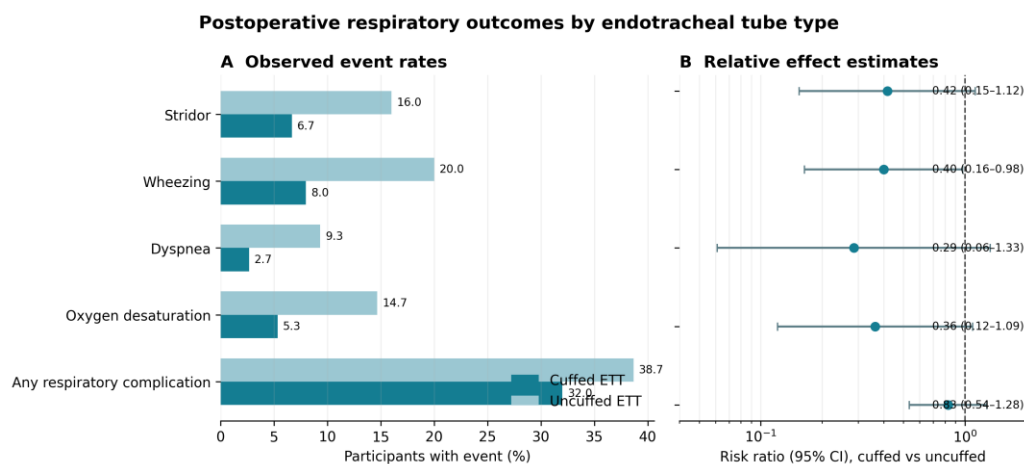
At least one postoperative respiratory complication was documented in 24 (32.0%) children with cuffed ETTs and 29 (38.7%) with uncuffed ETTs, corresponding to an RR of 0.83 (95% CI 0.54–1.28), an absolute risk difference of –6.7 percentage points (95% CI –21.9 to 8.6) and Fisher’s exact $p=0.495$. Thus, the data did not demonstrate a statistically conclusive difference in the composite outcome (Table 2). All four component outcomes occurred less frequently in the cuffed group. Stridor occurred in 5 (6.7%) versus 12 (16.0%) children (RR 0.42, 95% CI 0.15–1.12; $p=0.120$), dyspnea in 2 (2.7%) versus 7 (9.3%) (RR 0.29, 95% CI 0.06–1.33; $p=0.166$), and oxygen desaturation in 4 (5.3%) versus 11 (14.7%) (RR 0.36, 95% CI 0.12–1.09; $p=0.100$). Wheezing occurred in 6 (8.0%) children with cuffed ETTs and 15 (20.0%) with uncuffed ETTs (RR 0.40, 95% CI 0.16–0.98); the two-sided Fisher’s exact p value was 0.058. These unadjusted estimates indicate a consistent direction of association but substantial statistical uncertainty, particularly for the less frequent outcomes.

Table 2. Postoperative respiratory outcomes by ETT type

Outcome	Cuffed ETT	Uncuffed ETT	RR	95% CI	Risk difference, %	p value
Stridor	(n=75)	(n=75)	0.42	0.15–1.12	-9.3 (-19.4 to 0.7)	0.120
Wheezing	5 (6.7)	12 (16.0)	0.40	0.16–0.98	-12.0 (-22.9 to -1.1)	0.058
Dyspnea	6 (8.0)	15 (20.0)	0.29	0.06–1.33	-6.7 (-14.2 to 0.9)	0.166
Oxygen desaturation	2 (2.7)	7 (9.3)	0.36	0.12–1.09	-9.3 (-18.8 to 0.2)	0.100
Any respiratory complication	4 (5.3)	11 (14.7)	0.83	0.54–1.28	-6.7 (-21.9 to 8.6)	0.495

Values are n (%) unless otherwise stated. CI, confidence interval; ETT, endotracheal tube; RR, risk ratio for cuffed versus uncuffed ETT. All p values are from two-sided Fisher’s exact tests. The composite outcome denotes at least one documented respiratory complication; component events may overlap.

Figure 1. Postoperative respiratory outcomes by endotracheal tube type. Panel A shows observed event rates. Panel B shows unadjusted risk ratios with 95% confidence intervals; values below 1 favor cuffed ETTs. Component events may overlap within the composite outcome.



Across the component outcomes, absolute event-rate differences favoring cuffed ETTs ranged from 6.7 percentage points for dyspnea to 12.0 percentage points for wheezing. The RR estimates ranged from 0.29 for dyspnea to 0.42 for stridor; however, four of the five confidence intervals crossed 1.00, and the composite estimate was RR 0.83 (95% CI 0.54–1.28).

DISCUSSION

In this single-center observational comparison, the composite frequency of postoperative respiratory complications did not differ conclusively between children managed with cuffed and uncuffed ETTs during the first hour after extubation. Every component event was numerically less frequent in the cuffed group, but the estimates were imprecise. The findings therefore support neither a claim of equivalence nor a definitive protective effect; instead, they indicate that clinically meaningful differences remain plausible and should be evaluated in better-controlled studies.

The absence of an observed increase in complications with cuffed tubes is broadly consistent with comparative evidence. Weiss and colleagues found similar post-extubation stridor rates with cuffed and uncuffed tubes in a large multicenter randomized trial, while tube exchange was substantially less common with cuffed devices (12). Khine and colleagues also reported reliable selection of cuffed tubes in young children (13). Meta-analysis and Cochrane review evidence has generally shown fewer tube exchanges without a clear increase in stridor or other post-extubation morbidity (14–17). The present study extends this direction of evidence to a Pakistani tertiary-care setting, although its observational design and smaller sample provide much lower certainty than the larger randomized evidence.

Several mechanisms could explain why modern cuffed tubes did not produce more respiratory morbidity. A correctly sized high-volume, low-pressure cuff can create an effective seal without requiring the external tube diameter to fit tightly at the cricoid region. This may reduce air leakage, repeated laryngoscopy and tube exchange, each of which can contribute to mucosal trauma (7,8,12). Improved sealing can also support more reliable ventilation, capnography and delivery of anesthetic gases (6,14). These benefits depend on correct sizing and pressure management; the findings should not be generalized to oversized tubes or poorly monitored cuffs.

The consistent direction of the component estimates deserves cautious attention. Wheezing was recorded in 8.0% of the cuffed group and 20.0% of the uncuffed group, producing an RR of 0.40 with a 95% CI of 0.16–0.98, although the two-sided Fisher's exact p value was 0.058. This difference between the confidence-interval and exact-test boundaries reflects the use of different inferential approximations in sparse data and should not be converted into a binary claim of benefit. Stridor, dyspnea and desaturation also favored cuffed tubes numerically, but their confidence intervals were wide. The study was not an equivalence or non-inferiority trial, so non-significant findings cannot demonstrate that the devices are clinically interchangeable.

Postoperative respiratory outcomes are influenced by factors beyond tube type. Age, current or recent respiratory infection, airway surgery, ASA status, anesthetic technique, repeated intubation attempts and provider experience are established predictors of pediatric respiratory adverse events (2–4,25). Because the attending anesthesiologist selected the tube in routine care, tube choice may have

reflected age, airway characteristics or perceived procedural risk. Without group-specific baseline data or adjusted analysis, confounding by indication cannot be excluded. The balanced group size does not ensure clinical comparability because allocation was not randomized.

Cuff management is another important source of heterogeneity. Objective measurement is recommended because subjective inflation may yield underinflation or overinflation, and both patient size and tube diameter affect achieved pressure (18–24). The available study record did not support analysis of cuff pressure, tube size, leak pressure, number of intubation attempts or intubation duration. Consequently, the present findings are best interpreted as outcomes of local routine practice rather than a comparison of fully standardized cuffed and uncuffed protocols. Implementation efforts should emphasize appropriate size selection and objective cuff-pressure monitoring rather than treating tube type as an isolated safety decision.

The study has strengths, including prospective postoperative observation, equal-sized exposure groups, a clinically relevant local population and reporting of several specific respiratory outcomes. It also has important limitations. Purposive recruitment and a single-center setting limit generalizability; non-random tube selection permits selection bias and confounding; the sample-size rationale was not documented; outcome assessment was limited to one hour and was not reported as blinded; and standardized severity grades were unavailable. Sparse event counts produced wide confidence intervals, multiple component comparisons increase the possibility of chance findings, and the composite outcome may include overlapping events. Baseline characteristics were available only for the whole cohort, preventing assessment of group balance or adjusted modeling. These limitations mean that the direction of the observed estimates is hypothesis-generating rather than practice-changing.

Clinically, the results do not suggest that cuffed ETT use should be avoided solely because of concern about early postoperative respiratory complications. Device selection should remain individualized and accompanied by correct sizing, careful atraumatic intubation and objective cuff-pressure monitoring where cuffed tubes are used. Future multicenter prospective studies should prespecify outcome definitions, extend follow-up, document cuff pressures and intubation characteristics, and adjust for patient, surgical and anesthetic risk factors. A sufficiently powered randomized or pragmatic comparative design would be needed to establish equivalence or superiority.

CONCLUSION

Among 150 children undergoing elective surgery, the study did not detect a statistically conclusive difference in respiratory complications during the first hour after extubation between cuffed and uncuffed ETT groups. Component outcomes were consistently less frequent with cuffed tubes, but the estimates were imprecise and the observational design precludes causal or equivalence conclusions. Modern cuffed ETTs may therefore be a reasonable option when appropriately selected and managed, while confirmation requires standardized, adequately powered comparative research.

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