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Perioperative Outcomes With Laryngeal Mask Airway and Endotracheal Tube in Pediatric Laparoscopic Appendectomy: A Prospective Observational Cohort Study

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Abstract

Objective

This study aimed to compare intraoperative respiratory and hemodynamic parameters in pediatric patients undergoing laparoscopic appendectomy using either a laryngeal mask airway (LMA) or endotracheal tube (ETT), and to evaluate the effects of airway management on perioperative outcomes.

Methods

This prospective observational cohort study included 64 pediatric patients (ASA I–II, aged 2–18 years) undergoing laparoscopic appendectomy, of whom 32 were managed with an LMA and 32 with an ETT as part of routine clinical care. Anesthesia was induced with fentanyl, lidocaine, and propofol under standard anesthetic monitoring, whereas rocuronium was administered only in the ETT group. Hemodynamic parameters, peak airway pressure (Ppeak), end-tidal carbon dioxide ($EtCO_2$), and oxygen saturation (SpO_2) were recorded at predefined intraoperative time points. Repeated measurements were analyzed using generalized estimating equations (GEE). Anesthesia and surgical durations, surgeon satisfaction, and postoperative complications were also assessed. Respiratory complications, nausea, vomiting, and sore throat were evaluated during recovery and at the second postoperative hour. The primary outcome was to evaluate differences in peak airway pressures after the placement of airway devices and during pneumoperitoneum.

Results

Baseline and perioperative characteristics were comparable between groups. Heart rate was higher in the ETT group at early intraoperative time points. Peak airway pressure was significantly higher in the ETT group both at individual time points and in repeated-measures analysis (group effect $p = 0.003$), while no significant group differences were observed for $EtCO_2$, SpO_2 or blood pressure parameters. All variables showed significant time effects during surgery. Surgeon satisfaction and surgical field conditions were similar between groups. Postoperative complications were infrequent with cough observed only in the ETT group, and no cases of laryngospasm, bronchospasm, desaturation, or aspiration were recorded.

Conclusion

In selected pediatric patients undergoing laparoscopic appendectomy, LMA provided effective ventilation comparable to ETT while being associated with lower peak airway pressures. These findings suggest that LMA may be considered an alternative airway device in appropriately selected cases.

Introduction

Acute appendicitis is one of the most common causes of acute abdominal pain requiring surgical intervention in children (1, 2). It is characterized by acute inflammation of the vermiform appendix and remains a condition in which delayed diagnosis may result in increased morbidity. In most cases, the underlying mechanism involves obstruction of the appendiceal lumen, most commonly due to lymphoid hyperplasia or fecalith formation. Other causes, including foreign bodies and tumors are encountered less frequently (3). With the widespread adoption of laparoscopic techniques, laparoscopic appendectomy has become the first-line surgical approach, replacing open appendectomy in most cases. (4, 5) Minimally invasive laparoscopic techniques provide several benefits, including reduced surgical trauma due to smaller incisions, faster wound healing, less postoperative pain, earlier hospital discharge, and lower postoperative morbidity (6). But pneumoperitoneum during laparoscopy causes significant physiological changes in respiratory function, including increased peak airway pressure, reduced chest wall compliance, and impaired gas exchange, which may also increase the risk of pulmonary aspiration (6–8). In pediatric laparoscopic surgery, maintaining adequate ventilation and stable intra-abdominal conditions is essential for optimal surgical exposure and procedural safety. The choice of airway device may influence these conditions through its effects on airway pressure, ventilation, and the stability of pneumoperitoneum. However, data specifically addressing the impact of airway management on surgical conditions in pediatric laparoscopic appendectomy remain limited. For airway management during laparoscopic procedures, cuffed oral endotracheal tubes are most commonly preferred. Neuromuscular blocking agents (NMB) are also frequently administered to facilitate tracheal intubation and the surgical procedure. However, in recent years, the laryngeal mask airway (LMA) has increasingly been considered as an alternative for airway management in some laparoscopic surgeries (9–11). The LMA has several characteristics that make it an attractive alternative for airway management. It can be inserted easily without the need for neuromuscular blocking agents, provides better intraoperative haemodynamic stability and is associated with a lower incidence of postoperative respiratory complications. Moreover, it is associated with faster postoperative recovery, less impairment of mucociliary function and a lower incidence of postoperative sore throat. In recent years, numerous studies have reported the use of laryngeal mask airway (LMA) for airway management in adult patients undergoing lower abdominal procedures, laparoscopic cholecystectomy, and gynecologic laparoscopic surgeries (9, 12, 13). Studies conducted in paediatric populations have also suggested that LMA can provide safe and effective airway management in selected laparoscopic procedures. (7, 10, 11, 14). Although supraglottic airway devices have been evaluated in several pediatric laparoscopic procedures, evidence specifically addressing their use in pediatric laparoscopic appendectomy remains limited. Therefore, this study aimed to compare intraoperative respiratory and hemodynamic parameters, surgical conditions, and perioperative outcomes between pediatric patients managed with an LMA (without NMB) and those managed with an ETT (with NMB) during laparoscopic appendectomy.

Materials and Methods

This prospective observational comparative cohort study was conducted at the Department of Pediatric Surgery of Ankara University between February and December 2025, following approval by the local ethics committee. (Approval No: 20.02.2025 / İ02-130-25) and in accordance with the Declaration of Helsinki. Written informed consent was obtained from the parents or legal guardians of all participants before enrollment. The study is reported in accordance with the STROBE recommendations. A total of 64 pediatric patients aged between 2 and 18 years with an American Society of Anesthesiologists (ASA) physical status of I–II who were scheduled to undergo elective or emergency laparoscopic appendectomy were included. All patients underwent surgery in compliance with current guideline recommendations, with careful adherence to the prescribed preoperative fasting intervals (15). Airway management was determined by the attending anesthesiologist as part of routine clinical care without a predefined study-specific allocation protocol. Patients were subsequently categorized into the LMA or ETT group according to the airway device used. The decision was based on individual patient characteristics and the anesthesiologist's clinical assessment. The researcher did not assign the airway intervention. Patients were excluded if they declined participation, lacked parental consent, had an ASA physical status ≥ III, a history of upper respiratory tract infection within the preceding two weeks, known bronchial asthma or had a suspected difficult airway. Additional exclusion criteria included perforated appendicitis or the need for urgent surgery before completion of the recommended preoperative fasting interval and inability to establish intravenous access requiring induction with sevoflurane. Standard routine ASA monitoring, including electrocardiography (ECG), pulse oximetry (SpO_2) and noninvasive blood pressure (NIBP) was applied to all patients prior to induction of anesthesia. In all patients, iv lidocaine 1 mg/kg, propofol 2–3 mg/kg and fentanyl 1 µg/kg were administered. In the ETT group, rocuronium bromide was administered 0.6 mg/kg, whereas no rocuronium was administered in the LMA group. Prior to airway device (LMA or ETT) placement, an appropriately sized nasogastric (NG) tube was inserted for gastric decompression. Correct placement of the nasogastric tube was confirmed through epigastric auscultation and aspiration of gastric contents, and it remained in place until the surgery was completed. The appropriate endotracheal tube size was estimated using the formula 3.5 + (age in years/4), and tubes 0.5 size larger and 0.5 size smaller than the calculated value were kept available. Following intubation, bilateral auscultation was performed and the position of the endotracheal tube was adjusted accordingly before fixation.

LMA Classic™ (LMA North America, Inc., San Diego, CA, USA) (C-LMA) was used in all LMA groups. The appropriate laryngeal mask airway size was determined according to the manufacturer's recommended sizing guidelines. Patients in whom the LMA was successfully placed on the first or second attempt were included in the study. Cases requiring more than two insertion attempts or not ventilated effectively were excluded from the study and 0.6 mg/kg rocuronium was administered and patient intubated with appropriate size as mentioned above. Chest wall movement and capnography were used to confirm the successful placement of LMA. Ineffective ventilation with the LMA—defined as a tidal volume of less than 6–8 mL/kg, end tidal carbon dioxide ($EtCO_2$) value exceeding 45 mmHg, or SpO_2 value below 92 was considered a failed LMA placement. Following placement of the airway devices and ventilation, anesthesia was maintained in all patients using 1–1.5 MAC sevoflurane in a gas mixture containing 40%

oxygen. In both groups, mechanical ventilation parameters were set as follows; a tidal volume of 6–8 mL/kg and a positive end-expiratory pressure (PEEP) of 5 cmH_2O.

All operations were carried out under general anesthesia using a conventional laparoscopic appendectomy technique. Pneumoperitoneum was established by carbon dioxide insufflation and intra-abdominal pressure was maintained between 6 and 10 mmHg throughout the procedure in all patients. Demographic variables, heart rate (HR), mean arterial blood pressure (MAP), peripheral oxygen saturation (SpO_2), peak airway pressure (P peak), and $EtCO_2$ levels were recorded during surgery at predefined time points: baseline (t0: before airway intervention), after induction (t1), 1 minute after placement of the airway device and confirmation of effective ventilation (t2), before carbon dioxide insufflation (t3), 5 minutes following carbon dioxide insufflation (t4), after completion of desufflation (t5) and immediately prior to removal of the airway device (t6). At each time point, intra-abdominal pressure, peak airway pressure, driving pressure and $EtCO_2$ values were documented.

Postoperative pain control was achieved using local anesthetic infiltration at the trocar insertion sites together with intravenous paracetamol (10–15 mg/kg) and fentanyl (1 µg/kg). For prophylaxis against postoperative nausea and vomiting, intravenous ondansetron (0.1 mg/kg) and dexamethasone (0.15 mg/kg) were administered to all patients. In the ETT group, neuromuscular blockade was reversed with iv sugammadex (2–4 mg/kg).

During the recovery phase, respiratory complications such as laryngospasm, bronchospasm, coughing, breath-holding, and oxygen desaturation (SpO2 < 90%) were monitored and documented.

At the end of the surgery, surgeon satisfaction and the quality of surgical field visualization were evaluated using a four-point Likert scale. (1 = very poor, 2 = poor, 3 = good, 4 = excellent). Anesthesia and surgical duration, length of stay in the post-anesthesia care unit (PACU) and the presence of postoperative sore throat were recorded. Patients with a Modified Aldrete score of 9 or higher were considered fit for transfer from the recovery unit to the surgical ward. Postoperative nausea, vomiting, and sore throat were reassessed at the second postoperative hour.

Statistical Analysis

The sample size was determined using a power analysis based on detecting a difference between two independent groups, to compare the effects of LMA and ETT applications on respiratory parameters. Assuming a clinically meaningful moderate-to-large effect size (Cohen's d = 0.8), 5% type I error, and 90% power, the calculation determined that 34 patients per group would be sufficient.

Normality of continuous variables was assessed using the Shapiro–Wilk test. Variables with non-normal distribution were expressed as median (minimum–maximum), whereas categorical variables were presented as number and percentage.

Patient-level variables were compared between the ETT and LMA groups using the Mann–Whitney U test for continuous data, while categorical variables were analyzed with either the chi-square test or Fisher's exact test, as appropriate. Repeated intraoperative measurements were analyzed using a repeated-measures approach. Because linear mixed-effects models produced singular fit problems for some repeated variables in this dataset, generalized estimating equations (GEE) with an exchangeable correlation structure were used for the final repeated-measures analysis. The model included group, time, and group-by-time interaction. For peak airway pressure, an additional clinically relevant repeated-measures analysis was performed using post-airway time points only, because this variable is not physiologically applicable before airway device placement. A p-value of less than 0.05 was considered statistically significant.

The primary outcome was to evaluate differences in peak airway pressures after the placement of airway devices and during pneumoperitoneum.

Secondary outcomes included hemodynamic variables (heart rate and mean arterial pressure), respiratory parameters ($EtCO_2$ and SpO_2), perioperative durations, surgeon satisfaction scores, and postoperative complications.

Results

Between February and December 2025, 90 patients undergoing surgery for suspected acute appendicitis were assessed prospectively for eligibility. Twenty-six patients were excluded due to insufficient fasting time, suspected perforation or LMA/ETT placement failed after two attempts. A total of 64 patients were included in the final analysis, with 32 patients in each group (Fig. 1).

A total of 64 patients were included, with 32 patients in each group. Age was 11 (5–17) years in the ETT group and 9 (4–17) years in the LMA group (p = 0.191). Male sex was observed in 18 patients (56.3%) in the ETT group and 16 patients (50.0%) in the LMA group (p = 0.616) (Table 1).

Anesthesia duration was 90 (40–267) minutes in the ETT group and 77.5 (30–195) minutes in the LMA group (p = 0.210). Operation duration was 72.5 (11–245) minutes and 60 (20–180) minutes, respectively (p = 0.558). Recovery time was 10 (5–30) minutes in the ETT group and 10 (6–45) minutes in the LMA group (p = 0.107) (Table 1).

Surgeon satisfaction score was 4 (3–4) in the ETT group and 4 (2–4) in the LMA group (p = 0.291). Surgical field score was 4 (3–4) and 4 (2–4), respectively (p = 0.097). Aldrete score was 10 (8–10) in the ETT group and 10 (9–10) in the LMA group (p = 0.027) (Table 1).

Heart rate measurements were significantly elevated in the ETT group both after induction of anesthesia (t1) (110 (80–150) bpm vs. 100 (75–135) bpm; p = 0.003) and after LMA/ETT placement (t2) (115 (90–150) bpm vs. 102 (80–140) bpm; p = 0.016). Mean arterial pressure at t2 was 75 (60–95) and 73 (60–90), respectively (p = 0.42) (Table 2).

Peak airway pressure at t2 was 14 (10–20) in the ETT group and 11 (8–17) in the LMA group ($p < 0.001$). Before CO_2 insufflation (t3), values were 15 (10–22) and 13 (9–18), respectively ($p = 0.007$). 5 minutes after insufflation (t4), values were 17 (12–23) and 16 (11–21), respectively ($p = 0.046$). $EtCO_2$ at t2 was 36 (30–45) in the ETT group and 35 (30–45) in the LMA group ($p = 0.79$). At t3, values were 37 (30–45) and 37 (30–45), respectively ($p = 0.52$). At t4, values were 38 (32–46) and 39 (32–46), respectively ($p = 0.75$). SpO_2 was 99 (97–100) at t1 in the ETT group and 99 (98–100) in the LMA group ($p = 0.022$). (Table 2).

Graphical representation of repeated measurements is provided in Figs. 2–4. Peak airway pressure values were consistently higher in the ETT group across all time points (Fig. 2).

Cough was observed in 4 patients (12.5%) in the ETT group and 0 patients in the LMA group ($p = 0.113$). Nausea was observed in 3 patients (9.4%) in the LMA group and 0 patients in the ETT group ($p = 0.238$). Vomiting was observed in 1 patient (3.1%) in the LMA group and 0 patients in the ETT group ($p = 0.313$). No bronchospasm, laryngospasm, desaturation, or aspiration was observed in either group (Table 3).

In repeated-measures analysis using a generalized estimating equations (GEE) model, heart rate showed a significant group effect ($p = 0.011$), time effect ($p = 0.008$), and group-by-time interaction ($p = 0.025$), indicating a different temporal pattern between the groups. Peak airway pressure demonstrated a significant group effect ($p = 0.003$) and time effect ($p < 0.001$), with no significant interaction ($p = 0.186$) when all time points were included. When only post-airway time points were analyzed, peak airway pressure remained significantly lower in the LMA group ($p = 0.001$), with a significant time effect ($p < 0.001$) and no interaction ($p = 0.120$). End-tidal carbon dioxide ($EtCO_2$) showed a significant time effect ($p < 0.001$), without a significant group effect ($p = 0.462$) or interaction ($p = 0.359$), indicating comparable ventilation between groups. Peripheral oxygen saturation (SpO_2) showed a modest time effect ($p = 0.044$), with no significant group effect ($p = 0.125$) or interaction ($p = 0.091$). Systolic, diastolic, and mean arterial blood pressures demonstrated significant time effects ($p < 0.001$ for all), without significant group effects (SBP $p = 0.350$, DBP $p = 0.230$, MAP $p = 0.106$) or interactions (SBP $p = 0.258$, DBP $p = 0.309$, MAP $p = 0.095$) (Table 4).

Discussion

To the best of our knowledge, this is the first study that compared the use of a classic laryngeal mask airway (LMA) and an endotracheal tube (ETT) for airway management in pediatric laparoscopic appendectomy. The primary outcome of this study was peak airway pressure, which was lower in the LMA group compared to the ETT group after airway device placement and during pneumoperitoneum. This finding suggests that the use of LMA (without NMB agent) may provide favorable airway pressures under these conditions. Regarding secondary outcomes, heart rate differed between groups at early intraoperative time points, whereas $EtCO_2$, SpO_2, and blood pressure parameters did not differ significantly. Surgeon satisfaction and surgical field evaluation scores were similar between groups, and postoperative complication rates were low in both groups.

Repeated-measures analysis showed that heart rate changed differently over time in the two cohorts. The higher values observed after tracheal intubation may reflect the sympathetic response to airway instrumentation, although the non-randomized design prevents attribution of this difference to the device alone. Peak airway pressure, the primary outcome, remained consistently higher in the ETT group, supporting the association of LMA with lower airway pressures. The lack of a significant group-by-time interaction suggests that both groups followed a similar intraoperative course, and that the observed difference is more likely related to the airway device itself rather than to surgical factors such as pneumoperitoneum. In contrast, $EtCO_2$, SpO_2, and blood pressure values were similar between groups, indicating comparable ventilation and hemodynamic stability. Overall, these results suggest that LMA provides ventilation comparable to ETT, with the additional benefit of lower peak airway pressures.

An important observation in this study is that the use of a laryngeal mask airway did not adversely affect surgical field conditions, despite the differences observed in airway pressures. Despite the absence of muscle relaxant use in the LMA group, surgeon satisfaction and surgical field imaging scores were not found to be worse than in the ETT group. Therefore, it can be considered that LMA may provide adequate surgical conditions for operation in selected children. However, since the study was not randomized controlled trial and rocuronium was used only in the ETT group, we cannot say that the observed results were solely due to the airway device.

The results of this study revealed that in children undergoing laparoscopic appendectomy, use of a classic LMA without neuromuscular blocking agents provides effective ventilation and surgical conditions. Numerous studies have suggested that supraglottic airway devices can serve as effective alternatives to tracheal intubation in laparoscopic surgery. In elective and short-duration procedures such as inguinal hernia repair, orchidopexy, and hydrocele surgery, LMA has been reported to be a safe alternative for airway management (11, 14, 16, 17). Furthermore, a recent study involving 50 pediatric patients undergoing laparoscopic inguinal hernia repair reported that the adequacy of ventilation with LMA, as assessed by SpO_2 and $EtCO_2$ values, was comparable to that achieved with ETT. Similar to our findings, that study also reported higher peak airway pressures in the ETT group (18). The higher peak airway pressures observed in the ETT group may be related to the increased airway resistance created by the endotracheal tube, particularly in pediatric patients where smaller tube diameters are used. In contrast, supraglottic airway devices may generate less airway resistance and therefore require lower airway pressures during ventilation.

Although several reports support the use of LMA in elective, short-duration procedures, the available literature regarding its use in emergency settings remains limited. Fabregat-López and colleagues reported the use of the ProSeal LMA in 102 adult patients undergoing emergency lower abdominal surgery, the majority of whom underwent appendectomy (83 open and 12 laparoscopic) in carefully selected, fasted patients without additional risk factors for aspiration, surgery was completed without complications (13). In this series, ventilation and oxygenation parameters remained stable, no episodes of regurgitation or aspiration were reported, and the LMA was easily inserted, most often on the first attempt. However, this study was not specifically designed as a comparative study focused on

appendectomy. Despite the favourable outcomes reported in selected patient populations, a case report has described the development of acute respiratory distress syndrome (ARDS) secondary to pulmonary aspiration during adult laparoscopic appendectomy performed using a ProSeal LMA. In that report, pneumoperitoneum, the Trendelenburg position, and the underlying pathology were emphasized as factors that may increase the risk of regurgitation (20). The primary concerns regarding the use of LMA during laparoscopy include the potential inability to maintain effective ventilation and the possibility that supraglottic sealing pressure may be insufficient to prevent regurgitation and aspiration in the presence of increased intra-abdominal pressure. In light of these concerns, particular care was taken to ensure that all children adhered to guideline-recommended preoperative fasting times: 2 hours for clear fluids, 3 hours for breast milk, 4 hours for formula milk, and 6 hours for solid food (15). Patients with perforation or those in whom adequate fasting time could not be ensured were excluded from the study. In addition, in both groups, a nasogastric tube was inserted immediately before placement of the airway device to provide gastric decompression. As a result, no intraoperative regurgitation or aspiration was observed; however, the sample size was insufficient to draw conclusions regarding rare safety outcomes.

The increase in intra-abdominal pressure during pneumoperitoneum restricts diaphragmatic movement and leads to elevated peak airway pressures. These physiological changes raise concerns regarding the safe use of supraglottic airway devices during laparoscopic procedures. In our study, peak airway pressures measured after airway device placement, before insufflation, after insufflation, and throughout the surgical procedure were found to be statistically significantly lower in the LMA group compared with the ETT group. Consistent with our findings, studies in pediatric inguinal hernia surgery have shown that peak airway pressures tend to be lower in patients with LMA (14, 18). Also in both groups, $EtCO_2$ levels remained within normal limits, and no evidence of carbon dioxide retention was observed. These findings are consistent with results reported in previous studies in the literature (11). In our study, pneumoperitoneum was initiated only after effective ventilation through the LMA had been confirmed. We therefore believe that this approach contributed to maintaining $EtCO_2$ levels within normal limits. In a recent meta-analysis conducted by Anjishnujit Bandyopadhyay et al. (7), 8 randomized controlled trials including a total of 591 paediatric patients undergoing laparoscopic surgery were evaluated. This analysis compared supraglottic airway devices with tracheal intubation. No significant differences were found between the groups in terms of peak airway pressures and end-tidal CO_2 values measured during pneumoperitoneum, demonstrating comparable ventilatory efficacy under conditions of increased intra-abdominal pressure. In our cohort, $EtCO_2$ values were also similar between the groups, although peak airway pressure was lower in patients managed with an LMA. Differences in the surgical procedures, airway devices, ventilation strategies, and patient selection may account for this discrepancy.

Recent meta-analyses evaluating the effects of supraglottic airway devices (SGA) on respiratory and haemodynamic responses compared with tracheal intubation have suggested that the use of SGAs may offer several perioperative advantages. In a comprehensive meta-analysis including sixteen randomized controlled trials (16), patients managed with LMA demonstrated lower heart rate variability, a significantly reduced incidence of hypoxaemia and postoperative cough, and a higher success rate of

airway placement on the first attempt. In contrast, no significant differences were observed between LMA and endotracheal tube use with respect to complications such as bronchospasm, sore throat, mucosal injury, nausea and vomiting, or reflux/aspiration. Our findings are consistent with the results of this meta-analysis. In our study, heart rate values were higher in the ETT group than in the LMA group after induction and following intubation, which may be related to the secondary sympathetic response triggered by tracheal intubation. Additionally, postoperative cough was observed in four patients in the ETT group, whereas no cases of cough or sore throat were reported in the LMA group. These observations are in agreement with findings from previous studies in the literature (16, 22).

The effect of neuromuscular blockade on surgical conditions and complications in laparoscopic procedures performed with supraglottic airway (SGA) devices remains controversial. Wu et al. investigated pediatric laparoscopic inguinal hernia repair in which neuromuscular blocking agents were administered in one group, whereas airway management in the other group was achieved using a ProSeal LMA without neuromuscular blockade (17). They reported that surgical conditions and peak airway pressures were influenced primarily by the presence of neuromuscular blockade rather than by the airway device itself. In addition, the use of muscle relaxants was associated with improved surgical conditions. In contrast to these findings, no neuromuscular blocking agents were used in the LMA group in our study; nevertheless, surgical satisfaction was similar to that in the ETT group. Although duration of anesthesia and operation were shorter in the LMA group, the differences were not statistically significant. As these durations are influenced by multiple factors, including surgical experience and patient-related variables, they cannot be attributed solely to the airway management technique. Recovery time was longer in the LMA group, although the difference did not reach statistical significance. Because neuromuscular blockers were not administered in this group, a deeper anesthetic level may have been necessary, potentially contributing to delayed recovery. Anesthesia was maintained in all patients using 1–1.5 MAC sevoflurane but the lack of BIS monitoring is therefore an important limitation of this study. Nevertheless, the similarity in recovery times between groups and the absence of prolonged recovery in the ETT group may be explained by our routine use of sugammadex as the reversal agent. As demonstrated in previous studies, the use of sugammadex has been associated with a shorter recovery time following neuromuscular blockade (23).

Although many studies have preferred second-generation LMAs, we used a classic LMA in our study. Second-generation supraglottic airway devices are designed to enhance safety against aspiration through features such as a gastric drainage channel and higher sealing pressures. However, due to its simpler design, the classic LMA has been associated in several studies with a higher first-attempt success rate and shorter insertion time compared with second-generation devices such as the ProSeal (24, 25). In our clinical practice, the classic LMA is more commonly used and is associated with a higher rate of successful placement on the first attempt; therefore, it was preferred in this study. Consistent with this experience, LMA placement was successful on the first attempt in all patients, and no cases of gastric regurgitation were encountered. In order to achieve the advantage provided by second-generation SGAs, a nasogastric tube was inserted before placement of the airway device in both groups. None of the patients in our study experienced laryngospasm, bronchospasm, or desaturation. Sore throat was

not observed at any of the assessed time intervals. In light of our findings, we believe that this study provides a limited yet clinically meaningful contribution to the existing literature by demonstrating that, in appropriately selected pediatric patients undergoing laparoscopic appendectomy and with strict adherence to guideline-recommended fasting protocols, airway management with LMA can ensure adequate ventilation without increasing the risk of perioperative respiratory complications while also providing adequate surgical conditions.

Limitations

This study has several limitations. Airway management was performed by anesthesiologists with similar clinical experience. In keeping with the observational design, the choice between LMA and ETT was based on routine clinical assessment rather than random allocation. In addition, blinding of anesthetic management was not feasible due to the inherent nature of the airway interventions. Although the surgeons were aware of the airway device used (LMA or ETT), they were not aware that neuromuscular blockade was not administered in patients in the LMA group. Another important limitation of the study is the lack of bispectral index (BIS) monitoring for the assessment of anesthetic depth. The relatively small sample size limited the evaluation of uncommon complications such as aspiration, laryngospasm, and bronchospasm. Nevertheless, prospective data collection and standardized perioperative protocols helped reduce variability between the groups.

Conclusion

In this study, classic laryngeal mask airway use provided effective ventilation with lower airway pressures and fewer airway events during recovery in pediatric laparoscopic appendectomy. Considering the comparable surgical conditions and recovery profiles, LMA may serve as an alternative airway device in selected pediatric patients undergoing short-duration laparoscopic surgery. This approach may also prevent a potentially serious postoperative complication associated with muscle relaxant use and intubation. In appropriately selected children who adhere to preoperative fasting recommendations, LMA may be a reasonable alternative to endotracheal intubation. However, further randomized studies are needed to clarify whether the differences observed in this study are related to the airway device itself.

Abbreviations

HR
heart rate
Ppeak
peak airway pressure
$EtCO_2$
end-tidal carbon dioxide
SpO_2

peripheral oxygen saturation
SBP
systolic blood pressure
DBP
diastolic blood pressure
MAP
mean arterial pressure.

Declarations

Ethics approval and consent to participate. This study was approved by the Ankara University Institutional Review Board (Approval No: 20.02.2025 / İ02-130-25). All stages complied with the Declaration of Helsinki and the Guideline for Good Clinical Practice. Informed consent was obtained from the included patients.

Consent for publication. Not applicable; only demographic and clinical data were used. A copy of the informed consent form can be provided on request.

Availability of data and materials. The datasets generated and analysed during the current study are not publicly available because they contain potentially identifying clinical information, but a fully de-identified version, together with the statistical analysis files, is available from the corresponding author (Fatmanur Duruk Erkent, nurerkent@gmail.com) on reasonable request. Requests will be reviewed in accordance with the policies of the Ankara University Institutional Review Board, and data will be shared following completion of a data-sharing agreement.

Competing interests. The authors declare that they have no competing interests.

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Tables

Table 1. Baseline and Perioperative Data

Variable	ETT (n=32)	LMA (n=32)	p value
Age (years)	11 (5–17)	9 (4–17)	0.191
Male, n (%)	18 (56.3%)	16 (50.0%)	0.616
Anesthesia duration (min)	90 (40–267)	77.5 (30–195)	0.210
Operation duration (min)	72.5 (11–245)	60 (20–180)	0.558
Recovery time (min)	10 (5–30)	10 (6–45)	0.107
Surgeon satisfaction	4 (3–4)	4 (2–4)	0.291
Surgical field score	4 (3–4)	4 (2–4)	0.097
Aldrete score	10 (8–10)	10 (9–10)	***0.027***

Abbreviations: LMA, laryngeal mask airway; ETT, endotracheal tube; min, minimum; max, **maximum. Values are presented as median (min–max) or n (%).**

Mann–Whitney U test
Chi-square test

A p-value < 0.05 was considered statistically significant.

Table 2. Intraoperative parameters

Parameter	Time	ETT	LMA	p value
HR	t1	110 (80–150)	100 (75–135)	**0.003**
	t2	115 (90–150)	102 (80–140)	0.016
Ppeak	t2	14 (10–20)	11 (8–17)	**<0.001**
	t3	15 (10–22)	13 (9–18)	**0.007**
	t4	17 (12–23)	16 (11–21)	0.046
$EtCO_2$	t2	36 (30–45)	35 (30–45)	0.79
	t3	37 (30–45)	37 (30–45)	0.52
	t4	38 (32–46)	39 (32–46)	0.75
SpO_2	t1	99 (97–100)	99 (98–100)	0.022
MAP	t2	75 (60–95)	73 (60–90)	0.42

Abbreviations: HR, heart rate; Ppeak, peak airway pressure; MAP, mean arterial pressure; $EtCO_2$, end-tidal carbon dioxide; SpO_2, peripheral oxygen saturation.Values are presented as median (min–max).

 Mann–Whitney U test p-value < 0.05 was considered statistically significant.

Table 3. Postoperative Complications

Outcome	ETT (n=32)	LMA (n=32)	p value
Cough	4 (12.5%)	0 (0%)	0.113
Nausea	0 (0%)	3 (9.4%)	0.238
Vomiting	0 (0%)	1 (3.1%)	0.313
Respiratory complications	0 (0%)	0 (0%)	—

Abbreviations: LMA, laryngeal mask airway; ETT, endotracheal tube.

Values are presented as n (%).

 Fisher's exact test

A p-value < 0.05 was considered statistically significant.

Table 4. Repeated Measures Analysis (GEE model)

Variable	Group effect (p)	Time effect (p)	Group × Time (p)
HR	**0.011**	**0.008**	**0.025**
Ppeak (all time points)	**0.003**	**<0.001**	**0.186**
Ppeak (post-airway)	**0.001**	**<0.001**	**0.120**
$EtCO_2$	**0.462**	**<0.001**	**0.359**
SpO_2	**0.125**	**0.044**	**0.091**
SBP	**0.350**	**<0.001**	**0.258**
DBP	**0.230**	**<0.001**	**0.309**
MAP	**0.106**	**<0.001**	**0.095**

Abbreviations: HR, heart rate; Ppeak, peak airway pressure; $EtCO_2$, end-tidal carbon dioxide; SpO_2, peripheral oxygen saturation; SBP, systolic blood pressure; DBP, diastolic blood pressure; MAP, mean arterial pressure.

Repeated measures were analyzed using generalized estimating equations (GEE) with an exchangeable correlation structure. The model included group (ETT vs LMA), time (t0–t6), and group-by-time interaction terms.

Figures

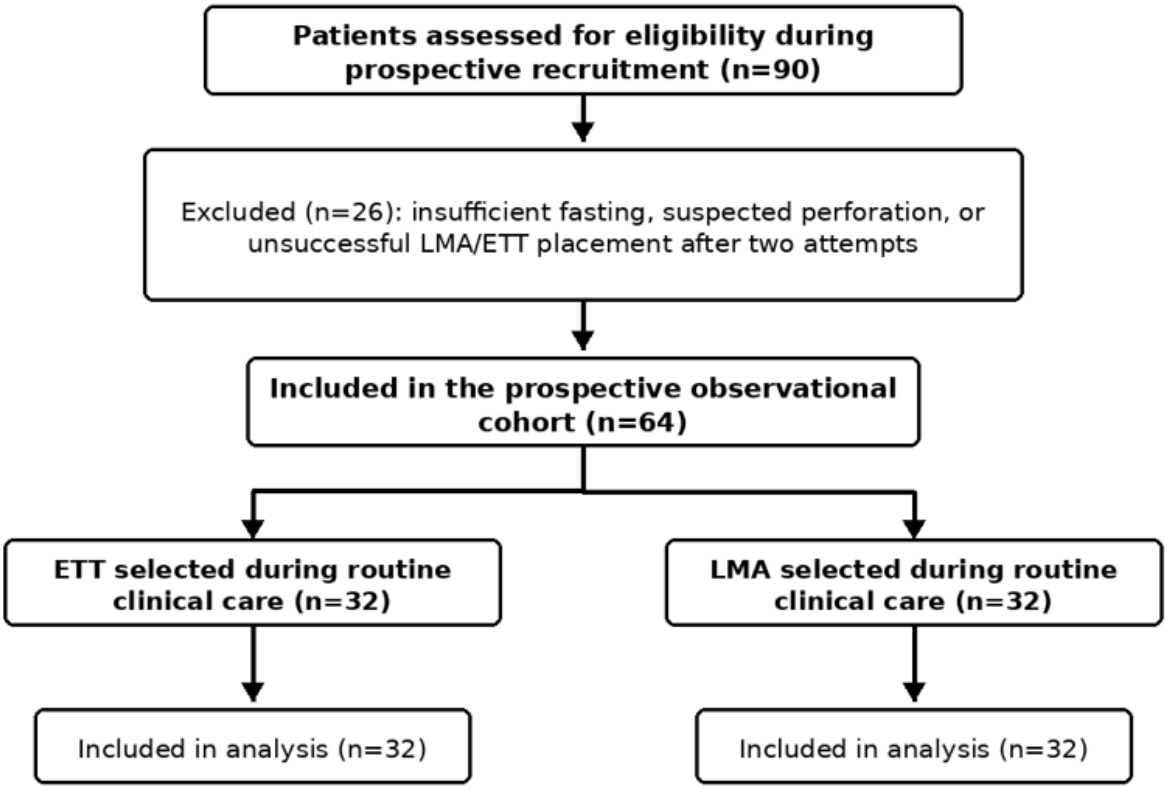

Figure 1

Participant flow for the prospective observational cohort

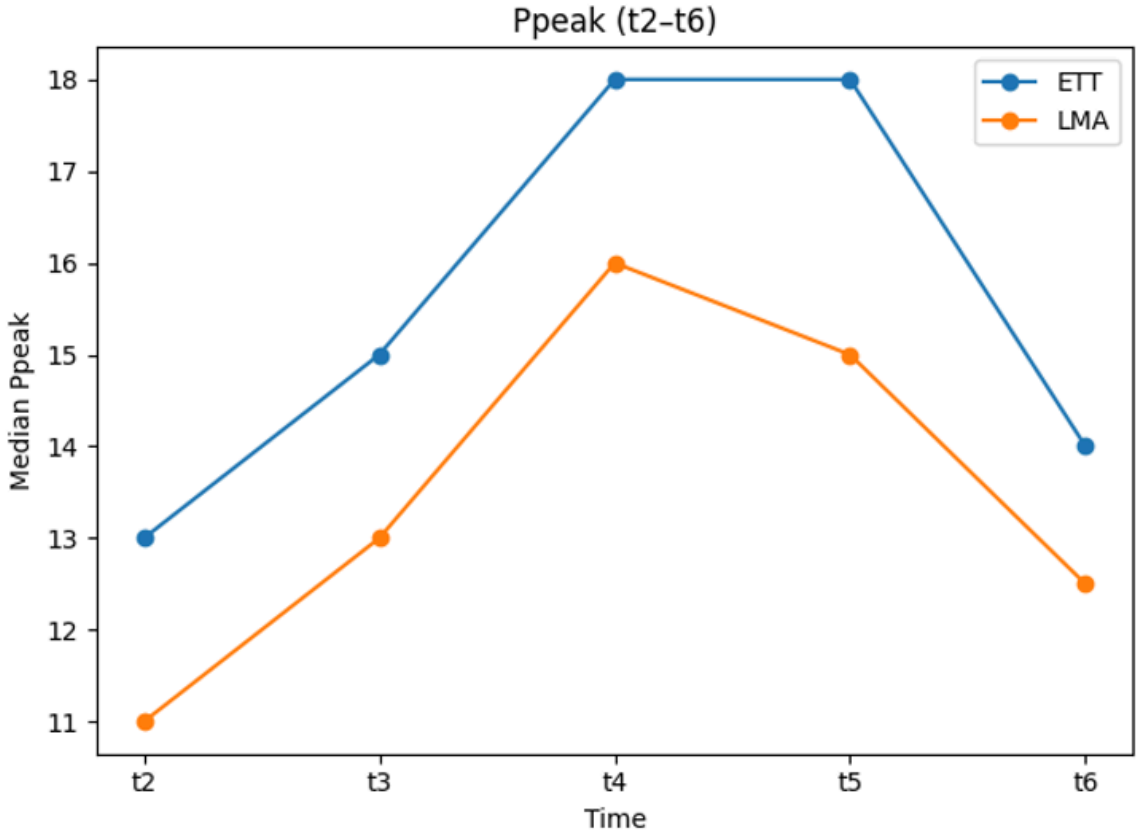

Figure 2

Median peak airway pressure (Ppeak) over time in LMA and ETT groups

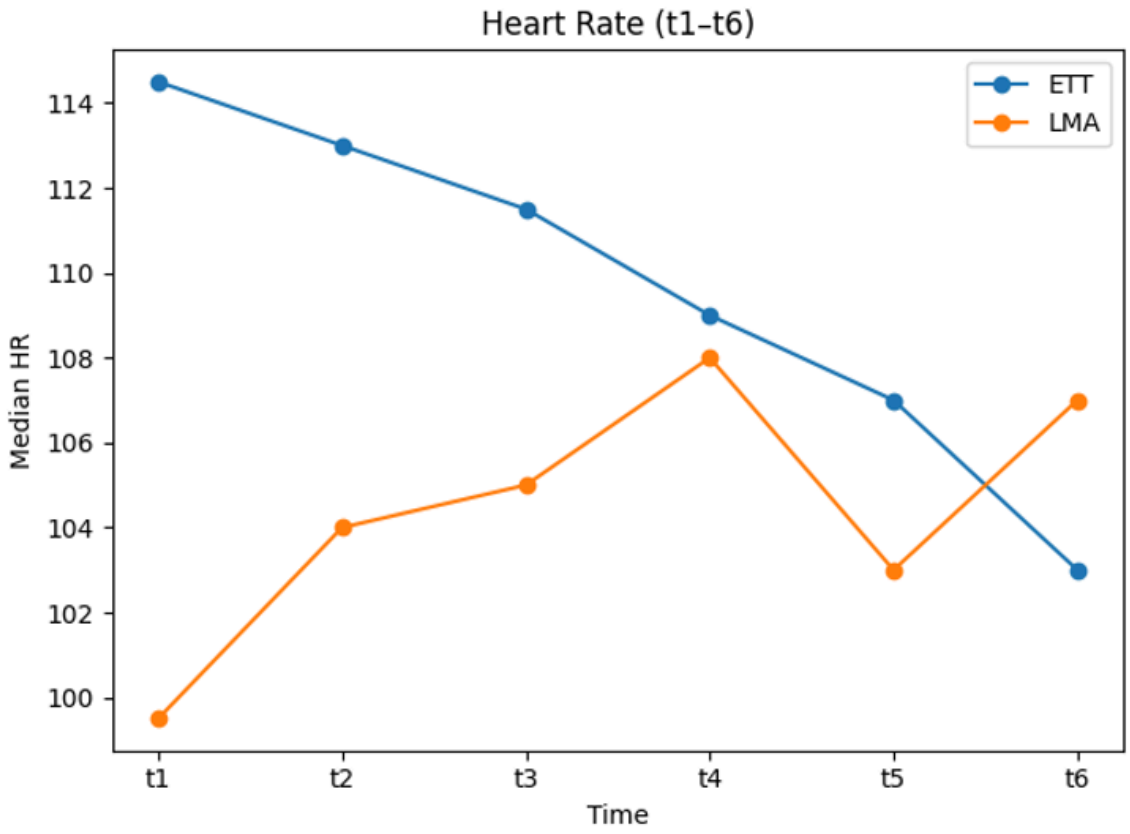

Figure 3

Median heart rate (HR) over time in the LMA and ETT groups.