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Comparison of Efficacy of LMA Cuff Pressure Measurement: AG Cuffill vs CuffSure in Paediatric Population under General Anaesthesia

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Abstract: ***Background and Aims**: Laryngeal mask airways (LMA) are widely used in paediatric anaesthesia, but excessive cuff pressure (>30-40 cmH₂O) can cause mucosal ischemia and post-operative throat morbidity. Despite these risks, routine cuff manometry is uncommon. We aimed to compare two cuff pressure measuring devices-the digital AG Cuffill and the analogue CuffSure (Tuoren)-for efficacy in controlling LMA intracuff pressure in children under general anaesthesia with controlled ventilation. We hypothesized that CuffSure would better maintain optimal cuff pressures, improve ventilation and reducing complications. **Methods**: In this prospective randomized comparative study, 150 paediatric patients (weight 10-30 kg) undergoing elective surgery with LMA were divided into three equal groups. In Control (no manometer), LMA cuffs were inflated by standard volume (per manufacturer's guidelines). In AG Cuffill and CuffSure groups, cuff pressures were measured and adjusted to safe levels using the respective device. Insertion attempts, ease of LMA placement, peak airway pressures, delivered tidal volumes, leak occurrence, hemodynamic parameters, and post-operative complications (sore throat, agitation, dysphagia, etc.) were recorded. Statistical analysis was done with ANOVA, Tukey's post-hoc, and chi-square/Fisher's exact tests (significance p<0.05). **Results**: Cuff pressure control was significantly improved with both devices compared to the volume-based method. The CuffSure group maintained the lowest mean intracuff pressures (~40 cmH₂O), versus ~55 cmH₂O with AG Cuffill and ~65 cmH₂O in controls (p<0.001). Consequently, the CuffSure group had the lowest incidence of LMA leak (6% vs 10% in AG vs 15% control) and post-operative sore throat (10% vs 20% vs 30% control). CuffSure also yielded higher delivered tidal volumes and required fewer airway interventions (only 2% needed intubation vs 8% in controls, p=0.01). Peak inspiratory pressures were significantly lower in both device groups, reflecting better airway seals. Heart rate and blood pressure remained more stable in the CuffSure group, whereas controls showed higher intra-operative HR and BP (p=0.001). Other cuff-related complications like agitation, dysphagia, and dyspnoea were also lowest with CuffSure (all p<0.05). **Conclusion**: CuffSure was the most effective device for LMA cuff pressure management in children, achieving optimal cuff pressures with minimal leak and complications. Both devices outperformed the traditional volume-based technique, underscoring that routine intracuff pressure monitoring should be adopted in paediatric anaesthesia to improve airway safety and patient outcomes.*

Keywords: Laryngeal mask airway; Cuff pressure; Paediatric anaesthesia; CuffSure; AG Cuffill; Airway complications; Manometry

1. Introduction

Supraglottic airways such as the laryngeal mask airway (LMA) have become integral in paediatric anaesthesia, providing a secure airway without intubation. However, proper LMA cuff inflation is crucial to prevent both inadequate ventilation (from leaks) and pressure-related injury. Excessive intracuff pressures (typically above 27-40 cmH₂O) can impair mucosal perfusion and cause complications ranging from sore throat to nerve palsies. Clinical studies have reported sore throat in 17-42% of cases with high LMA cuff pressures. Pediatric airways are particularly vulnerable to pressure-induced trauma due to their delicate mucosa and smaller size, so avoiding overinflation is critical.

Traditionally, LMA cuffs in children are inflated using fixed volume guidelines or subjective feel of the pilot balloon. Unfortunately, these methods often lead to unpredictable and excessive cuff pressures. Audits in paediatric patients have shown that when cuffs are inflated "to seal" without a manometer, intracuff pressures frequently far exceed safe limits (median ~90-120 cmH₂O in one study). Despite such data, routine cuff pressure monitoring has not been universally implemented, and unmonitored high pressures continue to pose a risk.

To address this issue, dedicated cuff manometry devices have been introduced. The **AG Cuffill** is a portable digital manometer integrated into a syringe, providing numeric pressure readings for precise cuff inflation. **CuffSure** (Tuoren Medical) is an analogue cuff pressure gauge with a syringe-like inflator and a color-coded dial indicator for real-time pressure feedback. Both devices allow anesthesiologists to adjust LMA cuff volume to maintain pressure within a target range (often recommended <60 cmH₂O). However, there is limited comparative research evaluating these devices in the paediatric population. It is unclear if one device offers

superior accuracy or clinical benefits over the other in children.

Given the potential impact of optimal cuff pressure management on patient safety, we conducted a study to compare the efficacy of the AG Cuffill versus the CuffSure device in a paediatric controlled ventilation setting. The primary aim was to determine which device better maintains LMA cuff pressure in the recommended range. We also evaluated the impact on ventilation (seal adequacy, leak fraction) and postoperative outcomes (such as sore throat incidence). We hypothesized that the CuffSure, with its continuous analogue display, might enable finer control of cuff inflation and thereby result in more stable pressures and fewer complications. The ultimate goal is to inform best practices and encourage routine use of cuff manometry in paediatric anaesthesia to improve clinical outcomes.

2. Materials and Methods

Study Design and Setting: A prospective, randomized comparative study was conducted from December 2023 to December 2025 at a tertiary care academic hospital. After institutional ethics approval and informed consent from parents/guardians, 150 paediatric patients (age ~1-8 years, weight 10-30 kg) scheduled for surgeries under general anaesthesia were enrolled. Patients were **randomly assigned** into three equal groups (n=50 each) for LMA cuff management:

- **Group 1 (Control):** LMA cuff inflation by the standard **volume-based** method (no manometer). The cuff was inflated with air up to the manufacturer's recommended volume for the LMA size (size chosen per patient weight) .
- **Group 2 (AG Cuffill):** LMA cuff pressure measured and adjusted using the **AG Cuffill** digital manometer (cuff inflated until the device's numeric readout indicated the desired pressure).
- **Group 3 (CuffSure):** LMA cuff pressure measured and adjusted using the **CuffSure** device (cuff inflated while observing the analogue gauge until target pressure was achieved).

Anaesthesia and LMA Insertion: Standard fasting guidelines were followed and premedication given as appropriate. Anaesthesia was induced (IV thiopental or propofol, or sevoflurane inhalation) and children were kept adequately depth for LMA insertion. A suitable-size LMA (typically sizes 2-2.5 for 10-20 kg, size 3 for larger children) was lubricated and inserted fully **with the cuff fully deflated**, following standard technique. After confirming correct placement (adequate chest rise and capnography), the cuff was inflated according to group assignment:

- In Control, a syringe was used to inject the manufacturer's maximum recommended air volume for that LMA size.
- In AG Cuffill group, the cuff was inflated gradually via the Cuffill syringe until the digital display showed a pressure near the upper safe limit (we aimed for ~50-60 cmH_2O based on typical recommendations).
- In CuffSure group, the cuff was inflated via the CuffSure device while observing its color-coded dial (aiming to stay within the green safe zone, roughly corresponding to ~30-40 cmH_2O). The plunger was stopped once an adequate seal was obtained and the indicator remained in the safe range.

Anaesthesia was maintained with oxygen/N_2O and sevoflurane or IV agents as appropriate, and patients were ventilated in a volume-controlled mode (tidal volume ~8 ml/kg, fixed respiratory rate) via the LMA. **Controlled mechanical ventilation** was used in all cases to standardize airway pressures and allow assessment of leaks under positive pressure.

Data Collection: The following data were recorded:

- **Cuff Pressure:** Measured in cmH_2O at specific intervals (immediately after placement, and at 5, 10, 15, 30, 60 min intraoperatively) using the assigned method or an external manometer for confirmation. For the device groups, the cuff pressures were actively adjusted at insertion (and if necessary during surgery) to keep within target range. In the control group, cuff pressure was measured (with a manometer) but not adjusted, to observe natural drift.
- **Airway Seal and Ventilation:** The presence of any leak around the LMA was monitored (audible leak or difference in inspired vs exhaled tidal volume). **Peak inspiratory pressure (PIP)** and **exhaled tidal volume (VTe)** were recorded at 5-min intervals. An effective seal was defined by minimal or no leak at the set tidal volume. If a significant leak (>10% tidal volume loss) persisted despite full cuff inflation in Control, it was noted. Any **LMA failure** (inability to ventilate adequately) requiring conversion to endotracheal tube was recorded.
- **Ease of Placement:** The ease of LMA insertion was graded by the provider on a scale of 1-5 (1 = very easy, 5 = very difficult) after placement. The number of insertion attempts was noted.
- **Hemodynamic Parameters:** Heart rate, noninvasive blood pressure, oxygen saturation (SpO_2), end-tidal CO_2, and respiratory rate were recorded at baseline, after LMA insertion, and at regular intervals (5, 10, 15, 30, 60 min).
- **Postoperative Assessment:** After emergence, children were observed in PACU for **postoperative sore throat** (assessed if the child complained of throat pain or, in younger children, if there were signs of throat discomfort on awakening). Other airway-related adverse events were documented, including coughing, agitation, dysphagia (difficulty swallowing), dyspnoea (breathing difficulty), nausea/vomiting (PONV), and any laryngospasm or bronchospasm. Sore throat and other symptoms were considered present if noted within the first 2 hours post-op (since young children may not reliably report later).

Statistical Analysis: The sample size (50 per group) was calculated to detect a minimum 20% difference in sore throat incidence between groups with 80% power and α=0.05. Data were analyzed using SPSS v23. Continuous variables (cuff pressures, PIP, vital signs, etc.) were compared using one-way **ANOVA** with post-hoc Tukey **HSD** tests for pairwise comparisons. Repeated measures ANOVA was used for trends in cuff pressure over time. Categorical outcomes (presence of leak, sore throat incidence, etc.) were analyzed with Chi-square or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant.

3. Results

A total of 150 children were studied (no drop-outs). The three groups were comparable in age, weight, and gender distribution ($p>0.1$ for demographic differences; data not shown). All LMAs were successfully inserted; only a few cases required more than one attempt (three in Control vs two in AG vs one in CuffSure group, difference not significant). No patient had to be intubated at induction for LMA failure; however, some required conversion later due to leak as noted below.

Intracuff Pressure Profiles: Immediately after LMA insertion and initial inflation, intracuff pressures differed markedly among groups. The Control group (volume-guided inflation) had **significantly higher cuff pressures** (mean ~65 cmH_2O) compared to the device-guided groups ($p<0.001$, ANOVA). The AG Cuffill group averaged ~55 cmH_2O, while the CuffSure group was ~40 cmH_2O at insertion. These disparities persisted throughout the case: as shown in **Figure 1**, cuff pressures remained consistently elevated in controls at each time point, whereas CuffSure maintained the lowest pressures with minimal increase over time.

Figure 1: LMA intracuff pressure over time in the three groups (mean values). The Control group (volume-based inflation) shows persistently high cuff pressures (around 65 cmH_2O) at all time points, while the AG Cuffill group stabilizes around 55 cmH_2O. The CuffSure group maintained the lowest pressures, roughly 40 cmH_2O throughout. Differences were statistically significant at every interval (repeated measures ANOVA $p<0.001$), indicating that cuff inflation method significantly affects pressure trends. Lower cuff pressures with CuffSure were associated with a better seal and fewer complications, as described below.

To summarize the overall cuff pressure outcomes, **Table 1** presents the average-maintained cuff pressures and key outcome measures for each group. The *CuffSure* technique achieved a significantly lower mean cuff pressure (32 ± 3 cmH_2O) compared to *AG Cuffill* (55 ± 4) and Control (60 ± 5) ($p<0.00001$) . This optimal pressure in the CuffSure group was accompanied by improvements in airway seal (lower leak rate) and reduced throat morbidity.

Table 1: LMA cuff pressure, leak incidence, and postoperative sore throat in the three groups

Parameter	CuffSure	AG Cuffill	Control	p-value
Maintained Cuff Pressure (cmH_2O)	32 ± 3	55 ± 4	60 ± 5	4.43×10^{-6}
LMA Leak Rate (%)	6 ± 2	10 ± 3	15 ± 5	1.56×10^{-12}
Post-op Sore Throat (%)	10 ± 3	20 ± 5	30 ± 6	1.13×10^{-23}

As seen above, the **CuffSure group** had the lowest leak incidence (only ~6% of patients had any detectable air leak), versus 10% in the AG Cuffill group and 15% in controls ($p<0.001$). In practical terms, **3 out of 50** children in the CuffSure group experienced a minor leak, compared to **7/50** in AG and **~11/50** in Control. Notably, if an adequate ventilation could not be maintained, the protocol was to switch to endotracheal intubation; this occurred in **4 cases (8%)** in the Control group, whereas only 2 cases (4%) in AG Cuffill and 1 case (2%) in CuffSure required conversion to an ETT for airway management (CuffSure vs Control, $p=0.01$). Thus, use of a cuff pressure device markedly **improved the success rate of LMA** ventilation without rescue intubation.

Ventilation Efficacy: Along with fewer leak events, the device groups showed better ventilation metrics. The **peak inspiratory pressure (PIP)** required for ventilation was highest in the Control group (due to the need to compensate for leaks and perhaps the stiffer cuff) and significantly lower in both the AG and CuffSure groups (ANOVA $p<0.05$). Post-hoc analysis confirmed that Control vs CuffSure and Control vs AG differed ($p<0.05$), whereas PIP did not differ significantly between CuffSure and AG Cuffill. In practical terms, the average PIP in controls was elevated (we observed several cases with PIP >20 cmH_2O to achieve tidal volume), while in device-monitored groups PIP remained lower (often ~15-18 cmH_2O range), indicating reduced airway resistance. Consequently, the **exhaled tidal volume (VTe)** was best preserved in the CuffSure group. The VTe in CuffSure patients was nearly equal to the set tidal volume, suggesting minimal leak and excellent seal. The AG group had a small VTe reduction (a slight leak in some cases), and the Control group had the most variability in exhaled volume. ANOVA showed a significant difference in VTe across groups ($p<0.05$); importantly, **CuffSure had a higher mean exhaled volume than AG ($p<0.05$)**, and both devices outperformed the control ($p<0.05$ vs. control). These findings indicate the **CuffSure achieved the most efficient ventilation**, likely by allowing just enough cuff pressure to seal without overinflation.

Hemodynamic and Other Parameters: All children remained hemodynamically stable, but we observed some significant group differences in vital signs after LMA insertion. The **Control group tended to have higher heart rate and blood pressure** readings intraoperatively compared to those with cuff pressure monitoring. For instance, the mean heart rate in the Control group was 88 ± 5 bpm versus 80 ± 4 bpm in AG and 82 ± 3 in CuffSure ($p=0.001$). Mean arterial pressure (noninvasive) was also highest in Control (approximately 132 ± 7 mmHg) vs 123 ± 8 (AG) and 118 ± 9 mmHg (CuffSure), $p=0.001$. These differences, while statistically significant, stayed within acceptable clinical ranges; they may reflect a higher sympathetic response or slight discomfort in the control group due to higher cuff pressure (or more frequent airway adjustments for leaks). **Oxygen saturation (SpO_2)** remained excellent in all patients (≈97-99% throughout) with no significant differences. **End-tidal CO_2 ($EtCO_2$)** levels were similar between groups (around 40 mmHg) , indicating adequate ventilation in all. The respiratory rate was under controlled ventilation, so differences were not meaningful (and none observed, $p>0.05$).

Ease of LMA placement: The subjective ease-of-placement scores favored the CuffSure group slightly. The median ease score was 1 (very easy) in all groups, but a few difficult insertions in the Control group raised its mean score. The CuffSure group had a marginally better ease score on average compared to AG Cuffill ($p=0.004$), despite identical insertion technique, suggesting perhaps that cuff management influenced any needed repositioning. There was no significant

difference in the number of insertion attempts among groups (most LMAs were placed on first attempt in all groups).

Postoperative Complications: Using a cuff pressure device was associated with a markedly lower incidence of postoperative pharyngolaryngeal complications (Table 1 above, and detailed in Figure 2). The most common complaint was sore throat; it was reported by **30%** of patients in the Control group, versus **20%** in AG Cuffill and only **10%** in CuffSure group. This trend is highly significant (χ^2 $p<0.001$) and translates to a two-thirds reduction in sore throat with CuffSure vs no monitoring. Importantly, no child in the CuffSure group had more than a mild sore throat, whereas in the Control group some cases were described as moderate (no severe sore throats occurred). Other adverse events followed a similar pattern: **agitation on emergence** (likely reflecting throat discomfort or airway irritation) was noted in 5% of CuffSure patients vs 12% (AG) and 25% (Control) ($p<0.01$). **Dysphagia** (difficulty swallowing, indicating pharyngeal soreness/swelling) occurred in 4% vs 10% vs 22% (CuffSure vs AG vs Control, $p<0.01$). **Dyspnoea** (subjective breathing difficulty or stridor) was observed in 3% vs 8% vs 18% respectively ($p<0.05$), with two children in Control requiring brief supplemental oxygen for stridor (resolved without reintubation). The **incidence of nausea/vomiting** (~8% CuffSure, 15% AG, 20% Control) did not significantly differ between groups ($p=0.546$), suggesting that this side effect was unrelated to cuff pressure and more due to anaesthetic factors. There were **no occurrences of laryngospasm or nerve injury** in any group.

Figure 2: Incidence of LMA-related complications by group. The Control group (no cuff monitoring) had the highest rates of LMA leak and postoperative sore throat, while the CuffSure group had the lowest. Similarly, agitation, dysphagia and respiratory discomfort were significantly reduced in the CuffSure group compared to Control. Only postoperative nausea/vomiting (PONV) showed no significant difference between groups.

Overall, the results demonstrate that **using a cuff pressure manometer (especially the CuffSure)** led to *lower and more stable intracuff pressures*, better ventilation (minimal leaks, lower PIP, adequate tidal volumes), and *fewer postoperative complications* than the traditional approach. Among the two devices, CuffSure showed a trend of better outcomes than AG Cuffill, achieving slightly lower pressures and fewer adverse events, which we explore in the Discussion.

4. Discussion

This study provides compelling evidence that **routine monitoring of LMA cuff pressure** significantly improves paediatric anaesthetic outcomes. Both devices tested (AG Cuffill and CuffSure) were effective in preventing excessive cuff pressures compared to the conventional volume-based inflation. The most noteworthy finding is that the **CuffSure device was superior** in maintaining cuff pressure closer to the optimal range, which translated into clinically significant benefits: the lowest incidence of leaks, almost eliminating the need for rescue intubation, and a marked reduction in postoperative sore throat and other morbidities.

Our findings are in line with, and expand upon, the broader literature advocating cuff pressure monitoring. *Seet et al.* (2010) conducted a randomized trial using manometry for LMA inflation in adults and found that keeping intracuff pressure <44 cmH_2O significantly **reduced pharyngolaryngeal complications** (sore throat, hoarseness, coughing). In our study, the CuffSure group's mean pressure (~30-40 cmH_2O) falls well below that threshold, likely explaining the low 10% sore throat rate. In contrast, the Control group's average pressure (~60+ cmH_2O) led to a 30% sore throat incidence, which aligns with prior observations that high cuff pressures strongly correlate with throat irritation. **Wong et al. (2009)** specifically demonstrated this pressure-morbidity relationship in a paediatric series: no children developed sore throat when LMA cuff pressure was maintained <40 cmH_2O, whereas >50% reported sore throat when pressures exceeded 100 cmH_2O . In that audit of 400 children, the overall sore throat incidence was 11% because many unmonitored cuffs were in an intermediate range (40-60 cmH_2O) . Our control group's 30% sore throat corresponds to pressures mostly around 60-70 cmH_2O, which is higher than Wong's moderate group and approaching the unsafe zone-emphasizing that even "standard" inflation without monitoring can overshoot safe levels.

It is instructive to compare with studies that deliberately limited cuff pressures. In an adult LMA study, maintaining cuff pressure at ~30 cmH_2O (vs >60 cmH_2O in controls) reduced sore throat from 39% to 15%. We observed a very similar magnitude of improvement (~67% reduction in sore throat, 30% → 10%) by using CuffSure, which kept pressures ~30-40 cmH_2O. Likewise, *Khan et al.* reported that keeping LMA pressure ~30 cmH_2O led to significantly lower sore throat at 2 and 6 hours post-op. These convergent results strongly support the practice of limiting LMA cuff pressures to around 30 cmH_2O in children and adults alike.

Another important observation from our study is that **overinflation of the LMA cuff did not improve, but rather worsened, the airway seal**. One might intuitively think a higher cuff volume/pressure ensures a tighter seal and less leak. However, our control group (highest pressures, ~65 cmH_2O) had the **highest leak rate (15%)**, whereas CuffSure at ~40 cmH_2O had only 6% leaks-an inverse relationship. This paradox is explained by cuff mechanics: beyond a certain point, an overinflated cuff becomes taut and less conforming to the airway, creating foldings or points of incomplete contact. *Bick et al.* (2014) noted that overinflation (>60 cmH_2O) can actually **impair the LMA seal** by distorting cuff shape and increase aspiration risk. Our data support this: the best ventilation was achieved with **moderate cuff pressures** (30-40 cmH_2O), not the highest. Previous paediatric studies also advocate using the **minimum effective cuff volume**-just enough to seal-to avoid unnecessary pressure. For instance, *von Ungern-Sternberg et al.* (2009) found that inserting LMAs with the cuff partially inflated can lead to a poor fit, prompting a cycle of adding more air to stop leaks, which ultimately **worsens the seal and raises pressure further**. They recommended inserting the LMA with the cuff fully deflated (which we did) and then inflating only to achieve a seal, as this seats the mask correctly without overpressure. Our results validate that approach-in the CuffSure group, providers likely stopped inflating as soon as

the gauge indicated a good seal, whereas in Control some may have overfilled in pursuit of a perfect seal, ironically causing more leak.

The **broader literature** increasingly calls for routine cuff pressure monitoring in airway management. *Rokamp et al.* (2010) documented that without manometry, LMA cuff pressures were wildly variable (median ~95 cmH_2O in their series of 82 patients) and concluded that **mandatory monitoring is needed** to maintain pressures in a safe range. *Ong et al.* (2008) similarly found that anesthesiologists using only clinical endpoints (no manometer) often overinflated paediatric LMA cuffs far above 60 cmH_2O in almost all cases. They urged the use of manometers routinely in children. Our study provides prospective evidence that doing so yields tangible improvements: we saw better oxygenation (slightly higher SpO_2) and lower heart rates in the monitored groups, suggesting less stress on the child's body (though SpO_2 differences were small) . *Al-Mazrou et al.* (2018) emphasized that children are more vulnerable to high cuff pressures and even short periods of overinflation can cause injury. Taken together with those studies, our findings make a strong case that **cuff pressure monitors should be standard equipment** during LMA use in paediatric anaesthesia.

A unique aspect of our research was the **head-to-head comparison of two monitoring devices** in a clinical scenario. Both the AG Cuffill and CuffSure significantly improved outcomes over no monitoring, but we observed that **CuffSure had a slight edge** in performance. The CuffSure group consistently had cuff pressures a few cmH_2O lower than the AG group and correspondingly fewer leaks and throat complaints (10% vs 20% sore throat). All differences between CuffSure and AG were statistically significant or at least clinically notable (for example, sore throat 10% vs 20%, $p<0.05$; and fewer intubation conversions 2% vs 4%, though our sample was small for this outcome). The **reason** for CuffSure's better performance may lie in its design and usability. The CuffSure provides continuous visual feedback via a color-coded analogue dial. This likely allowed the anaesthesiologists to titrate the cuff inflation more intuitively-stopping inflation as soon as the needle approached the green/yellow boundary (safe limit), or even deflating slightly if it overshot into warning zone. In contrast, the AG Cuffill gives a numeric readout intermittently (one has to inject air and then check the digital screen). It might be less immediate in feedback, and practitioners possibly felt comfortable as long as the reading was under the upper limit (~60 cmH_2O), tending to allow pressures somewhat higher (we noted ~5 cmH_2O higher on average than CuffSure). Human factor studies suggest that **analogue gauges can be easier to monitor** at a glance than digital devices for certain tasks. In our study, this manifested as CuffSure achieving the "goldilocks" inflation more often than AG Cuffill. Additionally, the CuffSure device doubles as the inflating syringe, so there is no need to switch between a syringe and a manometer; this convenience might streamline the process. We also found the ease-of-insertion scores marginally better with CuffSure-while LMA placement technique was identical, this could imply that the quick confirmation of cuff pressure with CuffSure allowed smoother workflow and fewer adjustments, which anesthesiologists perceived as an easier insertion overall.

From a **clinical perspective**, the use of either device is a substantial improvement over traditional blind inflation. The risk of sore throat and other complications can meaningfully impact patient comfort and satisfaction, especially in ambulatory surgeries where children go home the same day. Reducing sore throat from 30% to 10% (as we did with CuffSure) is not only statistically significant but very relevant for patient experience. Moreover, preventing high cuff pressures may avoid rare but serious complications such as mucosal ulceration, vocal cord paralysis, or recurrent laryngeal nerve neuropraxia that have been reported with LMAs left overinflated. Our findings reinforce the idea that **high intracuff pressures should never be considered a "necessary evil" for achieving a seal**-on the contrary, optimal moderate pressures give both a good seal and fewer adverse effects.

Some **technological advancements** are worth mentioning. Newer LMA products (e.g., Teleflex's LMA Cuff Pilot) now come with built-in cuff pressure indicators to continuously show intracuff pressure. These integrated solutions were developed in response to the very issues highlighted by our and others' research-that anesthesiologists often omit separate manometry. By making the pressure visible on the LMA itself (via a color gauge on the pilot balloon), it encourages continuous awareness. While our study did not involve such devices, the success of CuffSure's analog indicator suggests that visual cues are highly effective. In the future, widespread adoption of cuff pressure monitoring-whether through stand-alone devices like CuffSure/AG Cuffill or integrated cuff gauges-could become part of standard airway management protocols, just as routine as monitoring oxygenation or blood pressure.

5. Limitations

This study was single-center and involved a specific LMA type and patient population, which may limit generalizability. Our target pressures were based on manufacturer guidelines and clinical judgment; we did not test different pressure targets (e.g., comparing a 30 cmH_2O vs 60 cmH_2O strategy directly in a randomized fashion), because our intent was to compare devices rather than pressure thresholds. However, literature suggests 30-40 cmH_2O is an optimal target in children, which our results support. Another limitation is that the study was not blinded-the attending anaesthesiologist was aware of the group and device in use, which could introduce bias (for example, they might be gentler in placing LMAs when using a device). We attempted to mitigate this by having standardized protocols and objective endpoints. Lastly, long-term outcomes (e.g., if any throat soreness persisted beyond day of surgery) were not assessed, as our focus was immediate postoperative effects.

6. Recommendations

Based on our findings, we recommend that **routine LMA cuff pressure monitoring should be adopted in paediatric practice**. Even a simple analogue device like CuffSure can significantly improve safety. When such devices are not available, at minimum the cuff should be inflated to the **minimum effective volume** and checked with a manometer (even if just once after placement) to ensure it is within safe

range. Given the slight superiority of the CuffSure in our study, anaesthesia providers may prefer an analogue gauge device for its ease and possibly lower cost (the CuffSure is a simple manometer and likely less expensive than digital devices, though we did not perform a formal cost analysis). Future research could explore the cost-benefit aspect and the learning curve of using these devices. It would also be interesting to investigate if these results hold true in infants or older children (our sample mostly included toddlers to young children), and in other scenarios like laparoscopic surgeries where intra-abdominal pressure can further affect airway seal.

In conclusion, our study is the first, to our knowledge, to directly compare two cuff pressure devices in a paediatric LMA context. It provides evidence that **CuffSure and AG Cuffill both enhance patient safety** by preventing LMA overinflation, with the analogue CuffSure offering the best outcomes. These results add to the growing body of literature championing cuff pressure monitoring. Implementing routine use of manometry (or pressure-indicating LMAs) in paediatric anaesthesia can dramatically reduce airway-related complications and should become a standard of care going forward.

7. Conclusion

In paediatric patients under general anaesthesia with LMAs, **measuring and controlling cuff pressure is crucial** for safe and effective airway management. This study demonstrated that using cuff pressure manometers (AG Cuffill or CuffSure) significantly improves outcomes compared to traditional volume-based cuff inflation. The **CuffSure device** in particular maintained the most optimal cuff pressures (~30-40 cmH_2O), resulting in the best ventilation (minimal leaks, adequate tidal volumes) and the lowest incidence of postoperative sore throat and other complications. The digital AG Cuffill device also improved safety over no monitoring, but was slightly less effective than CuffSure in our paediatric cohort. Overall, these findings support the **routine use of cuff pressure monitoring** in children: it enhances airway sealing, minimizes mucosal injury, and improves patient comfort. We recommend that paediatric anaesthesia protocols incorporate regular intracuff pressure checks (using devices like CuffSure or similar), and that manufacturers continue to innovate user-friendly pressure indicators. By adopting these practices, anaesthesiologists can ensure LMAs are used to their full benefit with minimal risk, thereby improving the quality of care in paediatric anaesthesia.

References

[1] **Ong M, et al. (2008):** Laryngeal mask airway and tracheal tube cuff pressures in children-are clinical endpoints valuable for guiding inflation? *Anaesthesia* **63**(7):738-44 . (Audit showing routine clinical inflation often led to cuff pressures >60 cmH_2O in children, recommending manometry)

[2] **Wong JGL, et al. (2009):** Impact of LMA cuff pressures on incidence of sore throat in children. *Pediatr Anesth* **19**(5):464-9 . (Found 0% sore throat with cuff pressure <40 cmH_2O vs >50% when >100 cmH_2O; advocates keeping pressures low)

[3] **Seet E, et al. (2010):** Use of manometry for LMA reduces postoperative pharyngolaryngeal adverse events. *Anesthesiology* **112**(3):652-7 . (Randomized trial demonstrating that limiting LMA intracuff pressure <44 cmH_2O significantly lowers sore throat, cough, and hoarseness)

[4] **Rokamp KZ, et al. (2010):** Tracheal tube and LMA cuff pressure during anaesthesia-mandatory monitoring is needed. *BMC Anesthesiol* **10**:20 . (Observed very high LMA cuff pressures in routine care; urged routine monitoring to prevent mucosal ischemia)

[5] **Bick E, et al. (2014):** Fewer sore throats and a better seal: why routine manometry for LMAs must become standard. *Anaesthesia* **69**(12):1304-8 . (Editorial highlighting that overinflation >60 cmH_2O can impair LMA seal and increase complications, calling for routine cuff pressure checks)

[6] **von Ungern-Sternberg BS, et al. (2009):** LMA-to inflate or to deflate after insertion? *Pediatr Anesth* **19**(9):837-43. (Showed that inserting an LMA with cuff fully/partially inflated leads to higher starting pressures and worse fit; recommends inserting deflated and inflating minimally for seal)

[7] **Ali A, et al. (2018):** Comparison of different cuff pressures with LMA Supreme on hemodynamic response, seal and outcomes. *Turk J Anesth Reanim* **46**:151-7 . (Prospective RCT: maintaining a lower cuff pressure (≈45 cmH_2O) in LMA Supreme reduced hemodynamic responses and postoperative sore throat compared to normal higher pressure)

[8] **Al-Mazrou KA, et al. (2018):** LMA cuff pressure monitoring in pediatric anaesthesia: a prospective observational study. *Anaesth Intensive Care* **46**(3):279-284. (Found pediatric cuff pressures often exceeded safe levels without monitoring and that children's airways are highly susceptible to cuff trauma; advocated routine monitoring)