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ORIGINAL RESEARCH

A Comparative Study of Airway Management Efficacy and Postoperative Pharyngolaryngeal Discomfort Using SaCo Visual and WORK Laryngeal Masks in Adult General Anesthesia Laparoscopic Surgery: A Retrospective Analysis

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Objective: To compare the application of the SaCo visual laryngeal mask and the WORK laryngeal mask in adult laparoscopic surgeries under general anesthesia, and to assess their effects on postoperative pharyngolaryngeal discomfort.

Methods: A retrospective analysis was conducted on 90 adult patients who underwent elective laparoscopic surgery under general anesthesia between June 2022 and April 2024. Based on the airway device used, patients were divided into the control group (n=45, WORK laryngeal mask) and the observation group (n=45, SaCo visual laryngeal mask). The two groups were compared in terms of laryngeal mask insertion parameters (seal pressure, insertion time, first-attempt success rate, number of adjustments >2 times, peak airway pressure, endoscopic visibility grading, positioning accuracy, removal time), vital signs (heart rate, mean arterial pressure), perioperative outcomes (post-extubation time, time to regular diet, postoperative hospital stay), VAS-based pharyngolaryngeal discomfort scores, and complication rates.

Results: The observation group demonstrated significantly higher airway seal pressure at insertion, 1 hour, and 2 hours post-insertion ($P<0.05$). Adjustment rate >2 times was significantly lower, while positioning accuracy was significantly higher ($P<0.05$). No significant differences were found in heart rate or mean arterial pressure between groups. The observation group had significantly shorter post-extubation time, earlier diet resumption, and shorter hospital stays ($P<0.05$). Pharyngolaryngeal discomfort scores at 1, 3, and 7 days post-surgery were significantly lower in the observation group ($P<0.05$). The complication rate was also lower in the observation group (4.44%) than in the control group (20.00%) ($P<0.05$).

Conclusion: Compared to the WORK laryngeal mask, the SaCo visual laryngeal mask offers better sealing and placement accuracy, reduces pharyngolaryngeal discomfort, and promotes faster postoperative recovery with fewer complications.

Keywords: SaCo visual laryngeal mask, WORK laryngeal mask, general anesthesia, adult, laparoscopic surgery, pharyngolaryngeal discomfort

Introduction

Laparoscopic surgery is a commonly used minimally invasive technique known for reduced trauma, quicker recovery, and fewer complications compared to traditional open procedures.[1,2] General anesthesia with appropriate airway management is essential for ensuring patient safety, particularly during laparoscopic operations where pneumoperitoneum increases intra-abdominal pressure and elevates airway demands.[3,4] Although endotracheal intubation offers reliable ventilation, it is associated with postoperative complications such as sore throat (reported incidence: 30–70%) and hoarseness (14–50%) due to its invasive nature.[5] Laryngeal mask airways (LMAs), as supraglottic devices, are easier

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to insert, cause less trauma, and have been associated with lower incidences of postoperative sore throat (12–20%) and hoarseness (4–8%).[6,7]

The WORK laryngeal mask is widely used due to its convenience and stable performance in general anesthesia. However, during laparoscopic surgery, improper placement, air leakage, and adjustment issues remain concerns.[8] To address this, newer visualized LMAs like the SaCo visual laryngeal mask have emerged, featuring integrated video systems that allow real-time visualization of laryngeal structures, improving placement accuracy and airway sealing.[9,10] Despite the theoretical advantages of visual LMAs, no comparative clinical study has yet examined the differences between the SaCo and WORK laryngeal masks in adult patients undergoing laparoscopic surgery. This retrospective study investigates the two devices with a focus on laryngeal positioning, airway sealing, postoperative pharyngolaryngeal discomfort (assessed using VAS scores), and complication rates, aiming to offer clinical guidance for airway management in minimally invasive surgery.

Materials and Methods

Study Subjects

This retrospective observational study analyzed the clinical data of 90 patients who underwent elective laparoscopic cholecystectomy, appendectomy, or ovarian cystectomy under general anesthesia at Lishui People's Hospital of Jiangsu Province between June 2022 and April 2024. Patients were divided into the control group (n = 45, received WORK LMA) and observation group (n = 45, received SaCo visual LMA) according to the type of laryngeal mask airway used. Inclusion criteria: (1) Patients aged 18–75 years; (2) ASA classification I–III;[11] (3) Elective laparoscopic surgery with general anesthesia; (4) LMA-compatible anatomy and no contraindications; (5) Signed informed consent; (6) Complete and accessible clinical data. Exclusion criteria: (1) Emergency surgery; (2) Pregnant or lactating women; (3) Severe cardiopulmonary disease; (4) Systemic failure or advanced malignancies; (5) Abnormal airway anatomy or prior laryngeal surgery; (6) Allergy to materials used in surgery or anesthesia, including Dacron gel (composed of carboxymethylcellulose sodium, propylene glycol, and glycerin); (7) Severe psychiatric disorders; (8) Intraoperative conversion to endotracheal intubation. This study was approved by the ethics committee of Lishui District People's Hospital (Approval No. 24-MZ-HZ01), in accordance with the Declaration of Helsinki. Informed consent was obtained from all study participants.

Anesthesia Methods

All patients fasted for at least 8 hours and received no premedication. After entering the OR, standard monitoring was applied (ECG, HR, BP, SpO_2, $EtCO_2$, BIS). Venous access was secured, and patients were preoxygenated at 6 L/min for 3 minutes to replace nitrogen (nitrogen washout). Anesthesia induction used: Midazolam 0.05 mg/kg; Propofol 2.5 mg/kg; Rocuronium 0.6 mg/kg; Sufentanil 0.3 μg/kg; Atropine 0.4 mg IV Dacron gel, a water-soluble lubricant, was used for LMA lubrication. SaCo LMA was used in the observation group, and WORK LMA in the control group. LMAs were size-matched by weight. Cuff pressure was adjusted to 40 cmH_2O using a handheld manometer. Insertion success was confirmed by symmetrical chest rise, stable $EtCO_2$ waveform, and absence of audible leaks. If >3 attempts failed, endotracheal intubation was performed. Ventilation: Tidal volume 8 mL/kg; RR 10–14/min; I:E ratio 1:2; $EtCO_2$ maintained at 35–45 mmHg. Anesthesia maintained by TCI: propofol 2–4 μg/mL, remifentanil 3–5 μg/mL, additional sufentanil and rocuronium as needed. Patients were placed in reverse Trendelenburg or lithotomy positions depending on surgical type. Any LMA adjustments and changes in seal pressure due to positioning were recorded. Five minutes before surgery end, drugs were stopped. LMA was removed upon full spontaneous breathing recovery. Gastric contents were aspirated via a 14F tube. Perioperative drugs, including doses, were recorded.

Observation Indicators

Laryngeal Mask Insertion Conditions

The LMA cuff pressure was recorded immediately after insertion, 1 hour after insertion, and 2 hours after insertion. The measurement method: the APL valve was set to 40 cmH2O in the manual ventilation mode, oxygen flow was adjusted to

6 L/min, and the airway pressure was recorded when a leak was detected at the oropharynx. If the airway pressure exceeded 40 cmH2O without any leaks, the measurement was terminated, and the airway sealing pressure was recorded as 40 cmH2O. The LMA insertion time (from insertion into the oral cavity to connection with the breathing circuit when the chest rise was adequate and the 3rd PETCO2 waveform appeared on the monitor) was recorded. The number of successful first-time insertions, the incidence of LMA adjustment > 2 times, and the peak airway pressure immediately after successful insertion were also recorded. The endoscopic visibility grading (EVGS) was noted. The observation group used direct visualization with the SaCo visual LMA, while the control group used a fiberoptic bronchoscope to inspect the LMA with the ventilation tube: Level 1: Entire glottic aperture visible; Level 2: Partial glottic aperture visible; Level 3: Free edge of the epiglottis or tongue surface visible; Level 4: No identifiable structure or shadowed area. EVGS grading ≤ 2 was considered as accurate LMA positioning. The number of accurate LMA positions and the LMA removal time (from drug cessation to LMA removal) were recorded. Potential detection bias acknowledged due to differing methods.

Vital Signs

The heart rate (HR) and mean arterial pressure (MAP) were measured before LMA insertion, immediately after LMA insertion, and immediately before LMA removal.

Perioperative Indicators

Postoperative extubation time, time to normal diet, and length of postoperative hospitalization were recorded by the relevant medical staff.

Postoperative Pharyngolaryngeal Discomfort

VAS score (0–10)[12] assessed for sore throat and hoarseness only Recorded at 24 h, 48 h, and 72 h after surgery Symptom duration and need for treatment recorded.

Incidence of Complications

Record postoperative complications within 24 hours after surgery, including pharyngeal bleeding, coughing, hoarseness, difficulty swallowing, bronchospasm, etc., while also noting the symptoms and treatment requirements.

Statistical Analysis

SPSS 22.0 was used. Data were tested for normality using the Shapiro–Wilk test. Normally distributed data were expressed as ($\bar{x} \pm s$) and compared using independent-sample *t*-tests; non-normally distributed data were analyzed using the Mann–Whitney *U*-test. Repeated measures ANOVA was used for intra-group comparisons over time. Categorical data were compared using χ^2-test. $p < 0.05$ was considered statistically significant.

Results

Comparison of Basic Data

There were no significant differences in gender, age, body mass index (BMI), ASA classification, Mallampati classification, mouth opening, neck circumference, mentohyoid distance, surgery duration, or anesthesia duration between the two groups ($P > 0.05$), indicating comparability. See Table 1.

Comparison of Laryngeal Mask Insertion Conditions

The laryngeal mask sealing pressures at immediate placement, 1 hour after placement, and 2 hours after placement in the control group were (27.15 ± 5.36, 26.75 ± 5.48, and 25.91 ± 6.43), respectively; in the observation group, the corresponding values were (30.59 ± 8.32, 32.16 ± 7.84, and 31.68 ± 7.67), respectively. There was a significant difference between the groups in the laryngeal mask seal pressure ($F = 3.465$, $P < 0.05$). However, the time and interaction ($F = 1.126$ and $F = 0.947$, respectively) showed no significant difference ($P > 0.05$). At all time points, the seal pressure at insertion, 1 hour, and 2 hours after insertion was significantly higher in the observation group compared to the control group ($P < 0.05$), as shown in Figure 1. The observation group had a significantly lower rate of laryngeal mask adjustments (>2

Table 1 Comparison of Basic Data ($\bar{x} \pm s$, n[%])

	Control (n=45)	Observation (n=45)	t/x^2	P
Gender	–	–	0.528	0.467
Male	16 (35.56)	19 (42.22)	–	–
Female	29 (64.44)	26 (57.78)	–	–
Age (years)	57.36±10.49	58.21±10.82	0.378	0.706
BMI (kg/m²)	24.71±2.85	24.56±3.72	0.214	0.830
ASA Classification	–	–	0.493	0.482
I	3 (6.67)	6 (13.33)	–	–
II	37 (82.22)	35 (77.78)	–	–
III	5 (11.11)	4 (8.89)	–	–
Mallampati Classification	–	–	0.194	0.659
I	17 (37.78)	15 (33.33)	–	–
II	26 (57.78)	25 (55.56)	–	–
III	2 (4.44)	5 (11.11)	–	–
Mouth Opening (cm)	4.13±0.52	4.18±0.49	0.469	0.639
Neck Circumference (cm)	36.78±3.75	36.64±4.23	0.166	0.868
Mentohyoid Distance (cm)	6.95±0.58	6.87±0.64	0.621	0.536
Surgery Duration (min)	217.74±91.83	221.65±88.96	0.205	0.837
Anesthesia Duration (min)	253.89±101.69	255.48±95.89	0.076	0.939

times) and a higher correct placement rate compared to the control group ($P < 0.05$). There were no significant differences between the groups in insertion time, first insertion success rate, peak airway pressure, EVGS classification, and laryngeal mask removal time ($P > 0.05$), as shown in Table 2.

Comparison of Vital Signs at Different Time Points

There were no significant differences in HR between the two groups in terms of group ($F = 0.817$), time ($F = 0.594$), and interaction ($F = 0.482$) ($P > 0.05$), as shown in Table 3. Similarly, there were no significant differences in MAP between the two groups in terms of group ($F = 0.583$), time ($F = 0.759$), and interaction ($F = 0.504$) ($P > 0.05$), as shown in Table 4.

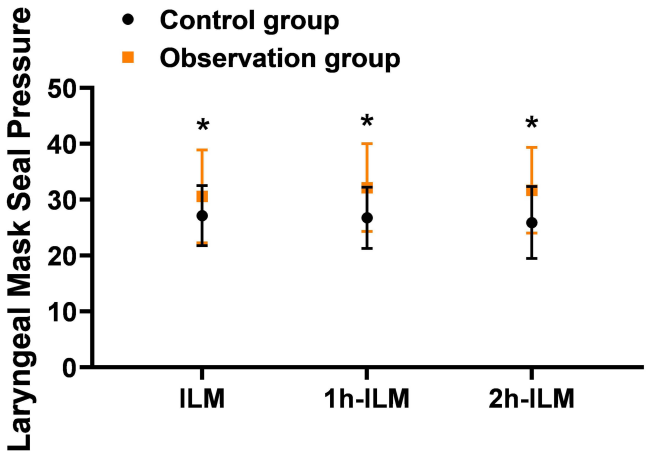

Figure 1 Comparison of Laryngeal Mask Seal Pressure at Different Time Points ($\bar{x} \pm s$, cmH2O).
Note: 1h-ILM = 1 hour after insertion; 2h-ILM = 2 hours after insertion. *P < 0.05 compared with the control group at the same time point.
Abbreviation: ILM, Insertion of laryngeal mask.

Table 2 Comparison of Laryngeal Mask Insertion Conditions ($\bar{x} \pm s$, n[%])

	Control (n=45)	Observation (n=45)	t/x^2	P
Insertion Time (s)	59.78±15.46	64.39±15.82	1.398	0.165
First Insertion Success	35 (77.78)	38 (84.44)	0.652	0.419
Adjustments >2 Times	6 (13.33)	0 (0.00)	4.464	0.034
Peak Airway Pressure (cmH2O)	17.72±3.95	16.48±4.73	1.349	0.180
EVGS Classification	–	–	0.180	0.671
I	24 (53.33)	26 (57.78)	–	–
II	6 (13.33)	5 (11.11)	–	–
III	8 (17.78)	6 (13.33)	–	–
IV	7 (15.56)	8 (17.78)	–	–
Correct Placement Rate	32 (71.11)	45 (100.00)	49.655	<0.001
Removal Time (s)	26.57±10.18	29.24±10.43	1.228	0.222

Table 3 Comparison of HR at Different Time Points ($\bar{x} \pm s$, Times/Min)

HR	Control (n=45)	Observation (n=45)	t	P
Before Laryngeal Mask Insertion	82.23±4.35	82.31±3.67	0.094	0.925
Immediately After Laryngeal Mask Insertion	82.97±5.26	82.43±4.35	0.530	0.597
Immediately After Laryngeal Mask Removal	82.81±5.12	82.17±4.19	0.648	0.518

Table 4 Comparison of MAP at Different Time Points ($\bar{x} \pm s$, mmHg)

MAP	Control (n=45)	Observation (n=45)	t	P
Before Laryngeal Mask Insertion	78.04±5.68	78.83±4.81	0.712	0.478
Immediately After Laryngeal Mask Insertion	78.76±5.49	78.29±4.37	0.449	0.654
Immediately After Laryngeal Mask Removal	78.62±5.25	78.61±4.53	0.009	0.992

Comparison of Perioperative Indicators

The control group had postoperative extubation time, time to resume regular diet, and postoperative hospital stay times of (12.13 ± 1.56, 5.74 ± 0.31, 6.52 ± 0.47), respectively. The observation group had postoperative extubation time, time to resume regular diet, and postoperative hospital stay times of (9.78 ± 1.15, 3.58 ± 0.17, 4.43 ± 0.31), respectively. The observation group had significantly lower extubation time, time to resume regular diet, and postoperative hospital stay times compared to the control group ($P < 0.05$), as shown in Figure 2.

Comparison of Postoperative Pharyngolaryngeal Discomfort at Different Time Points

The VAS scores on postoperative day 1, day 3, and day 7 in the control group were (5.37 ± 0.54, 3.78 ± 0.39, and 2.51 ± 0.27), respectively; in the observation group, the corresponding scores were (4.01 ± 0.46, 2.83 ± 0.42, and 1.62 ± 0.31), respectively. There was a significant difference between the groups in terms of VAS scores for group ($F = 12.105$), time ($F = 13.976$), and interaction ($F = 11.721$) ($P < 0.05$). Within each group, the VAS scores on postoperative day 3 and day 7 were significantly lower than on postoperative day 1, and the VAS score on postoperative day 3 was significantly lower than on day 7 ($P < 0.05$). Between groups, the observation group had significantly lower VAS scores on postoperative days 1, 3, and 7 compared to the control group ($P < 0.05$), as shown in Figure 3.

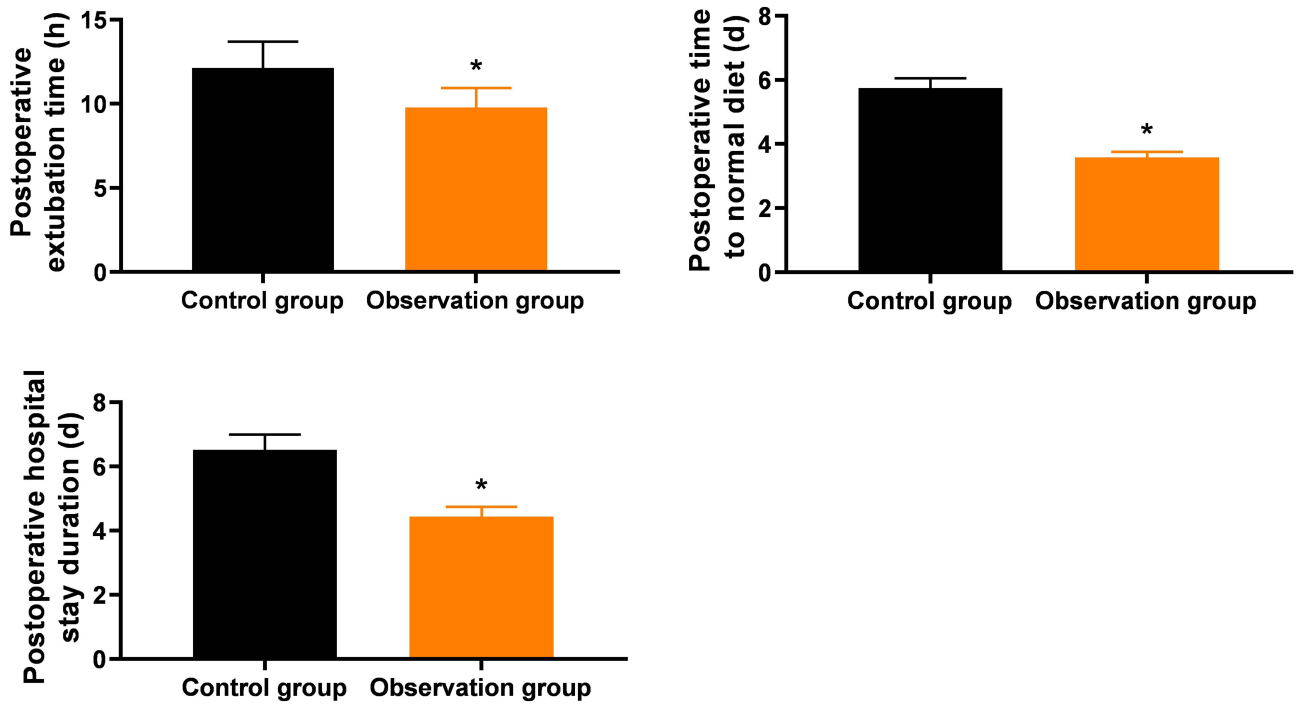

Figure 2 Comparison of Perioperative Indicators ($\bar{x} \pm s$).
Note: *P < 0.05 compared with the control group.

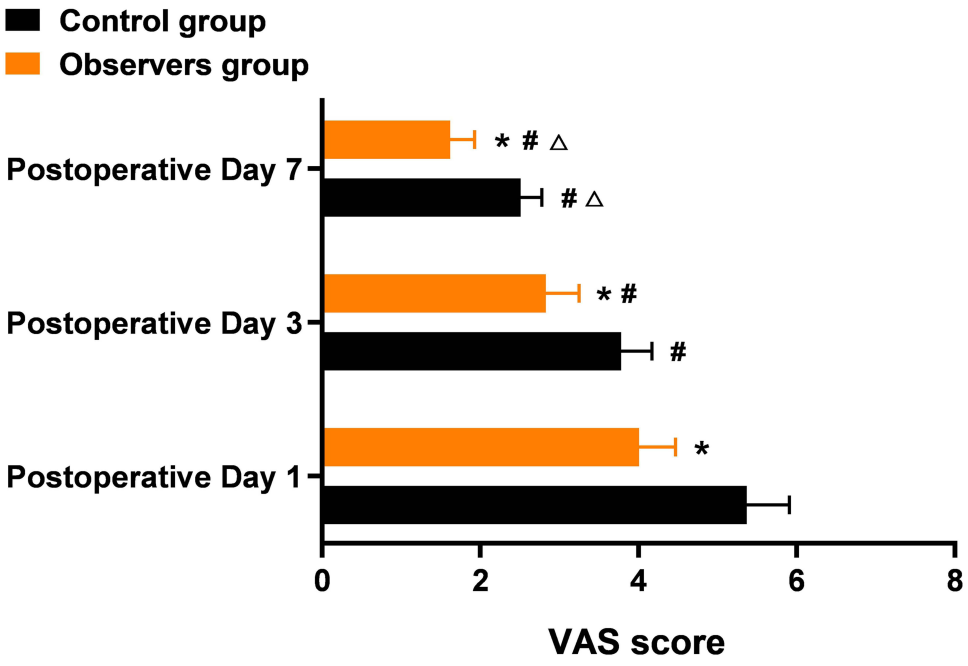

Figure 3 Comparison of Postoperative Pharyngolaryngeal Discomfort at Different Time Points ($\bar{x} \pm s$, points).
Note: *P < 0.05 compared with the control group at the same time point; #P < 0.05 compared with postoperative day 1 within the same group; ΔP < 0.05 compared with postoperative day 3 within the same group.

Comparison of Complications

The complication rate in the observation group (4.44%) was significantly lower than in the control group (20.00%) (P < 0.05), as shown in Table 5.

Table 5 Comparison of Complications [n(%)]

Complications	Control (n=45)	Observation (n=45)	t	P
Pharyngeal Hemorrhage	2 (4.44)	0 (0.00)	–	–
Coughing	2 (4.44)	1 (2.22)	–	–
Hoarseness	3 (6.67)	1 (2.22)	–	–
Dysphagia	1 (2.22)	0 (0.00)	–	–
Bronchospasm	1 (2.22)	0 (0.00)	–	–
Total Complications	9 (20.00)	2 (4.44)	5.074	0.024

Discussion

With the continuous advancement of medical technology, airway management strategies in the field of anesthesia have undergone ongoing innovation. In general anesthesia for laparoscopic surgery, effective airway management plays a critical role in maintaining adequate ventilation and preventing complications.[13] Although traditional endotracheal intubation remains widely used, LMA techniques are increasingly valued for their simplicity and reduced invasiveness, especially with the emergence of visual-guided LMAs that offer more clinical options.[14,15] In this study, the observation group used the SaCo visual laryngeal mask, while the control group used the conventional WORK laryngeal mask. Results showed no statistically significant differences between the two groups in terms of insertion time, first-attempt success rate, peak airway pressure, EVGS grading, or removal time ($P > 0.05$). These findings are consistent with previous literature,[16–18] indicating that both LMAs meet the expected clinical standards in overall performance and are suitable for use in laparoscopic procedures under general anesthesia. However, the observation group significantly outperformed the control group in terms of oropharyngeal leak pressure, alignment accuracy, and the number of insertion adjustments ($P < 0.05$). Airway sealing pressure is one of the core indicators of LMA performance.[19] The SaCo LMA features a dual-chamber structure with a wider anterior cuff, enhancing contact with the oropharyngeal mucosa and substantially increasing sealing pressure. Furthermore, the integrated visual channel enables real-time monitoring of the LMA's position relative to the glottis, thereby reducing the likelihood of misplacement or air leakage caused by blind insertion.[20–23] Data from this study showed that the SaCo group had significantly higher sealing pressures immediately after insertion and at 1 and 2 hours intraoperatively compared to the control group, suggesting its superior stability in maintaining airway seal throughout the surgical procedure. Coupled with the higher alignment accuracy and fewer insertion adjustments observed in the SaCo group, these findings indicate that real-time visual guidance improves placement precision, optimizes seal integrity, and reduces errors or delays associated with repeated adjustments.

Postoperative pharyngeal discomfort is a common adverse outcome of airway management, typically manifesting as sore throat, hoarseness, or cough. These symptoms are usually caused by mucosal injury or mechanical irritation from the airway device and can significantly impact postoperative comfort and recovery experience.[24,25] In this study, the SaCo group showed lower VAS scores for throat discomfort on postoperative days 1, 3, and 7 ($P < 0.05$). Moreover, the incidence of complications was lower in the SaCo group (4.44%) than in the control group (20.00%) ($P < 0.05$), indicating that the SaCo visual LMA has clear advantages in minimizing postoperative pharyngolaryngeal discomfort and related complications.

This difference may be attributed to the distinct insertion techniques and airway interaction profiles of the two LMAs. The SaCo visual LMA allows real-time visualization during insertion, ensuring accurate positioning and avoiding multiple attempts or adjustments common with blind insertion. This visual-guided approach reduces repetitive friction or compression on the pharyngeal mucosa, thereby lowering the risk of mechanical injury to airway tissues.[26] In contrast, the conventional WORK LMA lacks visual support, requiring operators to rely on experience and tactile feedback, often leading to repeated adjustments and increased risk of airway wall trauma. This trial-and-error approach can result in sore throat, hoarseness, or irritative cough postoperatively. Additionally, the SaCo LMA's anatomically adaptive dual-cuff design enhances fit and reduces localized mucosal pressure, while maintaining effective ventilation.

Limitations

This study has several limitations. First, its retrospective design may introduce inherent selection bias, as patient allocation was not randomized, and clinical variables may not have been equally distributed between groups. Second, all participants underwent laparoscopic procedures, limiting the applicability of findings to other surgical types or clinical settings. Third, the single-center nature of this study may reduce external validity. To enhance the robustness and generalizability of these results, future studies should adopt prospective, randomized, multicenter designs with larger sample sizes and include a broader range of surgical procedures.

Conclusion

Despite these limitations, the findings suggest that the SaCo visual laryngeal mask offers notable clinical advantages over the conventional WORK LMA in patients undergoing laparoscopic surgery under general anesthesia. Specifically, the SaCo LMA demonstrated better airway sealing, higher positioning accuracy, and lower incidence of postoperative complications such as sore throat and laryngeal trauma. These features support its increasing clinical adoption. As clinical experience with the SaCo LMA expands and further high-quality evidence accumulates, it is expected to play a more prominent role in airway management strategies during laparoscopic procedures and potentially beyond.

Disclosure

The authors report no conflicts of interest in this work.

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