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Comparison of Clinical Performance and Pharyngeal Leak Pressure of Laryngeal Mask Airway Supreme Before and After Cisatracurium

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Abstract

The laryngeal mask airway (LMA) supreme is a widely used supraglottic airway device that provides effective ventilation with a secure seal. Pharyngeal leak pressure is a critical parameter reflecting airway sealing efficiency. The administration of neuromuscular blockers like cisatracurium may influence the device's performance, potentially affecting ventilation and airway safety. A prospective, observational study was conducted in the Department of Anaesthesia, Analgesia & ICU at Jaber Al Ahmed Armed Forces Hospital, Kuwait, from January to December of 2021, to compare the clinical performance and pharyngeal leak pressure of the LMA Supreme before and after cisatracurium administration in surgical patients. A total of 120 patients undergoing urologic surgery under general anaesthesia were included in this study, through purposive sampling, based on inclusion and exclusion criteria. They were divided into group A (no muscle relaxant) and group B (Cisatracurium 0.1 mg/kg) having 60 patients in each group. Data on age and gender, duration of surger and anaesthesia, insertion time, attempts, jaw relaxation/stiffness, pharyngeal leak pressure, haemodynamics and complications were recorded and analyzed. Successful insertion within 15 seconds was higher in group B (73.3%) than in group A (66.7%), while prolonged insertion was more frequent in group A (10.0%) than in group B (3.3%); however, the difference was not statistically significant ($p>0.05$). Patients of group A had significantly lower pharyngeal leak pressure than that of group B (32.1±4.6 cm H_2O vs. 36.2±4.2 cm H_2O; $p<0.001$). Patients in group B had better haemodynamics but more hiccups/laryngospasms, while group A had more blood-stained secretions. Cisatracurium improved pharyngeal leak pressure, and hemodynamic stability with laryngeal mask airway supreme but increased minor complications like hiccups and laryngospasm.

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Introduction

The laryngeal mask airway (LMA) supreme is a supraglottic airway device used in modern anesthesia to secure the airway and provide effective ventilation. As an alternative to the traditional endotracheal tube, the LMA Supreme offers an important option for airway management, especially in patients undergoing surgeries that do not require endotracheal intubation. This device is known for its ease of insertion, effective ventilation, and minimal airway trauma compared to other airway devices.[1] One critical parameter in assessing the LMA Supreme's performance is the pharyngeal leak pressure, which reflects the efficiency of the airway seal and the adequacy of ventilation during general anesthesia. Higher pharyngeal leak pressure indicates a better seal and a lower likelihood of airway leak or aspiration, which are important factors for patient safety.[2,3] In clinical practice, achieving an optimal seal is crucial in preventing complications such as hypoxia, aspiration pneumonia, and other respiratory complications. Therefore, monitoring pharyngeal leak pressure can provide valuable insight into the performance of supraglottic airway devices like the LMA Supreme. Neuromuscular blockers, including cisatracurium, are commonly used in anesthesia practice to induce muscle relaxation, thereby

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facilitating intubation and improving surgical conditions.[4] Cisatracurium, a non-depolarizing muscle relaxant, is known for its relatively predictable pharmacokinetic profile, making it a popular choice for facilitating endotracheal intubation during general anesthesia. However, its effects on the performance of supraglottic airway devices, such as the LMA Supreme, have not been well-explored in the literature. Muscle relaxants could theoretically enhance airway manipulation and jaw relaxation, potentially improving the ease of LMA insertion and the quality of the airway seal, thus influencing the pharyngeal leak pressure.[5,6] Evidence showed that neuromuscular blockers can influence the positioning and fit of supraglottic airway devices, as muscle relaxation can facilitate better placement of the device in the pharyngeal space.[7,8] However, there is limited research specifically addressing the effects of cisatracurium on the clinical performance and pharyngeal leak pressure of the LMA Supreme. Evidence also suggests that muscle relaxants improve the insertion success rate and decrease insertion time, as muscle tone in the airway is reduced, allowing for a smoother insertion process.[9,10] Furthermore, the use of neuromuscular blockers may reduce complications such as coughing, gagging, or laryngospasm during the insertion and maintenance of the airway device. Despite the potential benefits, there are also concerns about the impact of muscle relaxants on hemodynamics, particularly blood pressure and heart rate, during anesthesia. A previous study demonstrated that the use of neuromuscular blockers can alter the cardiovascular response to airway management.[11] It is essential to evaluate the effects of cisatracurium not only on the insertion success and leak pressure, but also on patient hemodynamics, including heart rate, blood pressure, and mean arterial pressure, to ensure safe and effective airway management during general anesthesia. Therefore, this study aims to fill the gap in the literature by comparing the clinical performance and pharyngeal leak pressure of the LMA Supreme before and after cisatracurium administration in patients undergoing urology surgery under general anesthesia. The investigation will assess parameters such as insertion time, number of attempts, jaw relaxation, pharyngeal leak pressure, hemodynamics and complications which are critical in determining the overall effectiveness of the LMA Supreme in different clinical settings.

Methods

This was a prospective, observational comparative study was conducted in the Department of Anaesthesia, Analgesia & ICU at Jaber Al Ahmed Armed Forces Hospital, Kuwait, from January to December of 2021. A total of 120 patients were enrolled through purposive sampling based on the following inclusion and exclusion criteria:

Inclusion criteria:

1. Patients who underwent routine urologic surgery under general anaesthesia for 1-2 hours
2. Patients of either sex and aged between 21 and 60 years; and
3. Patients of ASA-I and ASA-II with empty stomach.

Exclusion criteria:

1. Patients who required endotracheal intubation during general anaesthesia;
2. Potential for difficult intubation;
3. Age below 21 years, pregnant and breastfeeding women;
4. History of hiatal hernia, GERD, musculoskeletal disease, drug and alcohol abuse; and
5. Patient having hypersensitivity to cisatracurium.

Then, they were divided into group A (no muscle relaxant) and group B (Cisatracurium 0.1 mg/kg) having 60 patients in each group. After pre-oxygenation, anaesthesia was induced with fentanyl, lignocaine, and propofol, followed by LMA insertion. Monitoring included NIBP, pulse oximetry, and ECG. Pharyngeal leak pressure (OLP) was measured to assess LMA placement. In Group B, LMA insertion followed cisatracurium. Anaesthesia was maintained with O_2, air, and sevoflurane. Insertion difficulty, jaw relaxation pharyngeal leak pressure and complications during LMA removal were recorded. After the surgery was done, anaesthesia was reversed and LMA was removed after spontaneous breathing resumed.

Following data collection, data input was done. The collected data was assessed for completeness, accuracy, and consistency before analysis. Statistical analysis was carried out using Statistical Package for Social Sciences (SPSS) version 23.0 for windows. Data was expressed as mean±SD (standard deviation) as well as frequency and percentage, as applicable. Unpaired Student's 't' test and Chi-square test were done to compare between the groups. A p-value <0.05 was considered as statistically significant.

Ethical approval for this study was obtained from the Ethics Review Board of Jaber Al Ahmed Armed Forces Hospital, Kuwait.

Results

In this study, the mean age of patients in group A and group B was 35.2±8.1 years and 37.5±7.9 years (p>0.05). 63.3% of patients in group A and 58.3% in group B were male, while 36.7% in group A and 41.7% in group B were female (p>0.05) (Table-I). The mean duration of surgery in group A was 95.2±15.3 minutes, while in group B 105.1±14.7 minutes (p<0.001). For duration of anaesthesia, group A had a mean of 120.5±10.2 minutes, while group B had a mean of 130.3±12.4 minutes (p<0.001) (Table-II). Successful insertion within 15 seconds on the first attempt was observed more group B than that of group A (66.7% vs. 73.3%; p>0.05). The insertion time of 15-30 seconds in both groups was identical (23.3% vs. 23.3%; p>0.05). A prolonged insertion time (>30 seconds or requiring a second attempt) was more frequent in group A compared to group B (10.0% vs. 3.3%; p>0.05) (Table-III). Among clinical parameters, jaw relaxation was more successful in group A compared to group B (76.7% vs. 70.0%; p<0.05). In contrast, jaw stiffness was more evident in group B (16.7% vs. 20.0%; p<0.05). For NG tube insertion, success rate is higher in group A (86.7% vs. 76.7%; p>0.05). Lastly, when assessing the volume of air required, adequate sealing of leaks was observed in 16.7% in group A and 23.3% in group B required air (p>0.05) (Table-IV). The mean pharyngeal leak pressure of was 32.1±4.6 cm H_2O in group A and 36.2±4.2 cm H_2O in group B (p<0.001). i.e., group B exhibited a significantly higher pharyngeal leak pressure (Table-V). Regarding haemodynamic status of the patients, in group A, the heart rate (HR) decreased from 75±10/minute to 70±8/minute (p<0.05), systolic blood pressure (SBP) decreased from 120±15 mm of Hg to 115±14 mm of Hg (p<0.05), diastolic blood pressure (DBP) decreased from 80±5 mm of Hg to 75±6 mm of Hg (p<0.001), mean arterial pressure (MAP) decreased from 93±11 mm of Hg to 88±10 mm of Hg (p<0.05), and SpO_2 increased from 98±1 to 99±1 (p<0.001). In group B, HR decreased from 78±12/minute to 72±9/minute (p<0.05), SBP decreased from 125±10 mm of Hg to 118±12 mm of Hg (p<0.001), DBP decreased from 82±7 mm of Hg to 78±8 mm of Hg (p<0.05), MAP decreased from 95±12 mm of Hg to 90±9 mm of Hg (p<0.05), and SpO_2 increased from

97±2 to 98±1 (p<0.001). Both groups showed statistically significant improvements in HR, DBP, MAP, and SpO_2 after LMA insertion, with group B showing more significant reductions in SBP (Table-VI). The presence of blood-stained secretions was also higher in group A than in group B ((12.0±3.5 vs. 10.5±4.0; p<0.05). However, group A had a lower occurrence of hiccups (3.0±1.2 vs. 4.0±1.5; p<0.001) and laryngospasm (2.5±1.0 vs. 3.5±1.1; p<0.001) than that of group A. Complications such as hiccups and laryngospasm were more frequent in group B, while blood-stained secretions were more common in group A (Table-VII).

Table-I: Age and gender distribution of the patients (N=120)

Variables	Group A (n=60)		Group B (n=60)		p-value
	Frequency	Percentage	Frequency	Percentage	
Age group (in years)					
21-30	20	33.3	10	16.7	
31-40	15	25.0	25	41.7	
41-50	10	16.7	15	25.0	>0.05
51-60	15	25.0	10	16.7	
Mean±SD	35.2±8.1 years		37.5±7.9 years		
Gender					
Male	38	63.3	35	58.3	>0.05
Female	22	36.7	25	41.7	

Table-II: Comparison of duration of surgery and anesthesia between two groups (N=120)

Variables (duration in minutes)	Group A (n=60) (Mean±SD)	Group B (n=60) (Mean±SD)	p-value
Surgery	95.2±15.3	105.1±14.7	<0.001
Anaesthesia	120.5±10.2	130.3±12.4	<0.001

Table-III: Comparison of time required for insertion between two groups (N=120)

Variables	Group A (n=60)		Group B (n=60)		p-value
	Frequency	Percentage	Frequency	Percentage	
1st attempt <15 sec	40	66.7	44	73.3	>0.05
1st attempt 15–30 sec	14	23.3	14	23.3	>0.05
1st attempt > 30 sec or 2nd attempt	6	10.0	2	3.3	>0.05

Table-IV: Comparison of intraoperative clinical parameters between two groups (N=120)

Variables	Group A (n=60)		Group B (n=60)		p-value
	Frequency	Percentage	Frequency	Percentage	
Jaw relaxation					
Relax	46	76.7	42	70.0	<0.05
Stiff	10	16.7	12	20.0	<0.05
Hard	4	6.7	6	10.0	<0.05
Successful NG tube insertion	52	86.7	46	76.7	>0.05
Volume of air needed	10	16.7	14	23.7	>0.05

Table-V: Comparison of pharyngeal Leak pressure in both groups (N=120)

	Mean±SD	Mean±SD	
Pharyngeal leak pressure cm of H_2O	32.1±4.6	36.2±4.2	<0.001

Table-VI: Comparison of the haemodynamic parameters between two groups (N=120)

	Group A (n=60)			Group B (n=60)		
	Before	After		Before	After	p-value
Variables	Mean±SD		p-value	Mean±SD		
HR /minute	75±10	70±8	<0.05	78±12	72±9	<0.05
SBP mm of Hg	120 ± 15	115 ± 14	<0.05	125 ± 10	118 ± 12	<0.001
DBP mm of Hg	80±5	75±6	<0.001	82±7	78±8	<0.05
MAP mm of Hg	93±11	88±10	<0.05	95±12	90±9	<0.05
SpO_2	98±1	99±1	<0.001	97±2	98±1	<0.001

Table-VII: Comparison of complications between two groups (N=120)

Complications	Group A (n=60) Mean±SD	Group B (n=60) Mean±SD	p-value
Bloodstained secretion	12.0±3.5	10.5±4.0	>0.05
Hiccup	3.0±1.2	4.0±1.5	>0.001
Laryngospasm	2.5±1.0	3.5±1.1	>0.001

Discussion

The present study was conducted to evaluate the clinical performance and pharyngeal leak pressure of the laryngeal mask airway (LMA) Supreme before and after the administration of cisatracurium in surgical patients. The findings revealed that cisatracurium significantly influenced pharyngeal leak pressure, and hemodynamic stability, with some differences in complication rates. The demographic characteristics, including age and gender distribution, showed no statistically significant differences between the two groups. This homogeneity suggests that the results were not influenced by demographic variability, allowing a more accurate assessment of the effects of cisatracurium. Similar findings were found by Byun *et al.* and Kishnani *et al.* in evaluating the role of neuromuscular blockers in airway management.[12,13] A key finding was that the duration of surgery and anaesthesia was significantly longer in group B (p<0.001). This could be attributed to the prolonged muscle relaxation effects of cisatracurium, which may have facilitated better intraoperative

conditions but also led to extended anesthesia time. Moreover, van Zundert *et al.* reported that neuromuscular blockade optimizes surgical field conditions, reducing airway resistance and improving ventilation efficiency.[14] Successful insertion within 15 seconds was higher in group B (73.3%) than in group A (66.7%), while prolonged insertion was more frequent in group A (10.0%) than in group B (3.3%); however, the difference was not significant (p>0.05). Chen *et al.* suggested that neuromuscular blockers are not necessary for placement of ProSeal LMA, rather it results in prolonged recovery time and hospital cost.[15] The observed non-significant results in LMAS insertion of our study further contradict the role of cisatracurium in optimizing supraglottic airway device placement. Pharyngeal leak pressure was significantly higher in group B (p<0.001). This suggests that cisatracurium enhances the airway seal, likely by reducing laryngeal muscle tone and improving LMA conformation to the airway anatomy. Higher pharyngeal leak pressures have been associated with reduced airway complications and improved ventilation efficiency, making cisatracurium a beneficial adjunct in LMA use.[16,17] Jaw relaxation was better in group A than that of group B (76.7% vs. 70.0%, p=0.015), which contrasts with findings suggesting that neuromuscular blockers generally improve jaw relaxation. This discrepancy could be due to individual variations in neuromuscular response or the dose-dependent effects of cisatracurium. Kim *et al.* indicated that muscle relaxants might affect NG tube placement due to altered airway muscle tone.[18] Haemodynamic parameters showed improvements post-insertion in both groups. Group B had a greater reduction in systolic blood pressure (p<0.001), which may be due to reduced airway stimulation during insertion. In another study done by van Zundert *et al.* demonstrated that neuromuscular blockers mitigate haemodynamic fluctuations by minimizing airway reflex responses.[14] The reduction in mean arterial pressure and diastolic blood pressure in group B supports the hypothesis that cisatracurium contributes to stable intraoperative haemodynamics. Complications varied between the groups. A higher incidence of blood-stained secretion was observed in group A, while hiccups and laryngospasms were more frequent in group B (p<0.001). These findings suggest that while cisatracurium enhances LMA performance, it may also increase airway sensitivity, predisposing patients to minor complications. Similar trends have been reported by Chen *et al.* while assessing neuromuscular blockers in airway management; The results indicate the need for careful patient selection and monitoring.[16] The administration of cisatracurium significantly improved pharyngeal leak pressure while providing better hemodynamic stability. However, the increased incidence of minor complications highlights the importance of individualized airway management strategies. Future studies with larger sample sizes and different surgical populations are needed to further validate these findings.

Conclusion

Cisatracurium administration significantly improved the pharyngeal leak pressure of the Laryngeal Mask Airway Supreme, ensuring better airway sealing and hemodynamic stability. However, it was associated with an increased incidence of minor complications such as hiccups and laryngospasm. These findings suggest that while cisatracurium enhances supraglottic airway performance, its risks should be considered in clinical practice. Further research is needed to optimize its use for improved patient outcomes.

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