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Evaluation of thyromental distance versus tongue width versus weight-based method for size determination of laryngeal mask airway in adults

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ABSTRACT

Background: Supraglottic airway devices (SGD) are indispensable for airway management. The successful placement of the laryngeal mask airway (LMA) supreme largely depends on the right size selection. **Aims and Objectives:** The study was undertaken to compare three LMA supreme insertion methods in short elective surgeries under general anesthesia. **Materials and Methods:** Atotal of 90 American Society of Anesthesiologists I and II patients (either gender, 18–55 years, Mallampati grade I and II) undergoing short surgeries were randomized into three equal groups (n = 30 in each). Insertion of LMA was done after an adequate depth of anesthesia for jaw relaxation (Young's criteria). The efficacy of controlled ventilation through LMA by each method, success rate, ease of insertion, insertion time, additional induction dose (propofol) required during insertion, hemodynamic stability (baseline vitals and 10 min after insertion), and adverse events after LMA removal were evaluated between groups. **Results:** Better ventilation (tidal volume at 10 cmH_2O) was observed in the thyromental group (448 ± 35) than in tongue width (440 ± 46) and weight-based (409 ± 33) groups. Minimum additional propofol requirement during insertion was in thyromental distance group. Thyromental distance group had the most easy LMA insertions (70%) with minimum insertion time (10 ± 4) and minimum additional propofol requirement during insertion ($P < 0.05$) than other groups. Overall hemodynamic stability and incidence of adverse events were comparable. **Conclusion:** Thyromental distance may be an alternative attractive choice for size determination of LMA supreme in female adults with normal airway anatomy in comparison to tongue width and conventional body weight-based methods.

Key words: Laryngeal mask airway; Anesthesia; Hemodynamic; Ventilation; Airway; Thyromental distance; Tongue width; Body weight

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INTRODUCTION

Airway management is of prime importance to an anesthesiologist and is a core component of anesthetic care. Laryngeal mask airway supreme (LMA Supreme, The Laryngeal Mask Company, Singapore), which brings together features of the LMA Proseal, the LMA Fastrach, and the LMA Unique, is a single-use inflatable device with an esophageal drainage tube for suctioning gastric contents developed by Archie Brain in 2006. American Society of Anesthesiologists (ASA) recommended the use of supraglottic airway devices (SGD) as rescue ventilatory devices for patients who cannot be intubated and ventilated conventionally.[1] Furthermore, there is no need for muscle relaxants during their application.[1,3] It takes just 20–40 s for the percentage saturation of hemoglobin with oxygen (SpO_2) to fall from 80% to 40%.[2] Thus, it is of immense benefit to simulate a difficult airway scenario and identify beforehand which supraglottic device would be able to establish airway successfully in minimum time in a real

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difficult airway scenario. Inserting an improper-size LMA Supreme may result in malposition[4-6] and failed ventilation. Although the manufacturer's stated recommendations for LMA Supreme size selection are based on body weight,[7] the size of the airway anatomy may not always correspond to body weight, especially in cases where the patient is obese or undernourished[8-10] The patient's weight may not even be known in an emergency. To our knowledge, no previous trials have compared more than two LMA Supreme insertion methods, and also, no comparison has been made between thyromental distance and tongue width methods. Therefore, in this prospective randomized study, a comparison of three supraglottic airway insertion methods, namely, thyromental distance, tongue width, and body weight-based methods, was done to compare the efficacy of ventilation (tidal volume generated at 10 cm H_2O inspiratory pressure) and the outcome differences (overall success rate, attempts made, the time required for successful insertion, and ease of insertion). Secondary objectives included end-tidal CO_2, SpO_2, additional induction drug required for adequate jaw relaxation for insertion, and associated adverse effects after removal (sore throat, blood staining on LMA). Hence leading to efficient and fast decisions and better airway management.

Aims and objectives

To compare thyromental distance, tongue width, and weight-based method for size determination of laryngeal mask airway supreme in adults. Comparison of efficacy of ventilation(primary objective). To study variables, additional induction doses, and adverse events(secondary objective).

MATERIALS AND METHODS

This prospective, randomized, and comparative study was conducted in the Department of Anaesthesiology, M.G.M. Medical College and M. Y. Hospital, Indore, Madhya Pradesh for 12 months, from October 01, 2021 to October 2022, after approval from Institutional Ethics and Scientific Review Committee (EC/MGM/JULY-21/17). Following written informed consent, randomization was done by chit method (n=30 in each group) and pre-anesthetic checkup was done. In *thyromental distance-based group*, the thyromental distance was measured by the palm of patient's hand. For example, if it was four fingers wide (index, middle, ring, and little fingers), size 4 LMA Supreme was selected (Figure 1). Scales corresponding to LMAs (Nos. 3, 4, and 5) were taken for the tongue width-based group. The largest width of each LMA, in which the cuff was least inflated, was used to calculate the width of each ruler. The patient was instructed to relax and open his mouth while protruding his tongue. The equivalent ruler, which was the same width as the tongue, was used

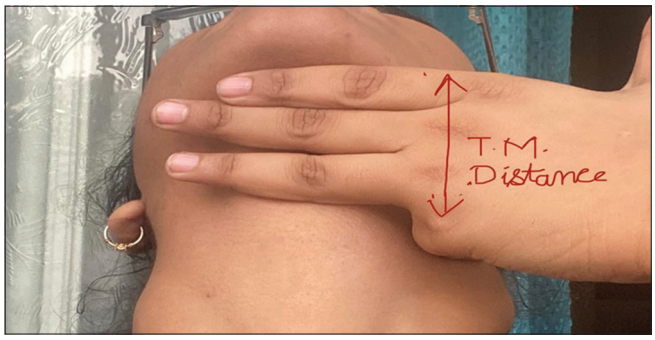

Figure 1: LMA Supreme size determination according to thyromental distance

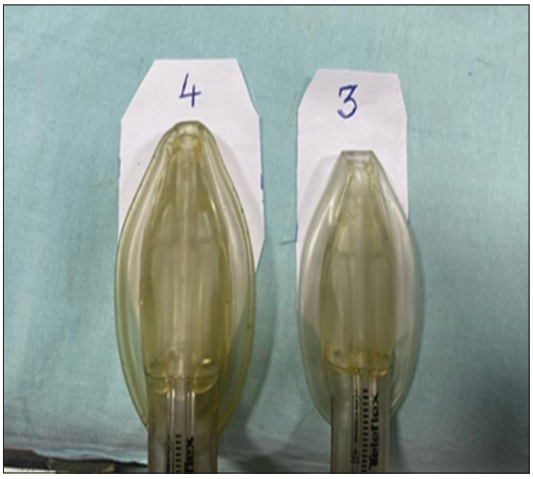

Figure 2: LMA Supreme size according to tongue width

to measure the size of the LMA (Figure 2). In weight-based group, the size of the LMA Supreme was chosen according to body weight. Size 3 was selected for body weight <50 kg, size 4 for body weight 50–70 kg, and size 5 for body weight >70 kg.

Inclusion criteria

The study included 90 patients of ASA grade I and II, age between 18 and 55 years, either sex, with Mallampati class I and II, posted for surgeries of time duration of <2 h after written informed consent.

Exclusion criteria

It was as follows: patient refusal, patients with body mass index <30 kg/m^2 or >30 kg/m^2, having a high risk of regurgitation or aspiration (Hiatal hernia, Zenker diverticulum, scleroderma, pregnancy, history of gastroesophageal reflux disease, uncontrolled diabetes mellitus, and obesity) or having a potentially difficult airway (history of difficulty airway, mouth opening <2 cm, limited neck extension or cervical spine pathology) or a preoperative sore throat or respiratory tract pathology or prone/lateral positions during surgery.

In the operating room, baseline hemodynamic parameters (HR, SBP, DBP MAP, $ETCO_2$, SpO_2) were noted and the size of LMA was determined according to the group allotted. The general anesthesia technique was standardized for all three groups. Induction was done with Inj. Fentanyl 2mcg/kg iv over 10 s and after 2 min, injection propofol 2 mg/kg IV over 1 min. The jaw thrust was used as an indicator of adequate depth of anesthesia.[11,12] LMA supreme insertion was done by an experienced anesthesiologist using index finger technique after lubricating the device.[13,16] On attempting LMA insertion, additional induction doses of propofol (0.5 mg/kg) were given over 30 s, if mouth opening was not adequate or excessive cough or gag reflexes preventing proper placement of LMA occurred. A square end-tidal carbon dioxide trace, adequate chest expansion, presence of equal breath sounds over all lung fields, indicate valid ventilation. Successful airway establishment was defined as a tidal volume >4 mL/kg achieved through LMA by a positive inspiratory pressure <15 cm H_2O. All the patients received pressure-controlled ventilation (PCV) (inspiratory pressure=10cm H_2O, respiratory rate (RR)=12/min, and an inspiratory/expiratory ratio (I: E) of 1:2. Grading of the efficacy of ventilation was done as excellent; if tidal volume was 8 mL/kg, or as "acceptable"; if 4 mL/kg< tidal volume <8 mL/kg.[14] If ventilation was inadequate, anesthetists were allowed to perform manipulations (adjusting head and neck position, adjusting depth of insertion, and applying jaw lift) to adjust LMA position. Induction time, insertion time, ease of insertion, number of attempts required for LMA insertion, additional doses of propofol during LMA insertion, and associated hemodynamic changes were considered and noted. At the end of the surgery, the airway device was inspected for the presence of visible blood by a blinded observer after removal. Patients were observed for complications (hypoxemia, sore throat, aspiration, laryngospasm, and bronchospasm) immediately after LMA removal and after 45 min in the postoperative period.

The following criteria were used for grading the insertion condition:[17]

Scores for jaw mobility

1. For a fully relaxed jaw with no muscle tone, 2 for moderately relaxed with some muscle tone, 3 for poorly relaxed with full muscle tone.

Scores for coughing/bucking

1. For no coughing, 2 for 1–2 coughs, 3 for ≥3 coughs, and 4 for bucking.

A combined score of ≤2 was considered optimal (easy) for LMA insertion, score 3- fair to insert, a score 4–5 – "difficult" to insert, and a score of 6–8 –"impossible" to insert.

RESULTS

Ninety patients were divided into three groups equally after consent. There were no significant differences in the patient demographics data (age, weight, height), surgical characteristics (induction time, surgery duration), ASA grade, and Mallampati grade. Except for gender, the majority of study participants were females, i.e., 78 out of 90, which was statistically significant (P<0.05) (Table 1).

Among LMA insertion parameters, the thyromental distance group had larger easy insertions than other groups, while the weight-based group had the most difficult insertions. Therefore, the thyromental distance group showed better ease of insertion than others (P<0.05) (Table 2).

LMA insertion time was maximum in the weight-based group, and was statistically significant (P<0.05) as compared to others, although insertion attempts were almost comparable in all the three groups (P=0.38). Maximum LMA adjustments were required in the weight-based group, which was statistically significant than in other groups (P=0.01). A larger LMA size was required according to the weight-based method (P=0.02) (Table 2).

Comparison of total propofol requirements among groups showed no significant difference among initial propofol requirements, although maximum additional propofol requirements during LMA insertion were observed in the weight-based group than thyromental distance and tongue width group (Table 2).

Distribution of patients according to baseline vital parameters (HR, SBP, DBP, MAP, SpO_2,) and 10 min after LMA insertion through different methods showed similar hemodynamic stability among all three groups and were comparable (Table 3).

Comparison of ventilation parameters after 10 min of LMA insertion showed mean Tidal volume at 10 cmH_2O significantly higher in the thyromental group than others and was least in the weight-based group (P<0.05). Similarly, respiratory parameters like mean $ETCO_2$ values 10 min after LMA insertion showed higher $ETCO_2$ value in the thyromental distance group and least in the weight-based group (P<0.05) (Table 3).

Among comparisons of patients based on adverse effects after LMA insertion postoperatively, there is no significant association between blood on LMA and different methods (P=0.48). Sore throat at 0 min was significantly high (P=0.02) in the weight-based group than others. At 45 min, there is no significant difference in the sore throat (P=0.16) among all three groups (Table 4).

Table 1: Comparison of the patients in terms of demographic profile and other parameters

Factors	Distribution	Thyromental distance	Tongue width	Weight based	P-value
Age	Mean±SD	34.10±13.428	33.50±11.587	37.23±14.083	0.49 (not significant)
Height	Mean±SD	162.48±6.197	160.33±3.47	161.33±4.866	0.25 (not significant
Weight	Mean±SD	58.20±9.683	54.10±10.118	54.83±9.494	0.22 (not significant)
Gender	Male	9 (30.0%)	1 (3.3%)	2 (6.7%)	0.004 (significant)
	Female	21 (70.0%)	29 (96.7%)	28 (93.3%)	
ASA grade	1	18 (60.0%)	19 (63.3%)	15 (50.0%)	0.55 (not significant)
	2	12 (40.0%)	11 (36.7%)	15 (50.0%)	
Mallampati grade	1	15 (50.0%)	10 (33.33%)	11 (36.66%)	0.37 (not significant)
	2	15 (50.0%)	20 (66.66%)	19 (63.33%)	
Induction time	Mean±SD	8.3±1.0	8.4±0.9	8.4±0.9	0.05 (not significant)
Duration of surgery	Mean±SD	74±21	72±16	76±22	0.05 (not significant)

Table 2: Comparison of the patients in terms of ease of insertion, insertion time (sec), propofol requirements (mg), insertion attempts, LMA adjustments required more than once, and LMA size

Parameters	Thyromental distance		Tongue width		Weight based		P-value
	Count	Column n %	Count	Column n %	Count	Column n %	
Ease of insertion							
Difficult	2	6.67%	5	16.67%	7	23.3%	0.007 significant
Easy	21	70.00%	19	63.33%	8	26.6%	
Fair	7	23.33%	6	20.00%	15	50.00%	
Insertion time (s)	10±4		13±5		18.5±7		0.0002 significant
Propofol requirements							
Initial dose (mg)	114±19		110±19		108±20		>0.05 not significant
Propofol requirements							
Additional dose (mg)	11±5		15±6		20±8		>0.05 not significant
Insertion attempts							
1	29	96.7%	26	86.7%	27	90.0%	0.38 not significant
2	1	3.3%	4	13.3%	3	10.0%	
LMA adjustment required more than once							
No	22	73.3%	21	70.0%	12	53.0%	0.01 significant
Yes	8	26.7%	9	30.0%	18	47.0%	
LMA size							
3	22	73.3%	21	70.0%	11	36.7%	0.02 significant
4	8	26.7%	9	30.0%	18	60.0%	
5	0	0.0%	0	0.0%	1	3.3%	

Table 3: Distribution of patients according to vitals (HR, SBP, DBP, MAP, SpO_2) and ventilation parameters (tidal volume and $EtCO_2$) 10 min after LMA insertion

10 min after LMA insertion	Group name						
	Thyromental distance		Tongue width		Weight based		One way ANOVA test applied
	Mean	Standard deviation	Mean	Standard Deviation	Mean	Standard deviation	P-value
HR	77	9	78	10	82	11	>0.05 not significant
SBP	108	9	106	8	107	10	>0.05 not significant
DBP	67	6	67	5	68	7	>0.05 not significant
MAP	81	7	80	5	80	7	>0.05 not significant
SpO_2	100	0	100	0	99	1	>0.05 not significant
Tidal volume under 10cm H_2O	448	35	440	46	409	33	<0.05 Significant
$EtCO_2$	35	2	34	2	32	2	<0.05 Significant

DISCUSSION

In this study, 90 patients undergoing short elective surgery under general anesthesia were randomly divided for comparison of three LMA supreme insertion methods, namely thyromental distance, tongue width, and conventional weight-based methods.

As stated by Tham,[18] a fundamental difficulty in predicting optimal LMA size are that the relationship between gender,

Table 4: Comparison of the patients based on adverse effects- blood on LMA, sore throat 0 min after removal and 45 min after removal

Parameters	Thyromental distance		Tongue width		Weight based		P-value
	Count	Column n %	Count	Column n %	Count	Column n %	
Blood on LMA							
No	28	93.3%	25	83.3%	26	86.7%	0.48 Not significant
Yes	2	6.7%	5	16.7%	4	13.3%	
Sore throat (0 min)							
None	29	96.7%	24	80.0%	20	66.7%	0.02 significant
Mild	1	3.3%	6	20.0%	8	26.66%	
Moderate	0	0.0%	0	0.0%	2	6.66%	
Sore throat (45 min)							
None	28	93.3%	25	83.33%	24	80.0%	0.16 Not significant
Mild	2	6.7%	4	13.33%	2	6.66%	
Moderate	0	0%	1	3.33%	4	13.33%	

weight, height, and pharyngeal geometry is inconsistent. In the present study, one of the objectives was to compare LMA insertion ease. A sum of scores of jaw mobility and coughing/bucking was used to assess the acceptable conditions for insertion of LMA supreme. A combined score of <2 was considered easy, 3 as fair, and 4–5 as difficult.[17] The thyromental distance group has the largest easy insertions (70%) while the weight-based group has the most difficult ease of insertion (23%) (Table 2) and this observation was supported by Miao and Weng[15] study. In the present study, the insertion time was shorter in the thyromental distance-based group (10±4 s), followed by the tongue width group (13±5 s), and the longest in the weight-based group (18.5±7 s). The insertion time in this study was similar to the study done by Timmerman et al.,[24] (10 s) but less than the study done by Weng et al.,[14] The difference can be attributed to different definitions of LMA insertion time taken in the studies (Table 2). Insertion attempts were almost comparable in all the 3 groups which is consistent with the results of other studies on LMA Supreme or LMA Proseal done by Yao et al.,[19] Howes et al.,[20] Tham LC,[18] Thm HM,[21] and Eschertzhuber S[22]. The majority of patients in the thyromental distance (73.3%) and tongue width (70%) groups required no LMA adjustments after insertion (P=0.01) when compared to the weight-based group (40%). The weight-based group required the largest LMA size, which was statistically significant (P=0.02), i.e., 60% (LMA 4) and 3.3% (LMA 5) in comparison to 26.7% (LMA 4) and 30% (LMA 4) for thyromental distance and tongue width, respectively which were consistent with the studies done by Miao and Weng[15] and Huang and Cherng.[23]

Mean Induction time, mean Duration of surgery, pre-induction vitals and vitals after LMA insertion between groups were found to be statistically non-significant (P>0.05), demonstrating similar hemodynamic status among the three groups for HR, SBP, DBP, MAP, RR, SPO_2 (Tables 1 and 3). However, a statistically significant difference (P<0.05) was found between ventilatory parameters, with the thyromental distance group showing the most efficacious ventilation. 10 min after LMA insertion, mean tidal volume at 10 cm H_2O positive inspiratory pressure, was significantly higher in the thyromental distance, followed by tongue width and least in the weight-based group. $ETCO_2$ achieved 10 min after LMA insertion was also highest in the thyromental group (35±2), tongue width (34±2), and least in the weight-based group (32±2) (Table 3).

Further, all patients who had unacceptable jaw relaxation were given additional induction doses of propofol after the estimated induction dose for the destined size of LMA according to a given group. The mean initial (induction) propofol dose (2.5 mg/kg) was according to Scalon et al., for LMA insertion. Additional propofol requirement for LMA insertion was statistically significantly high (P>0.05) for the weight-based group (20±8) than other groups (Table 2).

One of the complications arising from LMA insertion is intraoral mucosal scratching. No significant difference in the incidence of blood staining on the device was found among the study groups (P=0.48), with incidence (6.7–16.7%) in the present study. Other randomized studies have reported similar incidences of visible superficial hemorrhage (9–14%).[2,7] The whole incidence of mild sore throat (6.66–13.33%) at 45 min after LMA removal in this study was a little bit higher than that literature stated by Chew et al.,[25] (3–10%) This may be because, in the present study, LMA was removed after the patient regained consciousness (Table 4).

Overall, the results of the present study were in concurrence with the study done by Weng et al., which showed that patients in the thyromental distance-based group got significantly better ventilation and easier and faster LMA placement as compared to the weight-based group. Especially for overweight patients (BMI >23), the number of patients who achieved "excellent" tidal volume (>8 mL/kg) under 10 cm H_2O PCV was significantly more

in the thyromental distanced-based group as compared with that in the weight-based group.

Limitations of the study

There may be a gender bias in the results due to the majority of patients being women. The study only involved patients of BMI <30 kg/m^2 or >30 kg/m^2 for elective short surgeries, the results may not be applicable to other patients who are morbidly obese. Adults with normal airways (Mallampati grade 1, 2, adequate mouth opening and neck extension) and age group 18–55 years were only included; hence the results may not be applicable to patients with difficult airways, the elderly, and children. Furthermore, visual confirmation of correct device placement through a fibreoptic bronchoscope was not attempted.

CONCLUSION

Thyromental distance may be an alternative attractive choice for size determination of LMA Supreme in female adults with normal airway in comparison to tongue width and conventional body weight-based methods as LMA size determination by thyromental distance significantly provided the most efficacious ventilation than other methods. Thyromental distance was superior in providing better insertion conditions for LMA supreme because it resulted in the least insertion attempts, least LMA adjustments after insertion, smallest insertion time, and most ease in airway placement. In addition to the induction dose of propofol; a maximum additional dose of propofol was required by weight-based method during LMA insertion, followed by tongue width and minimum by thyromental distance method. In the group where LMA size was determined on body weight, the prevalence of adverse events such as sore throat was highest immediately following LMA removal.

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Authors Contribution:
SJ- Concept and design of the study, prepared the first draft of the manuscript and guidance; **PJ**- Interpreted the results; reviewed the literature, statistical analysis, and manuscript preparation; **AKK**- Guidance.

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