Clinical Reports

The advantages of the LMA over the tracheal tube or facemask: a meta-analysis

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A meta-analysis was performed on randomised prospective trials comparing the laryngeal mask airway (LMA) with other forms of airway management to determine if the LMA offered any advantages over the tracheal tube (TT) or facemask (FM). Of the 858 LMA publications identified to December 1994, 52 met the criteria for the analysis. Thirty-two different issues were tested using Fisher's method for combining the P values. The LMA has 13 advantages over the TT and four over the FM. The LMA had two disadvantages over the TT and one over the FM. There were 12 issues where neither device had an advantage. Advantages over the TT included: increased speed and ease of placement by inexperienced personnel; increased speed of placement by anaesthetists; improved haemodynamic stability at induction and during emergence; minimal increase in intraocular pressure following insertion; reduced anaesthetic requirements for airway tolerance; lower frequency of coughing during emergence; improved oxygen saturation during emergence; and lower incidence of sore throat in adults. Advantages over the FM included: easier placement by inexperienced personnel; improved oxygen saturation; less hand fatigue; and improved operating conditions during minor paediatric otological surgery. Disadvantages over the TT were lower seal pressures and a higher frequency of gastric insufflation. The only disadvantage compared with the FM was that oesophageal reflux was more likely. The importance of these findings in terms of patient outcome could not be determined from the published data.

Une méta-analyse d'études randomisées et prospectives comparant le masque laryné (ML) avec les autres modes de gestion des voies aériennes a été réalisée dans le but de déterminer si le ML présentait des avantages sur le tube trachéal (TT) et le masque facial (MF). Des 858 publications portant sur le ML compilées jusqu'en décembre 1994, 52 ont rencontré les critères de l'analyse. Trente-deux parutions différentes ont été analysées avec la méthode de Fisher pour la combinaison des valeurs de P. Le ML possédait 13 avantages sur le TT et quatre sur le MF. Le ML possédait deux désavantages sur le TT et un sur le MF. Dans douze parutions, aucun des dispositifs n'offrait un seul avantage sur les autres dispositifs. Les avantages du ML sur le TT comprenaient: l'augmentation de la vitesse et de la facilité d'insertion par du personnel inexpérimenté; l'augmentation de la vitesse d'insertion par l'anesthésiste; l'amélioration de la stabilité hémodynamique à l'induction et au réveil; l'amélioration de la saturation en oxygène à la phase de réveil; et une plus faible incidence de maux de gorge. Les avantages sur le MF étaient: la facilité de mise en place par le personnel inexpérimenté; l'amélioration de la saturation en oxygène; une fatigue moindre pour la main; l'amélioration de conditions chirurgicales pendant la chirurgie pédiatrique mineure. Les désavantages sur le TT étaient la baisse de la pression d'étanchéité et une augmentation de la fréquence de l'insufflation gastrique. Le seul désavantage sur le MF était une plus grande susceptibilité au reflux oesophagien. L'importance de ces constatations sur le devenir du patient n'a pu être déterminée à partir des données publiées.

Key words

LARYNGEAL MASK AIRWAY: meta-analysis, risk benefits.

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The laryngeal mask airway (LMA) has gained widespread acceptance as a general purpose airway with worldwide usage estimated at over ten million patients by 1993.[1] The popularity of the device for routine use stems from its perceived benefits for the patient and anaesthetist over traditional forms of airway management. Prospective surveys have shown the overall success rate for the technique to be high and the complication rate low,[2-5] but it has been suggested that there is a lack of

randomised prospective trials in peer review journals demonstrating any advantages over the facemask (FM) or tracheal tube (TT),[6] a view reiterated in a recent review[7] and accompanying editorial[8] published in the *Canadian Journal of Anaesthesia*.

The following meta-analysis of randomised prospective trials in peer review journals was performed to determine if the LMA offered any advantages over the TT or FM.

Methods

A literature search was conducted to obtain all publications on the LMA up to December 1994. Three medical databases (48 hours; Medline and Reference Manager Update) were searched for citations containing key words, subject headings and text entries related to the LMA. Additional references were obtained from the indices of anaesthetic journals listed in Index Medicus* and a comprehensive bibliography provided by Intavent, UK.† Prospective randomised studies comparing the LMA with the tracheal tube or facemask were selected for analysis. Only papers and abstracts from peer review journals were included. Data from abstracts published before 1990 or subsequently published as a full paper were excluded.

Data were obtained from the selected papers/abstracts about the type of comparative study (LMA vs TT, LMA vs FM, LMA vs FM vs TT), the study population size and type (adult, paediatric or mixed), the type of surgery (peripheral/superficial or head/neck), the phase of anaesthesia studied (induction, maintenance, emergence, postoperative), ventilation mode, LMA user (anaesthetist or non-anaesthetist), success with the device (considered successful if LMA technique was abandoned in $<5\%$ cases) and insertion technique (standard,[9] other or unknown). All issues addressed by each study were catalogued and their P values documented. The criteria for homogeneity were that the study issue and anaesthesia phase were identical. Where the studies were homogenous the P values for each issue were pooled and analysed. A null hypothesis was formed that the LMA offered no advantage over the TT or FM for a particular issue. This null hypothesis was tested for each issue using Fisher's method for combining the P values.[10] The test statistic for Fisher's method is -2 times the sum of the natural logarithms of the P values from each study, and this has a χ^2 distribution with degrees of freedom equal to twice the number of studies. Significance was taken as $P < 0.05$. Only issues addressed by two or more trials were included in the meta-analysis. For convenience, the study issues were divided into six sections: (1) placement; (2) physiology; (3) airway mechanics; (4) airway problems/complications; (5) postoperative aspects and (6) miscellaneous.

*Acta Anaesthesiologica Belgica, Acta Anaesthesiological Scandinavica, Anaesthesia, Anaesthesia and Intensive Care, Anasthesiologie und Réanimation, Anaesthetist, Anathesiologie, Intensivmedizin, Notfallmedizin, Schmerztherapie, Anesteziologiia I Réanimatologiia, Anesthesia and Analgesia, Anesthesiology, Annales Françaises D Anesthésie et de Réanimation, British Journal of Anaesthesia, Cahiers d'Anesthésiologie, Canadian Journal of Anaesthesia, Clinical Journal of Pain, European Journal of Anaesthesiology, International Anesthesiology Clinics, Journal of Cardiothoracic and Vascular Anesthesia, Journal of Clinical Anesthesia, Journal of Neurosurgical Anesthesiology, Klinische Anaesthesiologie und Intensivtherapie, Ma Tsui Hsueh Tsa Chi, Japanese Journal of Anesthesiology, Middle East Journal of Anesthesiology, Minerva Anesthesiologica, Regional Anaesthesie, Regional Anesthesia, Resuscitation, Revista Espanola De Anestesiologia y Réanimacion.

†LMA bibliography obtainable from Intavent Research Ltd, Cedar Court, 9-11 Fairmile, Henley-on-Thames, Oxon RG9 2JR, UK

Data abstraction

Eight hundred fifty-eight publications on the LMA were catalogued by the author to the end of 1994. This comprised: 160 papers, 132 abstracts, 40 mini-papers (letters containing study data), 61 full case reports, 105 case reports as letters to the editor, 287 other letters, 23 reviews, 15 editorials and 36 other publications, including coincidental use of the LMA in other studies, articles and manuals. The 160 candidate papers and 132 candidate abstracts were examined by two unblinded observers. Where there was a conflict in the observation a third observer was utilised. Two hundred forty papers/abstracts failed to meet the criteria for analysis primarily on the grounds that they were not randomised controlled trials comparing the LMA with other forms of airway management or had not been published in peer review journals. Fifty-two papers/abstracts met the criteria for analysis. This included 37 papers[11–47] and 15 abstracts.[48–62] Thirty-five studies compared the LMA with the TT (refs. 11–13, 15, 17–23, 31–35, 37, 38, 40–47, 51, 52, 54–58, 60, 62), 14 studies compared the LMA with the FM (refs. 14, 16, 24–28, 30, 36, 39, 49, 50, 53, 61), one study compared the LMA with the TT and FM[48] and two studies compared the LMA with a combined TT/FM technique where the TT was replaced by a FM for emergence.[29,59]

Results

The total study population was 2440 patients and the mean (SD, range) study population size was 47 (30, 10–130). Details about population type, ventilation mode, the LMA user, success with the device and insertion technique are given in Table I. The mean (range) for the

TABLE I Details about population type, ventilation mode, user, success with the device and insertion technique for comparative studies of the laryngeal mask airway (LMA), tracheal tube (TT) and or facemask (FM)

	LMA/FM	*LMA/TT*	*LMA/TT/FM*	*Total (%)*
Population type				
Adult	11	29	1	41 (78.8)
Child	3	6	1	10 (19.2)
Mixed	0	0	1	1 (1.9)
Ventilation mode				
IPPV	3	20	1	24 (46.2)
SV	10	11	2	23 (44.2)
Mixed	1	3	0	4 (7.7)
Unknown	0	1	0	1 (1.9)
User				
Anaesthetist	11	31	3	45 (86.6)
Non-anaesthetist	3	4	0	7 (13.5)
Insertion technique				
Standard	7	5	0	12 (23.1)
Other	0	0	0	0 (0)
Unknown	7	30	3	40 (76.9)
Success rate				
<5% failure	5	15	0	20 (38.5)
≥5% failure	2	5	1	8(15.4)
Unknown	7	15	2	24 (46.2)

number of issues assessed by each paper/abstract was 4.1 (1–14). A null hypothesis could be constructed for 23 issues between the LMA and TT and nine between the LMA and FM. The LMA had 13 advantages over the TT and four over the FM. The LMA had two disadvantages over the TT and one over the FM. There were 12 issues where neither device had an advantage. Advantages over the TT included: increased speed and ease of placement by inexperienced personnel; increased speed of placement by anaesthetists; improved haemodynamic stability at induction and during emergence; minimal rise in intraocular pressure following insertion; reduced anaesthetic requirements for airway tolerance; lower frequency of coughing during emergence; improved oxygen saturation during emergence; and lower incidence of sore throat in adults. Advantages over the FM included: easier placement by inexperienced personnel; improved oxygen saturation; less hand fatigue; and improved operating conditions during minor paediatric otological surgery. Disadvantages over the TT were lower seal pressures and a higher frequency of gastic insufflation. The only disadvantage compared with the FM was that oesophageal reflux was more likely. The detailed results of the meta-analysis are given in Table II.

Discussion

There were a number of deficits in the analysed studies which limit the findings. Firstly, only 10/52 studies were blinded allowing both user and observer bias. In most circumstances this was not an error of study design, but reflects the difficulties of blinding observational studies between different airway devices. Secondly, in only 12/52 studies was an attempt made to define the LMA insertion technique. It is probable that some techniques may lead to suboptimal positioning and thus influence measured variables.[63] Finally, in most studies whilst it was possible to determine if the user was an anaesthetist, their experience with the LMA was usually not defined and there is a probable learning curve with LMA usage.[64]

Despite these shortcomings, this analysis indicates that there is substantial evidence from randomised comparative studies that the LMA has some advantages and disadvantages over the tracheal tube and facemask. Unfortunately the data were not considered to be sufficiently homogenous to make meaningful estimates of the size of the difference between the airway devices. There was also no evidence that any of these differences result in an improvement in patient outcome. However, it is notoriously difficult to demonstrate outcome benefits even with items of anaesthetic equipment that have been universally accepted such as the pulse oximeter.[65,66] Furthermore, some of the benefits of the LMA cannot be measured in randomised controlled studies particularly in situations where the LMA compliments other forms of airway management or when it is used in unique situations such as airway rescue or as an aid to intubation. Also, where one form of airway management is contraindicated, comparisons between airway devices cannot be made.

There are several areas where the LMA has the potential to benefit patients compared with the TT. The increased speed and reliability of placement by inexperienced personnel suggests a potential role in resuscitation.[67] The haemodynamic stability at induction and during emergence may be of benefit to patients with cardiovascular disease, and a recent controlled trial comparing normotensive with hypertensive patients supports this concept.[68] The minimal changes in intraocular pressure may be of benefit to patients with glaucoma.[37] The low frequency of coughing during emergence may be beneficial to patients following open eye or ENT surgery where excessive straining is potentially harmful. The LMA may even offer advantages in terms of oxygen saturation during emergence. Postoperatively, the low incidence of sore throat and voice alteration may have advantages for professional voice users and reduce overall morbidity. It should be noted that the advantages of the LMA in terms of sore throat have not been adequately demonstrated in children.

TABLE II Hypotheses tested for laryngeal mask airway versus tracheal tube (LMA vs TT) and facemask (LMA vs FM) using Fisher's method for combining probability scores. *P* values that are underlined confer an advantage to the FM or TT. NS = not significant

	Null hypothesis			
	LMA vs TT		*LMA vs FM*	
	P value	*References*	*P value*	*References*
Placement				
Ease of placement same for non-anaesthetists	<0.001	11, 15, 34, 38	<0.001	26, 27, 30
Time for placement same for non-anaesthetists	<0.001	11, 15, 34, 38	NS	27, 30
Ease of placement same for anaesthetists	NS	13, 19, 56	-	
Time for placement same for anaesthetists	<0.025	17, 20, 44, 59	NS	39, 59
Physiology				
Pulse rate changes are similar during insertion	<0.001	17, 20, 21, 31, 34, 37, 40, 51	NS	14, 16, 26, 61
Blood pressure changes are similar during insertion	<0.001	17, 20, 21, 31, 34, 37, 40, 51	NS	14, 16, 26, 61
Pulse rate changes are similar during emergence	<0.001	31, 34, 54	-	
Blood pressure changes are similar during emergence	<0.001	31, 34, 54	-	
Intraocular pressure rises are similar during placement	<0.001	12, 19, 20, 31, 37	-	
Frequency of oesophageal reflux is similar	NS	42, 62	<0.001	24, 25, 49, 50
Airways are similarly tolerated catecholamine release is similar between devices	NS	31,40 43	-	
Mechanical				
Work of breathing is similar between devices	NS	43, 45, 55, 58	-	
Air leak is similar between devices	<0.005	35, 48, 56, 57	-	
Gastric insufflation is similar between devices	<0.005	18, 35		
Airway problems/complications				
Frequency of cough during emergence is similar	<0.001	12, 13, 19, 22, 34, 43	-	
Frequency of laryngospasm NS during emergence is similar	NS	22, 34, 56, 60	-	
Oxygen saturation is similar	<0.01	32, 34, 52, 56, 60	<0.025	14, 26, 29, 39
Postoperative				
Sore throat is similar in adults	<0.05	13, 17, 19, 22, 32, 43, 51	-	
Sore throat is similar in children	NS	14, 47	-	
Voice analysis is similar	<0.001	22, 23	-	
Postoperative surgical pain is similar	NS	32, 43	-	
Postoperative nausea and vomiting is similar	NS	32, 43	-	
Miscellaneous				
Surgical conditions are similar for minor otological surgery in children	-		<0.025	14, 39
Hand fatigue is similar	-		<0.025	26, 59

The main disadvantage of the LMA compared with the TT is that leak and gastric insufflation are more likely. The extent to which this occurs depends on the airway pressure generated and probably also on the precise position of the LMA. Data from very large series have shown that IPPV with the LMA is both safe and effective.[3] There were no episodes of gastric dilatation from a series of 11910 LMA anaesthetics.[69] Leak may be minimised if tidal volume is maintained $< 10 \text{ ml} \cdot \text{kg}^{-1}$.[55] Surprisingly the LMA causes an increased work of breathing compared with the TT even though the larynx, which contributes 25% of total airways resistance, is not bypassed.[70]

The advantage of the LMA over the FM is that it provides a better airway in terms of oxygen saturation, that it does not lead to hand fatigue and is more suitable for IPPV. Operating conditions are also superior during minor paediatric otological surgery. The main disadvantage of the LMA compared with the FM is that reflux is more likely with the LMA. However, this theory remains controversial[71,72] and dye[49,73] and oropharyngeal pH studies in both ventilated[74] and spontaneously breathing patients[62] have failed to confirm these findings. It has been suggested that the upper oesophageal sphincter may have a role in preventing aspiration.[75] Data from large audit or epidemiology studies suggest that the in-

cidence of aspiration is similar to that for the TT and FM during elective surgery.[76,77]

This meta-analysis demonstrates that the LMA has several advantages over the TT and FM and a few disadvantages, but does not allow definitive conclusions to be made regarding choice of airway. Further research is needed to determine the importance of these advantages and disadvantages in terms of patient outcome and cost to the health care system and to allow recommendations to be made. Maltby has suggested that randomised controlled trials comparing LMA with the TT and FM for a routine procedure such as arthroscopy would be useful.[8] However, such studies will require more meticulous design than are demonstrated in many currently available trials. In a recent review, Asai and Morris state that "the true features and role of the LMA will be established only through studies in which the device is used correctly."[7] It has been suggested that all authors should describe the level of experience of personnel placing the LMA, the method of insertion and where possible fibreoptic scoring should be conducted.[78,79] Adult studies for routine procedures in which first time insertion rates are less than 90%, overall success rates are less than 95%, or median fibreoptic scoring is less than 3.0, may reflect suboptimal use.[64]

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