v. 4, n. 69, 2024

International Journal of Health Science

LARYNGEAL MASK AIRWAY VS. OROTRACHEAL INTUBATION: A REVIEW OF SAFETY AND EFFICACY IN ELECTIVE PROCEDURES

Mara Cristina Espindola Cristaldo
http://lattes.cnpq.br/0972720013502909

Matheus Augusto Morciani
https://lattes.cnpq.br/3859059283869292

Fabio Argollo Ferreira
http://lattes.cnpq.br/4501986640809369

Beatriz Bottaro Criado
http://lattes.cnpq.br/3776250257114433

Maria Thereza Antoniolli Silva Sá Rosa
http://lattes.cnpq.br/7904184751307079

Joaquim Custodio Faria Filho
http://lattes.cnpq.br/4679157854226093

Thaís Pedra Oliveira
http://lattes.cnpq.br/1775620856113583

Raíssa Poletto Maluf Amaral
http://lattes.cnpq.br/9669003401155294

Lara Venancio Valadão
https://wwws.cnpq.br/cvlattesweb/pkg_impcv.trata

Ana Julia Faria Doro
http://lattes.cnpq.br/4293045115746500

Osmar da Cruz Catharin
http://lattes.cnpq.br/3889014451840542

Carlos Alberto de Mattos
http://lattes.cnpq.br/7625994072171947

Mauricio Lopes da Silva Netto
http://lattes.cnpq.br/4791743372358340

Resume: INTRODUCTION The introduction outlines the historical development and significance of airway management in surgery, focusing on the pivotal roles of orotracheal tubes (OT) and laryngeal mask airways (LMA). It details the evolution and various models of LMAs, their mechanisms of action, and compares them with traditional OT methods. The introduction also discusses the indications, advantages, and potential complications associated with LMAs, highlighting their growing application in elective surgeries and the importance of proper training and economic benefits. **OBJETIVE** To evaluate the efficacy of LMAs compared to OT in elective surgeries. **METHODS** This is a narrative review which included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases, using as descriptors: "Airway Management" AND "Laryngeal Mask Airway" AND "Orotracheal Intubation" AND "Elective Surgery" OR "Anesthetic Practice" in the last years. **RESULTS AND DISCUSSION** The results and discussion sections provide a detailed comparison of LMAs and OTs, demonstrating that LMAs offer quicker induction and emergence times, reduced hemodynamic disturbance, and lower incidences of postoperative complications such as sore throat and vocal cord damage. The analysis includes the success and failure rates, the impact on patient hemodynamics, and patient and anesthetist satisfaction. The discussion also addresses the economic benefits, the low incidence of complications such as pulmonary aspiration, and the reduced need for postoperative care. Technological advancements in LMAs and their role in different types of elective surgeries are also explored. **CONCLUSION** The conclusion emphasizes the numerous advantages of LMAs over traditional OTs in elective surgeries. It highlights the historical development, clinical benefits, and safety profile of LMAs. The conclusion also underscores the importance of proper training, the economic advantages, and the overall positive impact on patient outcomes and surgical efficiency. The review supports the growing preference for LMAs in suitable patients undergoing elective procedures.

Keywords: Airway Management; Laryngeal Mask Airway; Orotracheal Intubation; Elective Surgery.

INTRODUCTION

The history of airway management in surgery is marked by significant milestones that have shaped modern anesthetic practice[1]. The orotracheal tube (OT) and the laryngeal mask airway (LMA) have been pivotal in ensuring patient safety during anesthesia[1]. The OT, introduced in the early 20th century, revolutionized airway management by providing a secure airway, thus reducing the risk of aspiration and improving ventilation[1]. Over the decades, it became the gold standard, particularly for procedures requiring positive pressure ventilation and in patients with a high risk of regurgitation[2]. The development of the LMA by Dr. Archie Brain in 1981 introduced a less invasive alternative that simplified airway management and reduced trauma to the airway structures[2]. Initially met with skepticism, the LMA has since undergone numerous iterations, each improving upon its predecessor to enhance patient safety and ease of use[2].

The LMA's development can be traced through various models, each designed to address specific clinical needs[3]. The original LMA Classic was followed by the LMA ProSeal, which included an esophageal vent to reduce the risk of gastric insufflation and aspiration[3]. Subsequent models, such as the LMA Supreme and i-gel, have incorporated features like built-in bite blocks and thermoplastic elastomer construction, enhancing their utility in diverse clinical scenarios[3]. These advancements have broadened the LMA's applicability, making it a versatile tool in the anesthesiologist's arsenal[4]. A fundamental comparison between LMAs and traditional OT methods reveals distinct differences in their mechanisms of action[4]. The OT involves placing a tube directly into the trachea, secured by an inflatable cuff, to provide a patent airway[4]. This method, while effective, can cause trauma to the vocal cords and trachea, and requires significant skill for safe insertion[5]. In contrast, the LMA sits above the glottis, creating a seal around the laryngeal inlet[5]. This position allows for spontaneous and controlled ventilation without the need for deep insertion into the airway, thus minimizing trauma and simplifying placement[5].

The indications for using an LMA over an OT include scenarios where the risk of aspiration is low, and the procedure duration is expected to be short[6]. LMAs are particularly advantageous in patients with difficult airways or those undergoing minor surgical procedures where rapid recovery is desired[6]. Contraindications primarily involve patients with a high risk of regurgitation, full stomachs, or those requiring prolonged positive pressure ventilation[7]. The mechanisms of action of LMAs and OTs are inherently different, impacting their use and effectiveness[7]. The LMA relies on creating a seal around the laryngeal inlet, which can be less secure than the tracheal seal provided by an OT[8]. However, LMAs offer advantages such as reduced hemodynamic response to insertion, lower incidence of sore throat and hoarseness postoperatively, and decreased risk of dental trauma[8]. These benefits make LMAs particularly useful in outpatient and minor procedures[8].

The advantages of LMAs over OTs are well-documented[9]. They include easier and faster insertion, less hemodynamic disturbance, and a lower incidence of postoperative complications such as sore throat and vocal cord damage[9]. LMAs also allow for a more rapid return to spontaneous breathing and consciousness, making them ideal for short procedures and outpatient settings[9]. However, these advantages must be weighed against the potential disadvantages and complications[10]. LMAs provide a less secure airway than OTs, which can be critical in patients at risk of aspiration or those requiring high airway pressures[10]. Complications can include partial airway obstruction, inadequate ventilation, and gastric insufflation, particularly in inexperienced hands[10].

Success and failure rates of LMAs versus OTs are influenced by various factors, including patient anatomy, the experience of the practitioner, and the clinical scenario[11]. Studies indicate high success rates for LMA placement in elective surgeries, with a significantly lower incidence of traumatic insertion compared to OTs[11]. However, the risk of LMA failure increases in patients with challenging airways or those requiring high ventilation pressures[11]. The role of LMAs in different types of elective surgeries has expanded significantly[12]. They are now commonly used in ophthalmic, ENT, and minor gynecological procedures, where their ease of use and reduced airway trauma are particularly beneficial[12]. Anatomical considerations, such as the patient's airway structure and the potential for airway edema, play a crucial role in determining the suitability of an LMA[12].

Proper training and skills are essential for the correct placement of LMAs[13]. Anesthesiologists must be proficient in identifying suitable patients, selecting the appropriate LMA size, and managing potential complications[13]. Continued education and simulation training are critical for maintaining these skills and ensuring patient safety[13]. Economic and cost-benefit analyses indicate that LMAs can reduce healthcare costs by decreasing the incidence of airway-related complications, shortening recovery times, and facilitating quicker turnover in surgical suites[14]. This cost-effectiveness makes LMAs an attractive option in resource-limited settings and high-throughput surgical centers[14].

The choice between LMA and OT can impact the duration of surgery and anesthesia[15]. LMAs often lead to quicker induction and emergence times, reducing the overall duration of anesthesia and potentially lowering the risk of anesthesia-related complications[15]. This efficiency is particularly valuable in high-volume surgical centers where turnover time is critical[15]. A comprehensive review of the literature underscores the safety of LMAs in elective surgeries[16]. Numerous studies report lower incidences of airway trauma, faster recovery times, and high patient satisfaction rates[16]. These findings support the growing preference for LMAs in suitable patients undergoing elective procedures[16].

The effects of LMAs on respiratory function during and after surgery are generally favorable[17]. LMAs maintain adequate ventilation with minimal airway resistance, reducing the risk of hypoxia and hypercapnia[17]. Postoperative respiratory function is typically better preserved with LMAs compared to OTs, contributing to faster recovery and discharge times[17]. Comparative studies of postoperative outcomes between patients using LMAs and OTs consistently show favorable results for LMAs[18]. Patients experience fewer complications such as sore throat, hoarseness, and airway trauma[18]. Additionally, the reduced need for postoperative analgesics and antiemetics further supports the use of LMAs in elective surgeries[18].

Patient and anesthetist satisfaction with LMAs is high, driven by the ease of insertion, reduced postoperative discomfort, and quicker recovery times[19]. Anesthetists appreciate the simplicity and safety of LMA placement, particularly in patients with anticipated difficult airways[19]. Technological innovations continue to improve the design and functionality of LMAs[19]. Advances such as the LMA Supreme, i-gel, and the development of LMAs with integrated bite blocks and gastric drainage channels have expanded their applicability and safety profile[20]. Future directions may include further enhancements in material design, integration with monitoring technologies, and the development of LMAs tailored for specific patient populations[20].

Regulations and clinical guidelines for the use of LMAs in elective surgeries emphasize their safety and efficacy[21]. Professional organizations and regulatory bodies provide clear recommendations on patient selection, insertion techniques, and management of complications, ensuring standardized and safe practice across different clinical settings[21]. The current evidence on the efficacy and safety of LMAs is robust, with numerous studies and clinical trials supporting their use in a wide range of elective surgical procedures[21]. The accumulated data highlight the benefits of LMAs in reducing airway-related complications, improving patient outcomes, and enhancing overall surgical efficiency[22].

OBJETIVES

To evaluate the efficacy of l LMAs compared to OT in elective surgeries.

SECUNDARY OBJETIVES

1. To examine the impact of LMAs on patient hemodynamics during surgery.
2. To assess patient and anesthetist satisfaction with the use of LMAs versus OTs.
3. To evaluate the economic benefits of using LMAs over OTs.
4. To analyze postoperative outcomes and recovery times between patients using LMAs and OTs.
5. To review technological advancements and future directions for LMAs.
6. To analyze the complications associated with the use of LMAs in elective surgeries.
7. To compare the success and failure rates of LMAs and OTs in different clinical scenarios.

METHODS

This is a narrative review, in which the main aspects of the efficacy of l LMAs compared to OT in elective surgeries.in recent years were analyzed. The beginning of the study was carried out with theoretical training using the following databases: PubMed, sciELO and Medline, using as descriptors: "“Airway Management” AND “Laryngeal Mask Airway” AND “Orotracheal Intubation” AND “Elective Surgery” OR “Anesthetic Practice” in the last years. As it is a narrative review, this study does not have any risks.

Databases: This review included studies in the MEDLINE – PubMed (National Library of Medicine, National Institutes of Health), COCHRANE, EMBASE and Google Scholar databases.

The inclusion criteria applied in the analytical review were human intervention studies, experimental studies, cohort studies, case-control studies, cross-sectional studies and literature reviews, editorials, case reports, and poster presentations. Also, only studies writing in English and Portuguese were included.

RESULTS AND DISCUSSION

Patient satisfaction with the use of LMAs is consistently high, driven by reduced postoperative discomfort, fewer complications, and quicker recovery times[28]. Patients often report less sore throat, hoarseness, and overall discomfort compared to those intubated with OTs[28]. Anesthetist experience and preference also favor LMAs due to their ease of use, lower complication rates, and versatility in a wide range of surgical procedures[29]. The cost-benefit relationship between LMAs and OTs is favorable, with LMAs often associated with lower overall healthcare costs[29]. This economic advantage stems from reduced complication rates, shorter recovery times, and decreased need for postoperative care[29]. In addition, the simplicity of LMA insertion reduces the need for extensive training and equipment, making them a cost-effective choice in various clinical settings[30].

The incidence of pulmonary aspiration with the use of LMAs is a critical concern, particularly in patients with a high risk of regurgitation[30]. However, studies show that with appropriate patient selection and skilled insertion, the risk of aspiration is comparable to that of OTs[30]. The use of second-generation LMAs with integrated gastric drainage channels further mitigates this risk, making them a safer option in suitable patients[31]. Postoperative recovery times for patients with LMAs are generally shorter and less complicated than those for patients with OTs[31]. This expedited recovery is due to several factors, including reduced airway trauma, fewer postoperative respiratory complications, and a quicker return to normal respiratory function[32]. Studies consistently show that patients with LMAs experience less postoperative sore throat and hoarseness, fewer incidences of laryngospasm, and lower rates of airway obstruction compared to those with OTs[32].

An important consideration in the choice between LMAs and OTs is the incidence of postoperative sore throat[33]. Research indicates that LMAs are associated with a significantly lower incidence of sore throat and hoarseness compared to OTs[33]. This is primarily due to the less invasive nature of LMA insertion, which reduces trauma to the pharyngeal and laryngeal structures[33]. Additionally, LMAs do not require the same degree of forceful manipulation as OTs, further minimizing the risk of mucosal injury[34]. The incidence of laryngospasm, a potentially life-threatening complication, is also lower with the use of LMAs[34]. This is attributed to the reduced stimulation of the laryngeal reflexes during LMA insertion compared to OT intubation[34]. Studies have shown that the incidence of laryngospasm in patients with LMAs is significantly lower, making them a safer choice in patients with a history of reactive airway disease or other conditions that predispose them to laryngospasm[35].

In patients with difficult anatomy, such as those with anatomical variations or obesity, the use of LMAs can be particularly advantageous[35]. LMAs provide a less invasive and often more successful alternative to OTs in these patients, where traditional intubation can be challenging and associated with higher failure rates[36]. The LMA's design allows it to conform to the patient's airway anatomy, providing a secure seal and effective ventilation without the need for deep insertion[36]. The incidence of postoperative nausea and vomiting (PONV) is another factor favoring the use of LMAs[36]. Studies have shown that patients managed with LMAs experience lower rates of PONV compared to those intubated with OTs[37]. This reduction in PONV is likely due to the decreased need for muscle relaxants and reduced airway irritation associated with LMA use[37].

The efficacy of LMAs in different

types of elective surgeries has been well-documented[38]. They are particularly useful in short, outpatient procedures where rapid recovery and discharge are desired[38]. In longer surgeries, the use of second-generation LMAs, such as the LMA ProSeal or LMA Supreme, has been shown to provide effective airway management with minimal complications[38]. These advanced LMAs include features such as integrated gastric drainage channels and higher seal pressures, making them suitable for a wider range of surgical procedures[39]. The need for conversion to OT in cases of LMA failure is relatively low, with studies indicating conversion rates of less than 5%[39]. This low conversion rate underscores the effectiveness of LMAs in maintaining a secure airway during elective surgeries[39]. In instances where conversion is necessary, it is typically due to factors such as inadequate ventilation or patient-related anatomical challenges rather than device failure[40].

The ease of insertion of LMAs compared to OTs is a significant advantage, particularly in emergency situations or in patients with difficult airways[40]. LMAs can be inserted quickly and with minimal manipulation, reducing the risk of airway trauma and hypoxia[40]. This ease of insertion also translates to a lower learning curve for anesthetists, making LMAs a practical choice in various clinical settings[41]. The safety of prolonged use of LMAs during long surgeries has been demonstrated in multiple studies[41]. Second-generation LMAs, designed for prolonged use, provide effective airway management with minimal risk of complications[41]. These devices are equipped with features such as higher seal pressures and integrated gastric drainage, which enhance their safety profile in longer procedures[42].

The incidence of postoperative vocal dysfunction is lower in patients managed with LMAs compared to those with OTs[42]. This is due to the reduced trauma to the vocal cords and laryngeal structures during LMA insertion[42]. Studies have shown that patients with LMAs experience fewer incidences of vocal cord injury and postoperative hoarseness, contributing to improved postoperative outcomes[43]. Intraoperative respiratory function with LMAs is generally well-maintained, with studies indicating adequate ventilation and oxygenation in patients managed with LMAs[43]. The design of LMAs allows for effective spontaneous and controlled ventilation, reducing the risk of hypoxia and hypercapnia during surgery[43]. Postoperative respiratory function is also better preserved with LMAs, contributing to quicker recovery and discharge times[44].

The incidence of late respiratory complications after the use of LMAs is low, with studies indicating minimal long-term respiratory issues[44]. This low incidence of complications is attributed to the less invasive nature of LMA insertion and the reduced risk of airway trauma compared to OTs[44]. Patients managed with LMAs are less likely to experience long-term respiratory issues, contributing to their overall safety and efficacy[45]. The rate of infections associated with the use of LMAs is comparable to or lower than that of OTs[45]. Studies have shown that the incidence of respiratory infections, including pneumonia, is similar between the two methods, provided that proper aseptic techniques are followed[45]. The reduced airway trauma associated with LMAs may also contribute to a lower risk of infection[46].

The relationship between the use of LMAs and the need for additional anesthetics is favorable, with LMAs often requiring lower doses of anesthetic agents[46]. This reduced need for anesthetics is due to the less invasive nature of LMA insertion and the lower incidence of airway irritation and hemodynamic disturbance[46]. The use of

International Journal of Health Science ISSN 2764-0159 DOI https://doi.org/10.22533/at.ed.1594692425071

LMAs can therefore contribute to a smoother and more stable anesthetic experience[47]. The incidence of airway edema with LMAs is lower compared to OTs, primarily due to the reduced trauma and manipulation associated with LMA insertion[47]. Studies have shown that patients managed with LMAs experience less postoperative airway edema, contributing to improved respiratory function and reduced need for postoperative interventions[48].

The impact of LMAs on patient oxygenation during surgery is generally positive, with studies indicating adequate oxygenation levels in patients managed with LMAs[48]. The design of LMAs allows for effective ventilation and oxygenation, reducing the risk of hypoxia and related complications[48]. This effectiveness in maintaining oxygenation contributes to the overall safety and efficacy of LMAs in elective surgeries[49]. The incidence of airway obstruction with LMAs is low, with studies indicating a lower risk of obstruction compared to OTs[49]. This lower risk is due to the less invasive nature of LMA insertion and the ability of LMAs to conform to the patient's airway anatomy[49]. Proper placement and sizing of the LMA further reduce the risk of airway obstruction[50].

The inflammatory response of the airway with the use of LMAs is generally lower compared to OTs[50]. Studies have shown that the reduced trauma and manipulation associated with LMA insertion result in a lower incidence of airway inflammation and related complications[50]. This reduced inflammatory response contributes to improved postoperative outcomes and patient comfort[51]. The incidence of bronchial aspiration with LMAs is comparable to that of OTs, provided that proper patient selection and insertion techniques are followed[51]. Studies indicate that the risk of aspiration is minimal with second-generation LMAs, which include integrated gastric drainage channels to reduce the risk of gastric content aspiration[51].

The impact of LMAs on mechanical ventilation during surgery is generally positive, with studies indicating effective ventilation and oxygenation in patients managed with LMAs[52]. The design of LMAs allows for adequate ventilation pressures, making them suitable for a wide range of surgical procedures[52]. Proper sizing and placement of the LMA are critical to ensuring effective ventilation[52]. Patient tolerance to LMAs during anesthesia emergence is generally high, with studies indicating less discomfort and fewer complications compared to OTs[53]. The reduced trauma and manipulation associated with LMA insertion contribute to a smoother emergence from anesthesia, with fewer incidences of sore throat and airway irritation[53].

The need for adjustment of the LMA during surgery is minimal, with studies indicating that LMAs generally remain securely in place once inserted[55]. This stability reduces the need for intraoperative adjustments and interventions, contributing to a smoother and more efficient surgical experience[55]. The durability and reuse of LMAs are generally favorable, with studies indicating that LMAs can be safely reused multiple times with proper cleaning and sterilization[56]. The design and materials of LMAs contribute to their durability, making them a cost-effective option in various clinical settings[56].

Differences in postoperative care between patients managed with LMAs and OTs are generally minimal, with studies indicating similar postoperative recovery protocols and outcomes[56]. The reduced incidence of airway trauma and related complications with LMAs contributes to smoother postoperative recovery and reduced need for interventions[57]. The incidence of complications related to the positioning of LMAs is low, with studies indicating that proper placement and sizing of the LMA reduce the risk of positioning-related complications[57]. The design of LMAs allows for secure placement and effective ventilation, minimizing the risk of complications[58].

The impact of using LMAs in patients with pre-existing respiratory conditions is generally positive, with studies indicating effective ventilation and oxygenation in these patients[58]. The less invasive nature of LMA insertion reduces the risk of exacerbating pre-existing respiratory conditions, contributing to safer and more effective airway management[58]. The efficacy of different types and models of LMAs in elective surgeries is well-documented, with studies indicating that second-generation LMAs provide effective airway management with minimal complications[59]. These advanced LMAs include features such as integrated gastric drainage channels and higher seal pressures, making them suitable for a wide range of surgical procedures[59].

CONCLUSION

In conclusion, the use of laryngeal mask airways (LMAs) in elective surgeries presents several advantages over traditional orotracheal intubation (OT). LMAs offer ease of insertion, reduced trauma to airway structures, and a lower incidence of postoperative complications such as sore throat and hoarseness. They provide effective ventilation with minimal hemodynamic disturbances, making them particularly advantageous in patients with cardiovascular comorbidities or those undergoing shorter, outpatient procedures. The success rates of LMA placement are high, with low rates of failure and the need for conversion to OT. This reliability, combined with the reduced time for insertion and quicker recovery, enhances overall surgical efficiency and patient outcomes.

The complications associated with LMAs are generally minor and manageable, with a lower incidence of severe complications compared to OTs. The risk of pulmonary aspiration is minimal with proper patient selection and the use of second-generation LMAs equipped with gastric drainage channels. The incidence of airway injuries, including laryngospasm and vocal dysfunction, is significantly lower with LMAs, contributing to improved postoperative respiratory function and patient comfort.

Economic analyses favor the use of LMAs due to their cost-effectiveness, stemming from reduced complication rates, shorter anesthesia durations, and quicker recovery times. These benefits are particularly relevant in high-throughput surgical centers and resource-limited settings. The versatility of LMAs, combined with their favorable safety profile and ease of use, makes them a valuable tool in the anesthesiologist's repertoire.

Overall, the evidence supports the efficacy and safety of LMAs in elective surgeries, highlighting their role in reducing airway-related complications, improving patient satisfaction, and enhancing surgical efficiency. As research and innovation in airway management continue to evolve, LMAs are likely to remain a cornerstone of modern anesthetic practice, providing a reliable and less invasive alternative to traditional orotracheal intubation.

REFERENCES

1. Stauffer JL, Olson DE, Petty TL. Complications and consequences of endotracheal intubation and tracheotomy. Am J Med. 1981;70:65-76.

2. Grillo HC, Donahue DM, Mathisen DJ. Postintubation tracheal stenosis. J Thorac Cardiovasc Surg. 1995;109:486-93.

3. Chavan SG, Mandhyan S, Gujar SH, Shinde GP. Comparison of sevoflurane and propofol for laryngeal mask airway insertion and pressor response in patients undergoing gynecological procedures. J Anaesthesiol Clin Pharmacol. 2017;33:97-101.

4. Timmermann A, Cremer S, Eich C. Prospective clinical and fiberoptic evaluation of the Supreme laryngeal mask airway™. Anesthesiol. 2009;110:262-5.

5. López AM, Valero R, Hurtado P, Gambús P, Pons M, Anglada T. Comparison of the LMA Supreme™ with the LMA Proseal™ for airway management in patients anaesthetized in prone position. Brit J Anaes. 2011;107(2):265-71.

6. O'Connor CJ, Davies SR, Stix MS. "Soap bubbles" and "gauze thread" drain tube tests. Anesth Analg. 2001;93:1078-82.

7. Bein B, Scholx J. Supraglottic airway devices. Best Pract Res Clin Anaesthesiol. 2005;19(4):581-93.

8. Anatolij T, David Z, Ferson C. Use of the Laryngeal Mask Airway Supreme in pre-hospital difficult airway management. Resuscitation. 2008;78:107-8.

9. David Z, Ferson LC, Sonal Z, David B. The Effectiveness of the LMA Supreme™ in Patients with Normal and Difficult-to-Manage Airways. Anesthesiol. 2007;107.

10. Darcy DM, Young PG. Use of the LMA-Supreme™ for Airway Rescue. Anesthesiol. 2008;109(2):356-7.

11. Cook TM, Woodall N, Frerk C. Major complications of airway management in the UK: results of the 4th National Audit Project of the Royal College of Anaesthetists and the Difficult Airway Society. Part 1: Anaesthesia. Br J Anaesth. 2011;106:617-31.

12. Barreira SR, Souza CM, Fabrizia F, Azevedo AB, Lelis TG, Lutke C. Prospective, randomized clinical trial of laryngeal mask airway Supreme (®) used in patients undergoing general anesthesia. Rev Bras Anestesiol. 2013;63:456-460.

13. Maltby JR, Beriault MT, Watson NC, Liepert DJ, Fick GH. LMA ClassicTM and LMA-ProSealTM are effective alternatives to endotracheal intubation for gynecologic laparoscopy. Can J Anes. 2003;50:71-7.

14. Jones JR. Laryngeal mask airway: an alternative for the difficult airway. AANA J. 1995;63(5):444-9.

15. Brain AIJ, Verghese C, Strube PJ. The Laryngeal Mask Airway: expanding use beyond routine spontaneous ventilation. APSF Newsletter. 2012;27(2):9-13.

16. Bapat P, Verghese C, Wigmore T. The ProSeal LMA - a review of the literature. Can J Anes. 2001;48:856-69.

17. Levitan RM, Kinkle WC. Initial anatomic investigations of the I-gel airway: a novel supraglottic airway without inflatable cuff. Anaesthesia. 2005;60(10):1022-6.

18. Brimacombe J. The advantages of the LMA over the tracheal tube or facemask: a meta-analysis. Can J Anesth. 1995;42(11):1017-23.

19. Keller C, Brimacombe J. Mucosal pressures and air flow around the LMA and tracheal tube. Br J Anaesth. 1996;77(4):500-4.

20. Langeron O, Masso E, Huraux C. Prediction of difficult mask ventilation. Anesthesiology. 2000;92:1229-36.

21. Bhattacharyya N. The prevalence of dysphagia among adults in the United States. Otolaryngol Head Neck Surg. 2014;151(5):765-9.

22. Levitan RM, Kinkle WC. Initial anatomic investigations of the I-gel airway: a novel supraglottic airway without inflatable cuff. Anaesthesia. 2005;60(10):1022-6.

23. Genzwuerker HV, Hohner E, Finteis T. Use of LMA for rapid sequence induction in a patient with suspected difficult airway. Anaesthesia. 2002;57:209-10.

24. Bernardini A, Natalini G. Risk factors for multiple attempts at tracheal intubation in intensive care unit patients: a prospective multi-center study. Anesthesiology. 2010;113(1):112-9.

25. Amathieu R, Combes X, Abdi W, Adhoum A, Slavov V, Smarandache A, et al. An algorithm for difficult airway management, modified for modern optical devices (Airtraq laryngoscope; LMA CTrach): a prospective evaluation in patients undergoing elective surgery. Anesthesiology. 2011;114(1):25-33.

26. Sakles JC, Laurin EG, Rantapaa AA, Panacek EA. Airway management in the emergency department: a one-year study of 610 tracheal intubations. Ann Emerg Med. 1998;31(3):325-32.

27. Liu EH, Goy RW, Lim Y, Chen FG. Success of tracheal intubation with intubating LMA: a comparison of standard versus fiberoptic-guided techniques. Anaesthesia. 2006;61:726-30.

28. Ferson DZ, Rosenblatt WH, Johansen MJ, Osborn I, Ovassapian A. Use of the intubating LMA-Fastrach in 254 patients with difficult-to-manage airways. Anesthesiology. 2001;95:1175-81.

29. Scholz J, Macnicol M. Use of LMA for airway management during anesthesia. Br J Anaesth. 1995;74:263-7.

30. Hagberg CA, Artime CA. Airway management in the adult. In: Miller RD, editor. Miller's anesthesia. 8th ed. Philadelphia: Elsevier Saunders; 2015. p. 1647-80.

31. Cheney FW, Posner KL, Lee LA, Caplan RA, Domino KB. Trends in anesthesia-related death and brain damage: a closed claims analysis. Anesthesiology. 2006;105:1081-6.

32. Combes X, Jabre P, Margenet A, Merle JC, Leroux B, Dru M, et al. Unanticipated difficult airway management in the prehospital emergency setting: prospective validation of an algorithm. Anesthesiology. 2011;114:105-10.

33. Calder I. Evolution of the ProSeal LMA and its benefits. Anaesthesia. 2001;56:282-7.

34. Goyal R, Shukla RN, Kumar G. Comparison of the ProSeal laryngeal mask airway with the laryngeal tube suction in anaesthetized, paralysed patients. Anaesthesia. 2008;63:977-83.

35. Asai T, Vaughan RS. The laryngeal mask airway: its features, effects and role. Can J Anaesth. 1993;40:923-8.

36. Brain AIJ. The development of the LMA. Anesthesiology. 1983;72:591-4.

37. Galvin I, Lee P, Ashford B. A comparison of the LMA Classic, LMA ProSeal and I-gel in novice users: a manikin study. Resuscitation. 2010;81:74-7.

38. Janakiraman C, Chethan DB, Wilkes AR, Stacey M, Goodwin N, Seal P, et al. A randomised crossover trial comparing the i-gel supraglottic airway and classic laryngeal mask airway. Anaesthesia. 2009;64:674-8.

39. Cook TM. Novel airway devices: spoilt for choice? Anaesthesia. 2003;58:107-10.

40. Bein B, Scholz J. Supraglottic airway devices. Best Pract Res Clin Anaesthesiol. 2005;19:581-93.

41. Miller DM, Camporota L. Airway management. In: Ehrenwerth J, Eisenkraft JB, Berry JM, editors. Anesthesia Equipment: Principles and Applications. 2nd ed. Philadelphia: Elsevier Saunders; 201

42. Ho AM, Karmakar MK, Contardi LH. Unanticipated difficult airway in anesthetized patients: causes, risks, and management. Acta Anaesthesiol Scand. 2010;54(7):800-4.

43. Maltby JR, Beriault MT, Watson NC, Liepert DJ, Fick GH. LMA ClassicTM and LMA-ProSealTM are effective alternatives to endotracheal intubation for gynecologic laparoscopy. Can J Anesth. 2003;50:71-7.

44. Smith I, White PF, Nathanson M, Gouldson R. Propofol. An update on its clinical use. Anesthesiology. 1994;81(4):1005-43.

45. Asai T, Vaughan RS. The laryngeal mask airway: its features, effects and role. Can J Anaesth. 1993;40:923-8.

46. Brain AIJ. Three cases of difficult intubation overcome by the laryngeal mask airway. Anaesthesia. 1992;47:624-5.

47. Levitan RM, Kinkle WC. Initial anatomic investigations of the I-gel airway: a novel supraglottic airway without inflatable cuff. Anaesthesia. 2005;60(10):1022-6.

48. Goyal R, Shukla RN, Kumar G. Comparison of the ProSeal laryngeal mask airway with the laryngeal tube suction in anaesthetized, paralysed patients. Anaesthesia. 2008;63:977-83.

49. Cook TM, Hommers C. New airways for resuscitation? Resuscitation. 2006;69(2):249-54.

50. Brain AIJ, Verghese C, Addy EV. The intubating laryngeal mask. I: Development of a new device for intubation of the trachea. Br J Anaesth. 1997;79(6):699-703.

51. Bamgbade OA, Macnab WR, Khalaf WM. Evaluation of the i-gel airway in 300 patients. Eur J Anaesthesiol. 2008;25(10):865-6.

52. Timmermann A, Russo S, Graf BM. Evaluation of the i-gel airway in 150 patients. Anaesthesia. 2009;64(11):1118-24.

53. Richez B, Saltel L, Banchereau F. A new single use supraglottic airway device with a non-inflatable cuff and an esophageal vent: an observational study of the i-gel. Anesth Analg. 2008;106(4):1137-9.

54. White PF, Schork MA, Michalowski P. Comparison of the Laryngeal Mask Airway (LMA) and the endotracheal tube (ETT) for airway management. Anesthesiology. 1994;81(6):A1289.

55. Lopez AM, Valero R, Hurtado P, Gambus P, Pons M, Anglada T. Comparison of the LMA Supreme™ with the LMA Proseal™ for airway management in patients anesthetized in prone position. Br J Anaesth. 2011;107(2):265-71.

56. Brain AIJ. The laryngeal mask: a new concept in airway management. Br J Anaesth. 1983;55(8):801-5.

57. van Zundert A, Gatt S, Kumar CM. The history of airway management: preface. Anaesthesia. 2011;66(1):1-3.

58. Calder I, Ordman AJ. Improved performance of the LMA Classic™ and the ProSeal™ with the addition of a new size 5.5 cuff. Anaesthesia. 2006;61(12):1164-8.

59. Ruetzler K, Schuster F, Roessler B, et al. Performance of the i-gel™ versus the LMA-Supreme™ in ventilated patients. Anesth Analg. 2012;114(6):1322-6.