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Prolonged Use of the Laryngeal Mask Airway ProSeal™: A Report of Seven Cases Lasting 5-11 h

Berthold Moser[1*], Joseph Brimacombe[2], Bimla Sharma[3], Amitabh Dutta[3], Jayashree Sood[3], Ved P Kumra[3] and Christian Keller[1]

[1]*Department of Anaesthesia, Schulthess Klinik, Switzerland*

[2]*Department of Anaesthesia and Intensive Care, James Cook University, Australia*

[3]*Department of Anaesthesiology, Pain & Perioperative Medicine, Sir Ganga Ram Hospital, India*

[*]**Corresponding author:** Berthold Moser, Department of Anaesthesia, Schulthess Klinik, Lengghalde 2, 8008 Zürich, Switzerland, Tel: 0041 44 385 740; E-mail: berthold.moser@kws.ch

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Abstract

Background: There is controversy concerning use of laryngeal mask airway devices for procedures lasting more than 2 h. The LMA ProSeal™ is a laryngeal mask device with a modified cuff to facilitate ventilation and a drain tube to provide airway protection that is better suited for prolonged use than the LMA Classic™.

Objectives: We aimed to describe the successful use of the LMA ProSeal™ in seven patients in a variety of clinical situations for procedures lasting more than 5 h and provide practical guidelines about its use in this situation.

Results: The cases illustrate the use of the LMA ProSeal™ in a variety of clinical situations (supine and prone position) and for a variety of prolonged procedures: as a planned airway device and as an airway rescue device. LMA ProSeal™ forms an effective seal with the respiratory tract (10 cm H_2O higher) and is therefore suited as ventilator device. It also forms an effective seal with the gastrointestinal tract (30 cm H_2O higher), provides protection against aspiration and gastric insufflation and provides easy access to the gastrointestinal tract allowing the passage of a gastric tube reducing again the risk of aspiration.

Conclusion: The use of the LMA ProSeal™ for prolonged procedures is feasible. In principle, it should be safer and more effective than the LMA Classic™.

Keywords: Laryngeal mask; Pro seal; Rescue airway; Prolonged use

Introduction

There is controversy concerning use of the classic laryngeal mask airway (LMA Classic™) for prolonged procedures, particularly over 2 h [1], as some clinicians consider it unsuitable for positive pressure ventilation (needed to counter the alleged progressive respiratory fatigue with time [2,3]) and/or unsuitable for airway protection (needed to counter the alleged progressive increase in aspiration risk with time [4]). The LMA ProSeal™ is a laryngeal mask device with a modified cuff to facilitate ventilation and a drain tube to provide airway protection. In principle, the LMA ProSeal™ should be more suitable than the LMA Classic™ for prolonged procedures; however, there are only four reports [5-8] and one case series [9]. We describe the use of the LMA ProSeal™ in seven patients in a variety of clinical situations for procedures lasting more than 5 h.

Methods

This case series was registered retrospectively at ClinicalTrials.gov (NCT03033979) and approval was granted by the Ethics Committee Sir Ganga Ram Hospital, India (No: EC/01/17/1106). Written informed consent of all patients was obtained.

In this study the successful use of the LMA ProSeal™ in seven patients in a variety of clinical situations for procedures lasting more than 5 h is described and provides practical guidelines about its use in these situations.

Case 1

A 34-yr-old female (150 cm, 40 kg, ASA physical status I) was scheduled for elective laparoscopic proctocolectomy and ileostomy for familial polyposis coli with anal involvement. She had no significant past medical history and no symptoms of gastro-esophageal reflux. Premedication was with alprazolam 0.25 mg, ranitidine 100 mg and metoclopramide 7.5 mg given orally one hour preoperatively. Induction was with fentanyl 100 µg and propofol 80 mg. Face mask ventilation was easy. A size 3 LMA ProSeal™ was inserted at the first attempt using the introducer tool. Oropharyngeal leak pressure was >40 cm H_2O. The cuff pressure was maintained to 60 cm H_2O throughout the procedure by intermittently withdrawing gas. A gastric tube was easily inserted and no fluid aspirated initially from the stomach. Maintenance was with N_2O 66% in O_2 and a propofol infusion titrated to a bispectral index value of 45-55. Neuromuscular blockade was with vecuronium 0.1 mg/kg and 0.05 mg/kg boluses. The patient was ventilated at 8 ml/kg tidal volume, 12 breaths per minute and an inspiratory:expiratory ratio of 1:2 at fresh gas flows of 3 L/min *via* a circle anaesthesia breathing system. Intraabdominal pressure was 12-14 mmHg during surgery. Normothermia was maintained with warmed fluids and a hot airflow system. Peak airway pressures increased from 8 to 18 cm H_2O during carboperitoneum. Fentanyl 1

μg/kg boluses were given for analgesia. There were no episodes of hypoxia (SpO_2<90%), hypercarbia ($ETCO_2$>45 mmHg) or gastric insufflation. Four liters of crystalloid and two units of blood were given. A total of 60 ml of clear fluid was suctioned from the stomach. The temperature at the start and end of surgery was 37.5°C and 36.9°C, respectively. After completion of surgery, residual neuromuscular blockade was reversed with neostigmine 50 μg/kg and atropine 20 μg/kg. The emergence phase, which lasted 30 min, was uneventful. The LMA ProSeal™ was removed when the patient opened her mouth to command. Secretions on the dorsal and ventral surface of the cuff were negative for acid. There was no postoperative airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 11 h.

Case 2

A 27-yr-old female (145 cm, 35 kg, ASA physical status I) was scheduled for laparoscopic total colectomy and ileostomy for familial polyposis coli (she was, in fact, the sister of the first case). She had no significant past medical history and no symptoms of reflux. Premedication was similar to case 1. Induction was with thiopentone 125 mg, midazolam 1 mg and fentanyl 50 μg. Face mask ventilation was easy. A size 3 LMA ProSeal™ was inserted at the first attempt using the introducer tool. Oropharyngeal leak pressure was >40 cm H2O. A gastric tube was easily inserted and 10 ml of clear fluid suctioned from the stomach. The gastric pH was 4.5. The maintenance phase was identical to case 1 in terms of neuromuscular blockade, ventilation, cuff pressure control, temperature control and gastric suctioning; however, the position of the airway tube was also assessed fiberoptically at regular intervals. Peak airway pressure increased from 9 to 17 cm H2O during carboperitoneum. There were no episodes of hypoxia, hypercarbia or gastric insufflation. Haemodynamic parameters and urine output remained within normal limits. A total of 30 ml of clear fluid was suctioned from the stomach. The temperature at the start and end of surgery was 36.5°C and 35.7°C, respectively. There was no fiberoptically detected movement of the airway tube. After completion of surgery, residual neuromuscular blockade was reversed with neostigmine 50 μg/kg and atropine 20 μg/kg. The emergence phase, which lasted 20 min, was uneventful. The LMA ProSeal™ was removed when she opened her mouth to command. Secretions on the dorsal and ventral surface of the cuff were mildly alkaline. There was no postoperative airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 5.5 h.

Case 3

A 42-yr-old male (168 cm, 84 kg, ASA physical status I) was scheduled for anterior and posterior lumbar spinal fusion. He had a history of well-controlled asthma and reflux that was treated with omeprazole. No premedication was given. Induction was with midazolam 3 mg, alfentanil 1 mg and propofol 190 mg. Muscle relaxants were not administered. Face mask ventilation was easy. A size 5 LMA ProSeal™ was inserted at the first attempt using the laryngoscope-guided, gum elastic bougie-guided technique [10]. The Cormack and Lehane score was 2. Oropharyngeal leak pressure was 35 cm H_2O. A gastric tube was easily inserted down the drain tube and 26 ml clear fluid was suctioned from the stomach. The patient was ventilated at 10 ml/kg tidal volume, 12 breaths per minute, 5 cm of PEEP and an inspiratory:expiratory ratio of 1:2 at fresh gas flows of 3 L/min *via* a circle anaesthesia breathing system. Maintenance was with isoflurane 1-2% and N_2O 66% in O_2. Morphine was given for analgesia. Intracuff pressure was maintained at 60 cm H_2O by intermittently withdrawing gas. The gastric tube was suctioned every 15 min and left on free drainage in between. Normothermia was maintained as per case 1. There were no episodes of hypoxia, hypercarbia or gastric insufflation. There were no problems during rotation of the patient from the supine to prone position. Haemodynamic parameters and urine output remained within normal limits. A total of 260 ml of clear fluid was suctioned from the stomach. The temperature at the start and end of surgery was 36.8°C and 35.9°C, respectively. The emergence phase, which lasted 20 min, was uneventful. The LMA ProSeal™ was removed when he opened his mouth to command. There was no visible blood, but there was microscopic blood on the surface of the LMA ProSeal™. Secretions on the dorsal and ventral surface of the cuff were negative for acid. The patient had a mild sore throat that lasted 24 h, but there were no other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 8 h.

Case 4

An 82-yr-old female (162 cm, 56 kg, ASA physical status III) was scheduled for a total colectomy. She had a past medical history of chronic obstructive pulmonary disease, but no symptoms of reflux. Premedication was not administered. An epidural was established at T8/9. Induction was with alfentanil 0.25 mg and propofol 60 mg. Muscle relaxants were not administered. Face mask ventilation was easy. A size 4 LMA ProSeal™ was inserted at the first attempt using the laryngoscope-guided, gum elastic bougie-guided technique [10]. The Cormack and Lehane score was 1. Oropharyngeal leak pressure was >40 cm H_2O. A gastric tube was easily inserted, but no fluid was suctioned from the stomach. The maintenance phase was identical to case 3 in terms of ventilation, anaesthesia agents, cuff pressure and body temperature control, and gastric tube suctioning. There were no episodes of hypoxia, hypercarbia or gastric insufflation. Haemodynamic parameters and urine output remained within normal limits. A total of 108 ml of clear fluid was suctioned from the stomach. The temperature at the start and end of surgery was 36.4°C and 36.5°C, respectively. The emergence phase, which lasted 35 min, was uneventful. The LMA ProSeal™ was removed when the patient opened her mouth to command. Secretions on the dorsal and ventral surface of the cuff were negative for acid. There was no visible or microscopic blood on the surface of the LMA ProSeal™. Arterial blood gases were similar to pre-operative values 2 h postoperatively. There was no airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 9.5 h.

Case 5

A 39-yr-old male (182 cm, 83 kg, ASA physical status I) was scheduled for reconstructive surgery to his lower leg. He had no significant past medical history and no symptoms of reflux. Premedication was not administered. Induction was with midazolam 2 mg, fentanyl 500 μg and propofol 220 mg. Muscle relaxants were not administered. Face mask ventilation was easy. A size 5 LMA ProSeal™ was inserted at the first attempt using the laryngoscope-guided, gum elastic bougie-guided technique [10]. Oropharyngeal leak pressure was 35 cm H_2O. A gastric tube was inserted and 5 ml fluid suctioned from the stomach. The maintenance phase was identical to case 3 in terms of ventilation, intracuff pressure and body temperature control, and gastric tube suctioning; however, anaesthesia was maintained with

isoflurane 1% in air and oxygen 30% and a remifentanil infusion at a rate of 0.2 μg/kg/min, and the position of the airway tube was assessed fiberoptically every hour. There were no episodes of hypoxia, hypercarbia or gastric insufflation. No further fluid was suctioned from the stomach. Haemodynamic parameters and urine output remained within normal limits. The temperature at the start and end of surgery was 36.2°C and 37.2°C, respectively. There was no fiberoptically detected movement of the airway tube. The emergence phase, which lasted 15 min, was uneventful. The LMA ProSeal™ was removed when the patient opened his mouth to command. Secretions on the dorsal and ventral surface of the cuff were negative for acid. There was no visible or microscopic blood on the surface of the LMA ProSeal™. There was no airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 8 h.

Case 6

A 45-yr-old male (182 cm, 90 kg, ASA physical status I) was scheduled for reconstructive surgery to his hand. He had no significant past medical history, but was at risk of aspiration as the injury was recent. On examination he was Mallampati grade IV with a short neck, but refused awake airway management. Pre-medication was not administered. The airway management plan was to perform a rapid sequence induction and to place a gum elastic bougie either in the trachea (if any glottic structures could be seen) or in the esophagus (if no glottic structures could be seen) to facilitate insertion of a tracheal tube or LMA ProSeal™, respectively, as previously described [11]. After pre oxygenation, induction was with fentanyl 500 μg and thiopentone 500 mg. Face mask ventilation was easy. Muscle relaxation was with suxamethonium 150 mg. The vocal cords could not be seen even after the release of cricoid pressure and a size 5 LMA ProSeal™ was easily inserted. Oropharyngeal leak pressure was 40 cm H_2O. A gastric tube was easily inserted and 10 ml fluid suctioned from the stomach. The maintenance phase was identical to case 3 in terms of ventilation, intracuff pressure and body temperature control, and gastric tube suctioning; however, anaesthesia was maintained with isoflurane 1.2% end-tidal in air 30% and the position of the airway tube was assessed fiberoptically every hour. A continuous brachial plexus block was used for analgesia. There were no episodes of hypoxia, hypercarbia or gastric insufflation. No further fluid was suctioned from the stomach. Haemodynamic parameters and urine output remained within normal limits. The temperature at the start and end of surgery was 36.0°C and 37.8°C, respectively. There was no fiberoptically detected movement of the airway tube. The emergence phase, which lasted 20 min, was uneventful. The LMA ProSeal™ was removed when the patient opened his mouth to command. Secretions on the dorsal and ventral surface of the cuff were negative for acid. There was no visible or microscopic blood on the surface of the LMA ProSeal™. There was no airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 9 h.

Case 7

A 65-yr-old male (186 cm, 76 kg, ASA physical status I) was scheduled for urgent back surgery due to a prolapsed disk which was causing neurological problems. He had a past medical history of reflux which was controlled with omeprazole. He had no predictive indicators of difficult airway management. Premedication was with ranitidine 50 mg i.v. Induction was with alfentanil 0.5 mg and propofol 130 mg. Face mask ventilation was easy. Muscle relaxation was with vecuronium 5 mg. Laryngoscope-guided tracheal intubation proved impossible. An attempt at placement of a gum elastic bougie using a straight bladed laryngoscope resulted in esophageal misplacement. Rather than remove the bougie, a size 5 LMA ProSeal™ was railroaded along it and into its correct position in the hypopharynx. Oropharyngeal leak pressure was >40 cm H_2O and ventilation was easy. A gastric tube was easily inserted and 20 ml of clear fluid was suctioned from the stomach. There were no problems during rotation of the patient from the supine to prone position, but a further 10 ml of fluid was suctioned from the stomach. The maintenance phase was identical to case 3 in terms of ventilation, anaesthesia agents, intracuff pressure and body temperature control, and gastric tube suctioning. There were no episodes of hypoxia, hypercarbia or gastric insufflation. Haemodynamic parameters and urine output remained within normal limits. A total of 200 ml of clear fluid was suctioned from the stomach. The temperature at the start and end of surgery was 36.8°C and 36.3°C, respectively. The emergence phase, which lasted 20 min, was uneventful. The LMA ProSeal™ was removed when the patient opened his mouth to command. Secretions on the dorsal and ventral surface of the cuff were negative for acid. There was no visible or microscopic blood on the surface of the LMA ProSeal™. There was no airway morbidity or other sequelae. The total duration of time the LMA ProSeal™ was *in situ* was 5 h.

Discussion

Our cases illustrate the use of the LMA ProSeal™ in a variety of clinical situations and for a variety of prolonged procedures: as the planned airway device (cases 1-5) and as the airway rescue device (cases 6 and 7); in the supine (cases 1,2 and 4-6) and prone (cases 3 and 7) positions; in patients with reflux (cases 3 and 7), a potentially full stomach (case 6) and respiratory disease (cases 3 and 4); and for laparoscopy (case 1 and 2), laparotomy (case 4), spinal (case 3 and 7) and reconstructive limb surgery (cases 5 and 6). The only problem that occurred was a mild sore throat in one patient. There have been four previous reports and one case series of prolonged use of the LMA ProSeal™: i) middle ear surgery lasting 5 h [8], ii) urgent cesarean section and postoperative ventilation lasting about 9 h [7], iii) prolonged use as an airway rescue device in ICU lasting 40 h [5], iv) subcostal laparatomy lasting 8 h 40 min [6] and a case series with 24 adult patients undergoing peripheral plastic surgery lasting in mean 3 h [9]. In addition to these cases, two of the authors (JB, CK) have experience of using the LMA ProSeal™ in 5000 patients for procedures lasting from 3 to 5 h without any major problems.

Airway management for prolonged procedures has traditionally been with the tracheal tube to facilitate positive pressure ventilation and to provide airway protection. However, positive pressure ventilation is readily accomplished with the LMA Classic™ [12], the correctly positioned LMA Classic™ will provide some protection against aspiration [13] and the increased risk of aspiration with time is hypothetical, as it has only been the subject of one study [4]. In fact, the LMA Classic™ may offer advantages over the tracheal tube since: (i) spontaneous ventilation is easier due to a reduced work of breathing [14,15]; (ii) positive pressure ventilation can be performed without muscle relaxation due to better tolerance [16]; (iii) the risk of pulmonary infection may be reduced due to non-interference with pulmonary airway resistance [17] and ciliary motility [18]; and (iv) pharyngolaryngeal morbidity may be reduced as the vocal cords are not penetrated and mucosal pressures are lower [19]. A meta-analysis into prolonged use of the LMA Classic™ (based on 16 anecdotal reports, 4 descriptive [20,21] and 7 comparative studies) concluded

that there was reasonable evidence supporting its use for 2-4 h, some evidence for 4-8 h, but little evidence for more than 8 h [22]. Interestingly, the longest duration the LMA Classic™ has been *in situ* is 4 days in neonates [23] and 11 days in adults [24] and there were no untoward effects.

The LMA ProSeal™ is better suited for prolonged use than the LMA Classic™ for several reasons. First, it forms a more effective seal with the respiratory tract (10 cm H_2O higher) [25] and is therefore a better ventilatory device. Second, it forms a more effective seal with the gastrointestinal tract (30 cm H_2O higher) [26] and therefore provides better protection against aspiration and gastric insufflation. Third, it provides easy access to the gastrointestinal tract allowing the passage of a gastric tube, which further reduces the risk of aspiration and gastric insufflation, or the passage of a temperature probe, which facilitates core temperature measurement [27]. Fourth, it exerts lower pressures against the surrounding mucosa for a given seal pressure [28], which reduces the risk of mucosal ischemic injury. Fifth, it provides information about its position in the pharynx, making malposition with all of its attendant problems less likely. Finally, if a gastric tube is left *in situ* it can be used to reinsert the LMA ProSeal™ if there is displacement [29]. The only disadvantages the LMA ProSeal™ has over the LMA Classic™ for prolonged use is that the airway tube has a narrower bore, making it less suitable for prolonged spontaneous breathing anaesthesia and less useful as an airway intubator. A histopathological study in German country pigs showed that the prolonged use of the LMA ProSeal™ for up to 9 h is associated with no or only mild mucosal ischemic injuries [30].

The LMA Fastrach™ is unsuitable for prolonged procedures as it exerts high pressures against the mucosa [31,32].

From a practical viewpoint, we suggest that the use of the LMA ProSeal™ for planned prolonged procedures (>2 h) should only be undertaken by advanced users. However, there is no need to exchange the LMA ProSeal™ for a tracheal tube in the event of an unexpected prolonged procedure if you are an inexperienced user, as the process of exchange adds risk. We suggest inserting the LMA ProSeal™ using the laryngoscope-guided, gum elastic bougie-guided technique as this allows perfect positioning of the distal cuff and assessment of the laryngoscopic view. A gastric tube should be inserted and aspirated regularly to reduce residual gastric volume and any gas. The intracuff pressure should be monitored and controlled to reduce airway morbidity. Positive pressure ventilation is preferable to spontaneous breathing. Care should be taken to ensure that anaesthesia depth is sufficient to tolerate the LMA ProSeal™ during anaesthesia. Fiberoptic assessment of the position of the airway tube may be useful, particularly if the head and neck have been moved, though is not mandatory.

Conclusion

We conclude that use of the LMA ProSeal™ for prolonged procedures is feasible. In principle, it should be safer and more effective than the LMA Classic™ provided basic guidelines are followed.

Declarations

Ethics approval and consent to participate: approval by the Ethics Committee Sir Ganga Ram Hospital, India (No: EC/01/17/1106). Written informed consent to participate of all patients was obtained.

Trial registration

ClinicalTrials.gov - NCT03033979

Consent for publication

Written informed consent of all patients was obtained

Competing interests

The authors declare that they have no competing interests

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