Case Report

Use of a ProSeal™ laryngeal mask airway and a Ravussin cricothyroidotomy needle in the management of laryngeal and subglottic stenosis causing upper airway obstruction

T. M. Cook¹*, M. Asif¹, R. Sim² and J. Waldron²

¹Department of Anaesthesia and ²Department of Otorhinolaryngology, Royal United Hospital, Combe Park, Bath BA1 3NG, UK

*Corresponding author. E-mail: timcook@ukgateway.net

We report the successful use of a ProSeal™ laryngeal mask airway (PLMA) as a dedicated airway to allow fibre-optic inspection and passage through a tightly stenosed glottic and subglottic lesion, before fibre-optic-guided transtracheal placement of a Ravussin needle and jet ventilation. The described technique avoided both tracheostomy and the potential of ‘seeding’ the tumour by passage of the needle through the mass. The PLMA may be a useful ‘dedicated airway’ and has several advantages over the classic LMA and intubating LMA when used for this purpose. These include improved airway seal and reduced risk of aspiration. Four other cases of use of the PLMA as a dedicated airway during management of difficult airways are discussed.

Keywords: complications, difficult airway, tracheal stenosis; equipment, laryngeal mask airway, proseal

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The ProSeal™ laryngeal mask airway (PLMA) (Intavent Orthofix, Maidenhead, UK) is a modification of the classic laryngeal mask airway (cLMA) and has been available since 2000.¹ When correctly placed, it achieves a higher seal than the cLMA and functionally separates the gastrointestinal and respiratory tracts.¹ Like the cLMA, the PLMA may also have a role as a dedicated airway during difficult airway management. The Ravussin needle (VBM Medizintechnik GmbH, Sulz, Germany) is a specifically designed cannula-over-needle for cricothyroidotomy. We describe a patient with glottic and subglottic stenosis causing stridor, in whom blind invasive techniques were discouraged by our surgical colleagues, for fear of ‘seeding’ tumour. We used a PLMA to enable controlled ventilation, endoscopy and insertion of a Ravussin needle under direct vision, followed by jet ventilation during surgery.

Case report

A 83-yr-old man presented with a 3-month history of increasing hoarseness. He was otherwise well and rarely sought medical advice. At presentation he was hoarse, had mild stridor and a poor, non-occlusive cough. His exercise tolerance remained good and he was able to take deep breaths. He had normal external airway features, except slight reduction in neck extension. Nasendoscopic examination of the larynx revealed bilateral vocal cord palsy with midline positioning of both cords. The airway was critically narrowed. Computed tomography revealed a laryngeal and subglottic mass distorting and narrowing the larynx, with erosion of the thyroid cartilage (Fig. 1). The airway distortion extended down almost to the manubrium sternum and thyroid gland.

The case was discussed at some length by surgeons and anaesthetists. The surgeons wished to re-establish the airway and to obtain tissue for diagnosis of the lesion while avoiding tracheostomy, if possible, as this would involve operating through the mass with the risk of ‘seeding’ the tumour. The preferred method to enlarge the airway was with laser. The anaesthetists’ concern related to the potential difficulty of maintaining the airway during anaesthesia while allowing optimal surgical conditions. The mass was assessed as likely to be fixed and passage of a large tracheal tube likely to be difficult. We were also concerned that inserting anything other than a very fine tube might lead to ‘coring

¹Declaration of interest. Dr Tim Cook has received honoraria for lecturing for Intavent Orthofix and the LMA Company, both distributors of the ProSeal™ and other laryngeal mask airways. LMA is the property of Intavent Ltd.
out” tumour with bleeding and soiling of the airway. A blind transcricoid or transtracheal approach was relatively contraindicated for fear of seeding, as above.

The anaesthetic technique was explained to the patient. The monitoring was started in theatre and the lungs were fully pre-oxygenated. We administered lidocaine 70 mg i.v. as an anti-tussive, and a slowly increasing infusion of propofol using TIVA diprifusor until the patient was sedated (effect site concentration 1.2 μg ml\(^{-1}\)). At this point we were able to ventilate the lungs with relative ease (Han grade 1: ventilation by mask without adjuncts\(^2\)). The propofol target concentration was increased to 3 μg ml\(^{-1}\) at which point the patient was unresponsive. Ventilation was again confirmed both in the ‘sniffing’ position and in the tonsillectomy position. Fentanyl 100 μg was administered.

A PLMA size 5 was inserted (digital technique) on the first attempt and the cuff inflated to 60 cm H\(_2\)O. We confirmed the ability to ventilate the lungs before starting controlled ventilation from a Datex Ohmeda AS/3 anaesthetic machine (Datex Ohmeda, Madison, WI, USA) with a tidal volume 500 ml, peak airway pressure 24 cm H\(_2\)O. Spirometry showed a ‘closed’ flow-volume loop, indicating no gas leak.

We infiltrated the low anterior neck with 2 ml of lidocaine 1% with adrenaline 1:200,000. We passed a 4-mm fibre-scope via the PLMA revealing a full view of the vocal cords (grade 1 view\(^3\)). The vocal cords met along their length except at the anterior and posterior extremities, where slit like orifices were present. We explored the anterior orifice but could not pass the fibre-scope through and this caused a small amount of bleeding. It was however possible to pass the fibre-scope through the posterior orifice and negotiate it beyond the subglottic stenosis. We then passed a 13G Ravussin cannula (i.d. 2.0 mm) into the neck as low as possible. The tip was seen to be indenting the anterior tracheal wall, well below the tumour, between tracheal rings 2 and 3 before it was advanced into the trachea. The cannula was advanced into the trachea and its position confirmed before withdrawing the fibre-scope, then starting jet ventilation. We secured the Ravussin cannula to the patient’s neck and started jet ventilation (Fig. 2) before administering rocuronium 40 mg.

Anaesthesia and airway management took approximately 7 min; oxygenation and haemodynamics were stable throughout.

Surgery took place over the next 30 min. Posterior sections of both vocal cords were biopsied and then resected with a carbon dioxide laser. Haemostasis from the tumour required diathermy. At the end of surgery the propofol infusion was discontinued, neuromuscular relaxation was reversed and jet ventilation was continued until spontaneous ventilation resumed. The Ravussin cannula was left in place until the patient had fully recovered.

The patient made a good recovery from anaesthesia and surgery, with no recall of events. Histology showed a squamous cell laryngeal carcinoma (T4, N0, N0). The patient underwent uncomplicated laryngectomy several weeks later.

**Discussion**

The novel aspects of this case are the use of the PLMA as a ‘dedicated airway’\(^4\) and the use of a fibre-scope to ensure correct placement of a Ravussin needle.

The PLMA has potential advantages over other laryngeal masks for use as a ‘dedicated airway’. It allows controlled ventilation more reliably than the cLMA\(^5\) and the available evidence indicates that the PLMA also offers reduced regurgitation and aspiration risks compared with the cLMA.\(^6\)\(^-\)\(^8\) The ability to ventilate patients with low lung compliance and a degree of protection against aspiration are both desirable features when managing a difficult airway. Of note regurgitation and pulmonary aspiration are reported to occur in up to one in seven cases of difficult/failed intubation.\(^9\)\(^-\)\(^10\) In this particular case the airway had increased airway resistance because of stenosis; it is
unlikely that controlled ventilation would have been possible using a cLMA as airway seal with the cLMA exceeds 30 cm H₂O in less than 4% of cases. The ability to view the vocal cords via the PLMA is equivalent to the cLMA and both probably exceed the intubating LMA (ILMA). In theory, the absence of grilles or epiglottic elevator means that the view of the larynx, when the PLMA lies over the glottis, may be better than that with the cLMA or the ILMA, and access to the glottis for instrumentation of the airway is uniquely unimpeded, but this has not been studied.

Alternative strategies for management of this patient could include awake tracheostomy, or attempted insertion of a laser tube or transglottic catheter (e.g. a Hunsaker catheter). Awake tracheostomy in this circumstance cannot be guaranteed to be complication free and had the further disadvantage of risking seeding the tumour. The combination of severe narrowing, the likelihood of bleeding and the fixed nature of the obstruction would certainly have made passage of a laser tracheal tube traumatic and possibly impossible. Surgical laryngoscopy after this would likely have been difficult or impossible. If passage of a laser tube had failed and a smaller tube such as a microlaryngo-scopy tube (which in our hospital are not available in a laser compatible material) had been used, this would have precluded use of a laser. We did not have access to, nor experience with transglottic catheters and it is doubtful that passage would have been easy. Even if it were successful jet ventilation may also have been difficult or impractical as any device inserted through the glottis might have obstructed the already critically stenosed airway, thereby preventing gas entrainment and expiration. For this reason, we did not use jet ventilation after fibre-optic-guided placement of the Ravussin catheter until the fibre-scope was removed. Instead of a PLMA we might have used a Combitube. This is not a device we stock in our hospital and there are concerns over the incidence of trauma associated with its use. In addition the small airway orifices of the Combitube make fibre-optic endoscopy via the Combitube less easy.

Two aspects of our care might be considered controversial. We chose to use a slow, incrementally stepped i.v. induction of anaesthesia with target-controlled propofol rather than a gaseous induction. The stepped total i.v. anaesthesia technique has been reported before (in patients with normal airways) and recently in patients predicted to be difficult to intubate. Hamard and colleagues recently reported use of a stepped incremental dose of propofol in 17 patients predicted to have difficult airways. Sedation and topical lidocaine to the oropharynx allowed successful insertion of the ILMA in all patients and intubation in 16. Mean propofol concentration required (1.25 μg ml⁻¹ in that report) was similar to that we used and amnesia and satisfaction rates were high in that report. Our experience with sedation and anaesthesia is that slow target-controlled infusion of propofol, without opioids, provides smooth slow-onset sedation and anaesthesia with minimal respiratory depression and good control of airway reflexes.

Coughing was avoided and a trial of gentle hand ventilation was possible at light levels of sedation. Use of TIVA also allowed us to maintain anaesthesia during airway manipulation and jet ventilation.

Secondly, the use of a supraglottic airway in the situation of severe laryngeal obstruction is certainly controversial. The cLMA has been reported for use during management of cases of tracheal stenosis. However we believe the improved success of the PLMA in enabling reliable ventilation and protecting the airway gives it a use that other supraglottic airways such as the cLMA would not have. It is notable that in one report of two cases of severe tracheal stenosis, the cLMA was ineffective in restoring ventilation and both patients died. An alternative would have been to perform fibre-optic inspection of the glottis and the trachea without a dedicated airway, either awake or under general anaesthesia. Potential problems with awake techniques included bleeding from the tumour and the ‘cork in a bottle’ effect, leading to obstruction and distress, if attempts were made to pass through the obstruction. Even awake techniques and topical anaesthesia in the critical airway do not ensure safety. Overall we considered an awake technique to be more likely to cause problems than a technique under general anaesthesia. Using a dedicated airway allowed us to make a careful stepwise approach to this difficult airway problem without ever ‘burning bridges’. No approach to this man’s airway was without risk, however assessing the airway at multiple points during induction of anaesthesia was likely to allow reversal of anaesthesia before hypoxia developed if airway obstruction occurred. Trauma to the tumour during insertion of the PLMA was possible, but as much of the tumour was subglottic and as this risk was inherent to all other techniques; we considered this an ‘acceptable risk’. Ultimately our technique allowed us to provide optimal surgical conditions while avoiding inserting our tracheal cannula into the tumour, which was considered clinically important to avoid seeding the tumour.

Matioc and Arndt used a PLMA to maintain the airway during hemicolectomy. At the end of surgery a tracheal tube was required for postoperative ventilation; the authors used a fibre-scope to place a guidewire into the trachea via the PLMA. A Cook airway exchange kit (Cook Critical Care, Letchworth, UK) was then passed over the guidewire and after removal of the PLMA a tracheal tube was passed over the exchange catheter.

Nixon and colleagues rescued a ‘can’t intubate can’t ventilate’ situation following accidental extubation of a patient in an intensive care unit. The PLMA was then used as a dedicated airway while a size 6.0-mm tracheal tube was placed with fibre-optic guidance.

We have also used this technique on two occasions, in a previous patient with a lesser degree of laryngeal stenosis, as a result of papillomas, requiring laser resection. Again in this patient (who had exercise limiting stridor but an airway diameter of ~4 mm) the PLMA provided a clear airway.
and good ventilation prior to fibre-scope-guided needle cricothyroidotomy.

We have recently rescued the airway of a patient when bleeding after carotid endarterectomy led to a rapidly expanding neck haematoma and complete airway obstruction. We used the PLMA to re-establish the airway and then proceeded with fibre-optic-guided placement of an Aintree catheter\textsuperscript{TM} (Cook Critical Care, Letchworth, Hertfordshire, UK) and tracheal intubation.

First time insertion success with PLMA is lower than that for cLMA when the manufacturer’s recommended techniques are used (PLMA 85%, cLMA 93%, meta-analysis \( P<0.05 \)), but there is no difference in overall insertion success (PLMA 99%, cLMA 100%, meta-analysis \( P=\text{not significant} \)).\textsuperscript{11} Howarth has recommended placement by rail-riding the drain tube over a gum-elastic–bougie inserted into the oesophagus.\textsuperscript{23} With this technique 100% first time success is reported.\textsuperscript{23–25} We would agree that where first time placement appears essential this may be a suitable insertion technique.\textsuperscript{25}

Finally our local experience may also be pertinent. In our Intensive Care Unit we regularly perform percutaneous tracheostomy by extubating the patient and inserting a PLMA. The PLMA is then used as a ‘dedicated airway’ for bronchoscopic control of the percutaneous tracheostomy. We have now performed more than 100 of these procedures.\textsuperscript{26} Many of these patients have supraglottic oedema after several days of orotracheal intubation (also stiff lungs from underlying pathology) and therefore in some ways mirror this patient’s condition. In our percutaneous tracheostomy experience, even in the presence of a degree of supraglottic oedema the airway is routinely secured and both leak-free controlled ventilation and fibre-optic access to the trachea is almost always easy to achieve.

To summarize we report the use of a PLMA as a dedicated airway to allow inspection and instrumentation of the airway in a patient with severe airway stenosis. The ability of the PLMA to enable a clear view of the larynx and good access with a fibre-scope while allowing controlled ventilation and protecting the airway are all potential advantages of the PLMA.

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