Glottic insertion of the ProSeal™ LMA occurs in 6% of cases: a review of 627 patients

[L'insertion glottique du ML ProSeal™ survient dans 6 % des cas : une revue de 627 patients]

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Purpose: Glottic insertion of the ProSeal™ Laryngeal Mask Airway (PLMA) has received little attention in the anesthesiology literature. We investigated the incidence and depth of insertion associated with this important cause for a failed insertion attempt with the PLMA.

Methods: With Institutional Review Board approval, we reviewed 15-months' use of the PLMA. Diagnosis of glottic insertion involved a test with children's bubble solution placed on the drain tube port, as well as a fibreoptic examination of the airway of patients experiencing airway obstruction. Patients were anesthetized and paralyzed and the PLMA was inserted deflated with the fingertip method (women size 4, men size 5). The cuff was inflated and a soap membrane established on the drain tube port. Glottic insertion was diagnosed by applying fingertip pressure to the patient's chest wall and observing pulmonary exhalation via the drain tube and bubble formation. The PLMA was then removed and reinserted without further assessment. For all patients, we used a fibrescope to determine the cause of unexplained airway obstruction after the PLMA was considered successfully inserted.

Results: There were 627 patients (391 women, 236 men). We diagnosed glottic insertion in 38/627 (6.1%) patients, 37 by the soap membrane test and one with airway obstruction and direct fibreoptic visualization of malposition. Following glottic insertion, successful reinsertion of the PLMA behind the larynx was always associated with greater depth of insertion by an average 2.0 cm.

Conclusion: Glottic insertion can be easily and quickly diagnosed and our results suggest the incidence and importance of malposition are under-reported in the literature.

Objectif : *L'insertion glottique du masque laryngé ProSeal™ (MLP) a reçu peu d'attention dans les publications sur l'anesthésiologie. Nous avons vérifié l'incidence et la profondeur de l'insertion associée à cette importante cause d'échec de l'insertion du MLP.*

Méthode : *Avec l'accord du Comité d'examen de l'institution, nous avons passé en revue l'utilisation du MLP sur 15 mois. Le diagnostic d'insertion glottique relève d'un test réalisé avec du savon à bulles pour les enfants placé sur l'ouverture du tube de drainage et d'un examen fibroscopique des voies aériennes obstruées. Les patients ont été anesthésiés et paralysés et un MLP dégonflé a été inséré avec le bout des doigts (femmes : taille 4, hommes : taille 5). Le ballonnet gonflé, une pellicule savonneuse a été créée sur l'ouverture du tube de drainage. L'insertion glottique a été diagnostiquée en pressant la paroi thoracique du patient du bout des doigts et en observant l'expiration pulmonaire par le tube de drainage et la formation de bulles. Ensuite, le MLP a été retiré et réinséré sans évaluation supplémentaire. Chez tous les patients, l'usage d'un fibroscope nous a permis de définir la cause de l'obstruction non expliquée des voies aériennes après que l'insertion du MLP a été considérée comme réussie.*

Résultats: *Il y avait 627 patients (391 femmes, 236 hommes). Une insertion glottique a été diagnostiquée chez 38/627 (6,1 %) patients, 37 par le test de la pellicule savonneuse et une par l'obstruction des voies aériennes et la visualisation fibroscopique directe de la mauvaise position. Après l'insertion glottique, la réinsertion réussie du MLP derrière le larynx était toujours associée à une insertion plus profonde selon une moyenne de 2,0 cm.*

Conclusion : *L'insertion glottique peut être facilement et rapidement diagnostiquée et l'incidence et l'importance d'une malposition sont peu diffusées.*

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AN important malposition of the ProSeal™ Laryngeal Mask Airway (PLMA) (Laryngeal Mask Company, Henley-on-Thames, UK) discussed in the introductory article and instruction manual is glottic insertion.[1,2] This describes unsuccessful insertion of the PLMA during which the tip of the mask enters and then obstructs the laryngeal vestibule. As shown by the fibreoptic image in Figure 1, the drain tube orifice at the leading edge of the PLMA then merges end-to-end with the glottis and trachea. Rather than entering the esophageal inlet for channelling gastrointestinal contents to the outside, the drain tube acts as an extension of the pulmonary tract with this malposition. When positive pressure ventilation is attempted using the PLMA the patient experiences upper airway obstruction. Such upper airway obstruction worsens when the mask is pushed inwards because this obstructs the laryngeal inlet further.[1,2] The malposition clearly represents an increased risk to the patient for ineffective ventilation and inadequate separation of gastrointestinal and respiratory tracts as intended for a properly positioned PLMA.[1]

Diagnosis of glottic insertion is possible using a soap membrane test, described previously, to detect pulmonary airway pressures in the drain tube.[3] We have used this simple test for over two years to rapidly identify insertion attempts resulting in glottic insertion. We have also used a fibrescope for two years to examine unexplained airway obstruction occurring in our patients.[4] Here we summarize our regular use of this soap membrane test and fibreoptic examination to report the incidence of glottic insertion of the PLMA.

Methods

Hospital Institutional Review Board approval was obtained for this 15-month retrospective study of PLMA utilization by two physicians (C.J.O. and M.S.S.) from May 2002 through July 2003. We have used the soap membrane test since 2001 and began documenting glottic insertion in our patients at the beginning of May 2002. We used a fibrescope in the operating room regularly from October 2001. Patients were not excluded from PLMA use due to gastroesophageal reflux, hiatal hernia, or obesity.

PLMAs were prepared by careful manual deflation without use of the deflator tool and were lubricated with a water-soluble gel. Patients had an *iv* induction of anesthesia, ventilation by facemask with 100% oxygen, and neuromuscular blockade. The PLMA was then inserted with the fingertip method,[2] using size 4 masks in women and size 5 masks in men, and the cuff inflated to 60 cm H_20 (Portex Inc., Cuff Pressure Indicator #660001, Keene, NH, USA).[5] Following insertion, we recorded the depth of insertion of the mask with a scoring system comparing positioning of the integral bite block to the upper incisors.[6]

Using a non-toxic children's soap bubble solution, a soap membrane was placed on the drain tube by wetting a fingertip and then touching the port.[7] Glottic insertion was diagnosed with: 1) large and rapid centimetre-scale oscillation of the soap membrane associated with cardiac pulsation; and 2) formation of a soap bubble from the drain tube following gentle fingertip pressure applied to the patient's chest wall in the infraclavicular area. The first indication of malposition was the important oscillation of the soap membrane. For complete confidence, however, it was required to observe pulmonary exhalation via the drain tube and bubble formation following fingertip chest compression. Once diagnosed, the PLMA was removed without further assessment and reinserted. Videos demonstrating the soap membrane test and glottic insertion of the PLMA are available as Additional Material on the Journal's website (www.cja-jca.org).

Next, we tested a second common malposition of the PLMA – foldover of the tip of the mask.[2,8,9] With a soap membrane on the drain tube port we pressed the patient's suprasternal notch. If the soap membrane remained entirely flat we determined that the tip of the PLMA was folded backward.[9–11] The PLMA was then removed and reinserted. If the membrane bulged while pressing the suprasternal notch, the PLMA was considered satisfactorily positioned and the device was secured in place with tape over both maxillae.[10]

Because airway obstruction is a common feature with the PLMA,[12,13] the anesthesia circuit was then attached and airway patency carefully assessed. We judged feel of the anesthesia bag and slowed-refilling,[14] assessed chest rise and fall, listened for stridor, examined the capnograph, and measured maximum minute ventilation.[4] Whenever significant upper airway obstruction was present, we performed a fibreoptic endoscopy. All changes in airway management and adverse perioperative complications attributable to the PLMA were recorded.

Incidences of glottic insertion were contrasted for anesthesiologists C.J.O. *vs* M.S.S. and for women *vs* men using a 2×2 Chi-squared test and considered statistically significant if $P < 0.05$.

Results

The retrospective study included 627 patients with demographics presented in the Table. Glottic insertion occurred in 38/627 (6.1%) patients, 20/391 (5.1%) women and 18/236 (7.6%) men. Incidence of

TABLE Demographics of 627 patients

	Women *n = 391*	*Men* *n = 236*
Age (yr)	17 – 92 (56 ± 17)	16 – 88 (58 ± 16)
Height (cm)	137 – 183 (162 ± 7)	155 –198 (177 ± 8)
Weight (kg)	32 – 146 (72 ± 17)	59 – 206 (91 ± 19)
BMI ($kg \cdot m^{-2}$)	14 – 54 (27 ± 6)	18 – 63 (29 ± 6)
BMI > 35 ($kg \cdot m^{-2}$)	42	21

Data are range (mean ± SD). BMI = body mass index.

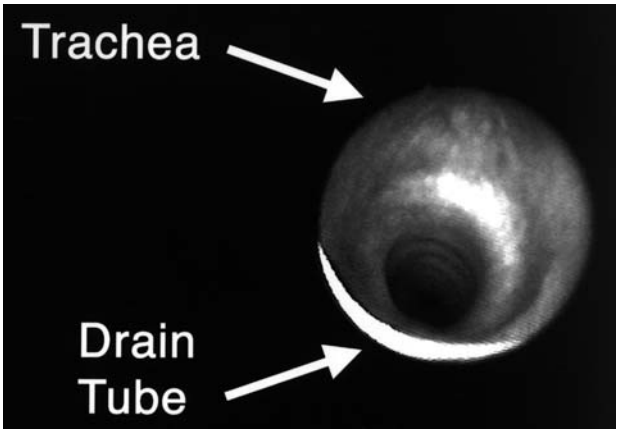

FIGURE 1 Fibreoptic image from the tip of the drain tube during glottic insertion demonstrating view of trachea.

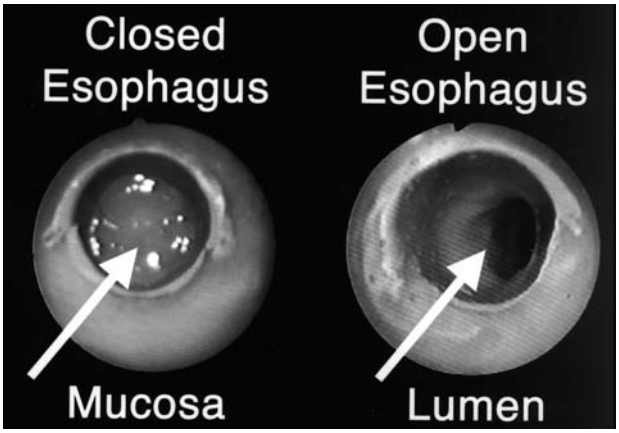

FIGURE 2 Fibreoptic views from the tip of the drain tube during normal positioning demonstrating both "closed" and "open" states of esophageal lumen.

glottic insertion in women was not statistically different from that encountered in men. Incidence of glottic insertion for anesthesiologist C.J.O. was not statistically different from M.S.S. The PLMA was successfully reinserted in all patients except one with repeated glottic insertion; endotracheal intubation was used without complication.

Most diagnoses of glottic insertion, 37 of 38, were identified with the soap membrane method. The PLMA was simply removed without further assessment and then reinserted. Once the PLMA was considered satisfactorily inserted, we used a fibrescope to diagnose the cause for airway obstruction (in roughly 5% of the 627 patients). During the 15-month study only one patient experienced a severe airway obstruction resulting from glottic insertion of the PLMA diagnosed by fibreoptic examination. Other patients experiencing airway obstruction were all found to have the PLMA situated behind the larynx and cause was usually compression of the laryngeal inlet by the bulky cuff and tip of the mask.

Depth of insertion was measured in 17/20 of the women with glottic insertion and in 15/18 of the men. In each of these patients the glottic insertion depth was subtracted from normal positioning depth after the device was successfully inserted. Normal positioning of the PLMA always had a greater depth of insertion. For women range was 0.8 to 3.1 cm and average was 1.9 cm deeper. For men range was 1.1 to 3.9 cm and average was 2.1 cm deeper.

Discussion

We have presented our clinical findings pertaining to glottic insertion of the PLMA based largely on our regular use of a simple soap-membrane test, supplemented with occasional fibreoptic examination of patients with severe airway obstruction. Although glottic insertion is a relatively uncommon malposition with the Classic™ LMA,[15,16] we found an occurrence during insertion of 6% of cases using the PLMA in anesthetized and paralyzed patients. It is certainly possible that a lack of experience may have contributed to finite incidence of this malposition. We suspect that we are not alone in, occasionally, requiring more than one insertion attempt to place the PLMA successfully. For example, an original article by experienced users of the prototype gastric-LMA encountered a 6.7% failure rate to establish a patent airway within two insertion attempts with the PLMA.[17] This failure rate is strikingly similar to our incidence of glottic impaction.

FIGURE 3 Use of self-inflating bulb. With normal positioning of the ProSeal™ laryngeal mask airway the bulb injects easily and then remains collapsed, as shown. With glottic insertion the bulb re-inflates.

Brimacombe and colleagues have also recently documented difficulty using the fingertip and insertion tool techniques with first insertion success rates of only 87% and 84% respectively.[11] It would appear that malposition is more common during insertion of the PLMA compared to the Classic™ LMA. Although effort in an improved insertion technique is warranted, it is just as important for clinicians to understand the common malpositions of the PLMA and means for rapid diagnosis and recognition.

We were interested in the depth of glottic insertion and, due to the absence of centimetre depth markings, we recorded distances with a system observing positioning of the integral bite block compared to the upper incisors.[6] We found that glottic insertion occurred at depths that appeared normal and the bite block was always situated between the patient's teeth. Unlike the foldover malposition where the bite block frequently protrudes entirely from the mouth providing instant diagnosis,[6] glottic insertion could not be diagnosed solely by observing insertion depth. However, we did find that when the PLMA was successfully reinserted it achieved a greater depth of insertion by, on average, 2 cm (the approximate height of the cricoid cartilage).[18] This provided an important element of feedback related to repeat insertion attempts.

Because the insertion depth can appear normal, the diagnosis of glottic insertion can be difficult and potentially confusing. The bite block is between the teeth, yet the patient experiences near complete upper airway obstruction when positive pressure ventilation is attempted. In the absence of muscle relaxation it can easily be mistaken for laryngospasm. Little gas appears to reach the lungs, capnography fails to display evidence of gas exchange, and there is absence of chest rise and fall. Pushing the mask inwards does not improve the situation. Passage of a fibrescope through the airway tube characteristically demonstrates a shallower than normal depth of insertion with excessive view of the base of the tongue and tip of the epiglottis visible in the distance draped over on top of the distal drain tube (videos available as Additional Material at www.cja-jca.org). Negotiating the fibrescope under the epiglottis shows the tip of the PLMA obstructing the entire laryngeal vestibule. Alternatively, passage of the fibrescope through the drain tube shows the drain tube emerging at the glottis and trachea.

Once we realized that the soap membrane test provided an easy and rapid diagnosis of glottic insertion, and after many confirmations of this malposition using a fibrescope, we soon began relying on this test completely during initial assessment of PLMA positioning. We simply removed the device without further testing and immediately began preparations for another insertion attempt. After gaining confidence, there was little temptation to spend time confirming the diagnosis by proving airway obstruction or passing a fibrescope. In addition, we frequently found that it could take three to five more insertion attempts before we were successful and assessment of airway patency following each attempt was inefficient. We can be criticized, therefore, for relying so heavily on a blind test for glottic insertion without even testing airway patency to determine positioning of the PLMA. In all cases hindsight assured us of proper judgement; successful reinsertion made the soap membrane signs disappear and the depth of insertion was noted to increase.

One subtlety of the soap membrane test deserves discussion with the help of Figure 2. Occasionally, following insertion of the PLMA the esophagus can be found to be "open," as opposed to the usual state where it is "closed" and completely collapsed as a virtual space. The incidence of an open esophagus has been quoted to range between 3 to 9%.[19,20] Both "open" and "closed" views of the esophagus are shown in Figure 2. When the esophagus is "open" and a soap membrane is positioned on the drain tube the membrane shows large up and down oscillations. This occurs because cardiac contractions distort the esophageal lumen and drive esophageal air up and down the drain tube. A similar effect occurs with glottic insertion when cardiac pulsations drive tracheal gases up and down in the drain tube. Large oscillations of the soap membrane therefore characterize both an open esophagus as well as a glottic insertion.

To distinguish one from the other it is necessary to observe pulmonary exhalation via the drain tube and formation of a soap bubble. This is an easy test, pressing gently on the patient's chest wall with one or two fingers in the infraclavicular area, and watching for bubble formation. Bubble formation occurs with glottic insertion and not with an open esophagus.

Another subtlety of the soap membrane test involves use of neuromuscular blockade. As described, we used these drugs in all of our patients. However, if a clinician does not use these drugs laryngospasm can occur. Laryngospasm would make the soap membrane diagnosis of glottic insertion difficult.

We have described use of a soap membrane test using the drain tube to diagnose glottic insertion of the PLMA. The drain tube size is considerable, comparable to a 6.0 or 7.0 mm internal diameter endotracheal tube for a size 4 and 5 PLMA respectively, and it is important to realize its role in diagnosis of PLMA malpositioning. In addition to the soap membrane method there are at least two other simple tests of the drain tube that offer quick diagnosis of glottic insertion. We have used a self-inflating bulb[21] illustrated in Figure 3, to confirm glottic insertion of the PLMA. With normal positioning of the PLMA the bulb injects easily and then remains collapsed whereas during glottic insertion the bulb injects easily and re-inflates. The self-inflating bulb technique has been described previously for use with a supraglottic airway device, the esophageal tracheal Combitube™ (Kendall-Sheridan Catheter Corp., Argyle, NY, USA).[22] Another simple method involves a Trachlight™ (Laerdal Medical, Wappingers Falls, NY, USA) with stylet removed passed via the drain tube, a technique recently described to diagnose the foldover malposition.[23] Just as for blind endotracheal intubation, the Trachlight™ could provide means to quickly distinguish glottic from esophageal location of the tip of the PLMA mask. The drain tube therefore provides a minimum of three simple options to diagnose glottic insertion – 1) soap membrane, 2) self-inflating bulb, and 3) Trachlight™ – all without resorting to a ventilatory trial. We have most experience and most confidence with the soap membrane method but all three techniques should be worthy of consideration.

In summary, we used the PLMA during 15 months in 627 patients and a simple soap membrane test to document insertion attempts resulting in glottic impaction. Glottic insertion occurred in 6% of cases and represents the largest reported incidence of such malposition to date in the anesthesia literature. It is important for clinicians to understand the common malpositions of the PLMA and simple means for rapid diagnosis and recognition.

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