Use of a 3D-Printed Laryngeal Mask Airway Mouth Prop During Pediatric Dental Sedation Procedures

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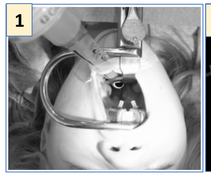
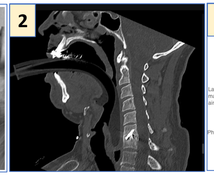
Introduction

The concept of using a laryngeal mask airway (LMA) for shared access oral procedures is well documented in the ENT literature. LMA use allows access for tonsillectomy/adenoidectomy (T/A) procedures and prevents aspiration of blood secondary to bleeding. Using the mouth gag the LMA is fixed in an appropriate position (over the tongue) and is unable to move but allows surgical access. Our concept uses a custom designed bite block as a Prop to allow the LMA to be fixed and out of the dental field on one side of the mouth.





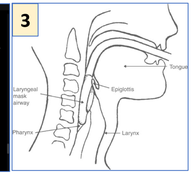
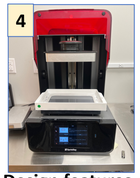


Figure 1: LMA in place for T/A
Figure 2. Sagittal view from CT scan of LMA in place
Figure 3. Diagram of LMA placement

Methods

Preparation

The flexible LMA Mouth Prop is designed using the online CAD program Tinkercad. After the LMA Prop is designed it is exported as an .stl file that is uploaded into the 3D printer software. SpintRay 3D printer, washer, and oven are used with the SpintRay Die & Model 2 biocompatible 3D printing material to fabricate the Prop.



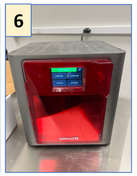


Figure 4: 3D Resin Printer
Figure 5. 3D Resin Ethanol Washer
Figure 6. 3D Resin Oven

Design features

The LMA Prop is similar to a bite block, with a channel to retain the LMA in position. The size 2 Prop is related to a small bite block. Prop designed to fit size 2.0, 2.5, and 3 LMA Sizes (Parker brand)

Size 2:	15 to 20 kg	Size 3:	30 to 60 kg
Size 2.5:	20 to 35 kg	Size 4.0	60 to 80 kg

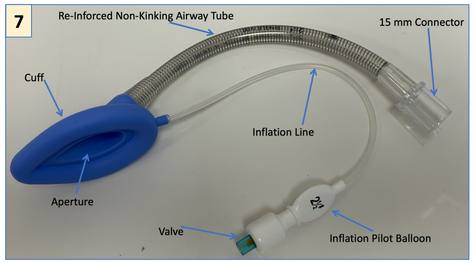
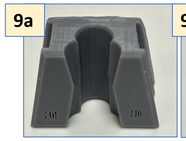
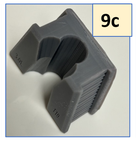


Figure 7: Flexible LMA features
Figure 8. LMA and Prop





Figures 9 a-d: The 3D printed Prop showing a) X-channel b) Ridges for teeth c) Double channel concept, d) pinch line between channels

Results

Due to IRB delays concerning the possible need for an IDE for the proposed study we cannot report the results from a series of patients yet, as such IRB approval for the case series is still pending. We can report on the changes in practice and any things we have noted over the first ~100 patients we have used this device on. All comments about occurrence rates from the LMA Prop use are post hoc recollection by the anesthesiologist from his clinical case experiences.

Indications

Restoration of 3-5 teeth for resident case, or 6+ teeth for attending case, any case with more than 2 permanent extractions or 5+ total extractions
Tonsil size 2+ or Mallampati score 4 where open airway sedation may not be appropriate
BMI >22 (ages 6-12) or BMI > 25 (ages 13+)
Taking 2 or more psychiatric medications
Poor cooperation/behavioral concerns

Pre-Op Alternate Plan

Unable to place IV while conscious

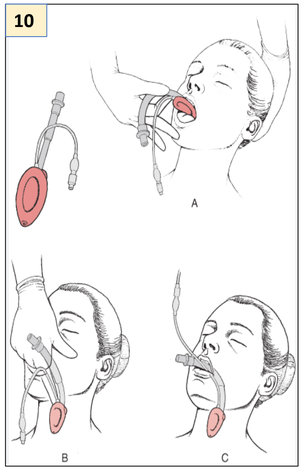
Rescue

Airway issues with Deep Sedation – placement of LMA to complete case

"Post Hoc" Description of Use

LMA and Monitoring

Placement of LMA uncomplicated, LMA curves around tongue uninflated, rarely needs finger guidance, sits in the supraglottic region and can be seen/felt in the anterior neck. Adjustments/repositioning rarely necessary. In rare instances of LMA not seating correctly, pushing too far out, or appearing to be too large despite appropriate weight range, change from a size 2.5 to 2.0 is completed.
Cuff inflated with recommended volume of air, and positive pressure ventilation tested with 20mmHg support. Drager Anesthesia machine Ventilation Monitor screen observed for appropriate volume (5-6 ml/kg). The LMA cuff appears to help significantly with preventing LMA movement. Every time the LMA is moved or reconnected its position is confirmed with gentle positive pressure ventilation.



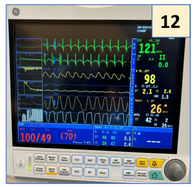


Figure 10: Technique for placing the LMA
Figure 11: Anesthesia machine used to supply the anesthetic. Usually; sevoflurane induction, IV placement then LMA placement. Morphine, Ketorolac and Ondansetron are also given
Figure 12: The Monitor showing capnography and endotracheal sevoflurane

Figure 13: LMA & Prop in place
Figure 14: Access for dental procedure demonstrated

PROP Placement

There are two sizes of Prop for each LMA, regular and large. The large facilitates maximum mouth opening ~4-5mm more. If the child is at the upper range of the LMA weight, the large Prop may be more appropriate.
After several different placement method attempts, the best method seems to be when the anesthesiologist opens the mouth and the dentist places the Prop on one side (opposite to desired procedure start side), anesthesia sweeps the tongue away from the Prop with index finger and secures the LMA into the channel with other hand. This ensures the LMA tube is pinched between the lingual and buccal channel for a secure fitting, usually only the front part of the Prop is in the buccal channel once the LMA in secured in place.

PROP Movement

The Prop has been noted to move/slide out slightly during procedure, despite the ridges on the teeth surface side of the Prop. This may require gentle repositioning during the procedure. Some slack is required in the posterior pharynx of the LMA so that if the Prop moves it does not pull the LMA out. Very rarely the Prop may need to be repositioned completely, notably in instances where no/ few teeth left after extraction (may not sit as securely). Gauze is often placed over sockets of recently extracted teeth and the gauze may impair the positioning of the Prop, careful observation is required to ensure it does not move.
If the LMA is not secured in the pinch point between the channels properly then it can release from the Prop and need to be resecured. Accessing the Prop with tongue sweep method has lessened this LMA release issues.

Opiate Selection

Initially fentanyl was used as the peri-operative opiate as it is used for our deep IV sedation. However, at small 12.5-25 mcg dosing, apnea for several minutes was not uncommon and required some ventilatory assistance until spontaneous respiration returned. A switch was made to using morphine (2 mg/patient) and the issue has since resolved.

Sevoflurane % During the Case

After induction with 8% sevoflurane and IV placement, 100% O2 is given prior to LMA placement. During the case, the O2/N2O is 1L each and sevoflurane is lowered to 3%. Sevoflurane percentage is adjusted as vital signs dictate, generally in the range between 2% and 3%. Patient is returned to 100% O2 prior to LMA removal.

LMA Removal

Patient is on 100% O2 and semi-recumbent in the cart. The Prop is removed and the oropharynx suctioned above the LMA. The LMA is the removed while the child is still deeply sedated (in children this tends to result in less coughing and a lower risk of spasm, whereas adults and older children can wake up and just "spit" the LMA out). Full facemask O2 is applied, and an oral airway may be used, especially if it was required during the induction phase. As they are under general anesthesia, a jaw thrust is often required for a few minutes to open the airway until sedation lightens. The child is monitored in the procedure room for 10 minutes, until awake and requiring no airway support except 2L O2 via nasal cannula. There seems to be more emergence movement when compared to short mask sevoflurane cases, but this generally resolves quickly.

Discussion

We feel that our initial clinical experience with the LMA Prop device has proven useful in its evolution the the present version (X-channel). Once we have IRB approval, the formal study will commence with scoring systems for Prop and flex LMA placement, ease of surgery, reliability of Prop and LMA secure placement, and post LMA complications. We have found the LMA provides appropriate access for the dentist as well as giving the anesthesiologist a secure airway with which ventilatory assistance may be provided if needed.