Pediatric Airway workshop

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Objectives:
This workshop is designed to teach:
a) Normal and difficult pediatric airway anatomy.
b) Use of LMA and other supra-glottic devices.
c) Technique of fiberoptic intubation in children
d) Other intubating methods like intubating sytlets and Bullard scope.
e) Techniques like retrograde intubation and crico-thyroid puncture.

Pediatric Airway Anatomy:

Normal Pediatric Airway:
Pediatric airway anatomy differs from adult in many ways and anesthesiologist should be aware of these differences. These differences have significant impact on the airway management. During fetal life, laryngeal apparatus develops from brachial clefts and descends in the caudal direction. At birth, laryngeal inlet is at C3-4 level. This cephalic position of larynx combined with a large omega shaped epiglottis and posteriorly placed tongue form a sphincter often referred to as ‘glosso-pharyngeal sphincter’. This dynamic sphincter allows newborn to feed and breathe simultaneously. This has earned them the label of ‘obligatory nasal breathers’. Newborns and infants also have a large occiput Combination of the above-mentioned features makes it difficult for the anesthesiologist to visualize the laryngeal opening. In addition, neonates have prominent arytenoids and deeply seated vocal cords that are angled anteriorly.

Difficult Pediatric Airway:
Fortunately the incidence of unexpected difficult pediatric airway is low. Most of the difficult airways are associated with congenital syndromes. A detailed preoperative evaluation of the airway may be difficult in an uncooperative child. Small, receded mandible can be missed easily. Every attempt should be made to evaluate child in a lateral profile.
Difficulty in managing airway can arise from one or more of the following three reasons:
a) Accessing the airway: In these children, using a direct laryngoscope to intubate the patient is often impossible because of the limited mouth opening or a large soft tissue mass obstructing the approach to the airway. For example children with Freeman- Sheldon syndrome have very limited mouth opening, children with Beckwith-Wiedeman syndrome, Mucopolysaccroidossis have large tongues and make direct laryngoscopy impossible to perform.
b) Visualizing the airway: After performing adequate direct laryngoscopy, one does not get a complete or even partial view of vocal cords. Direct laryngoscopy requires displacement of tongue to the submandibular space. In children with small mandible, there is not enough space in the submandibular area to accomodate the tongue during laryngoscopy. This gives the appearance as if the larynx is extremely anterior. Common examples are children with Pierre- robin, Treacher- Collin syndrome.
c) Challenges of the target tissue: These patients are at high risk of losing the airway. In these patients, one is able to visualize the laryngeal inlet without any difficulty but intubation and/or effective ventilation may still not be adequate. Examples include anatomical abnormalities of larynx, foreign bodies of trachea, anterior mediastinal masses, laryngeal papilomatosis etc

Management of Pediatric Airway:

There are many devices available to assist an anesthesiologist to manage the pediatric airway. The choice of the device depends on the experience and familiarity of the anesthesiologist with the device.
These devices can be grouped into two main categories
1. Alternatives to the endotracheal intubation.
2. Alternatives to direct laryngoscopy.

Alternatives to endotracheal intubation: Supraglottic devices

Supraglottic devices can be used to secure airway inn cases of emergency. These devices can be inserted blindly and can be used for positive pressure ventilation. However these devices do not provide adequate protection against aspiration. A number of such devices are available in the market. LMA is one of the most frequently used and tested supraglottic device

Use of LMA in children

Patrick N. Olomu, MD, FRCA

The Laryngeal Mask Airway (LMA™) is a supraglottic airway device that was invented by Dr. Archie Brain, a British anesthetist. It became commercially available in the UK in 1988 and gained FDA approval in the US in 1991. Since then, a wide range of pediatric sizes of the different LMA types have been introduced. It is safe to say that the LMA has advanced the practice of contemporary anesthesia in all age groups.

The Classic LMA is the original LMA and is considered a general purpose device. It has been used extensively for different general surgical, urologic, orthopedic and ophthalmic procedures as well as for procedures outside the operating suite (flexible laryngotracheobroncoscopy, upper GI endoscopy, imaging and interventional radiology and radiation therapy). It has also proved useful as a conduit for endotracheal intubation in difficult airway situations in certain syndromic neonates and children. It has also gained wide usage for airway resuscitation and rescue and has been used as a conduit for drug administration, including the administration of surfactant to neonates with respiratory distress syndrome. The LMA Unique™ is similar to the Classic LMA in every way except that it is made of medical grade PVC. It is designed for single use and to reduce the risk of disease transmission.

The special purpose LMAs (LMA Flexible™ and LMA ProSeal™) have also seen increasing usage in pediatric anesthesia. The Flexible LMA has been utilized for adenotonsillectomy, head and neck surgery, oral surgery, ophthalmic and dental surgery as well as radiation therapy. An overall insertion success rate of 97% has been reported for the Flexible LMA.

The recent introduction of pediatric sizes of the ProSeal LMA has further expanded the role of the LMA in pediatric anesthesia. The PLMA is designed to facilitate positive pressure ventilation and provide airway protection. The integral drain tube allows for passage of a gastric tube. Laparoscopic procedures, laparotomies and certain chest wall and thoracoscopic procedures can now be undertaken with the PLMA.

The advanced use of these special purpose LMAs requires an impeccable technique and good communication with the operating surgeon.

Use of the LMA in children is not without potential problems. An increased risk of airway problems and epiglottic downfolding have been reported in infants. Also, the extreme anatomic and physiologic differences predispose to malpositioning in this subgroup.

So what does the future hold? It is hoped that a “true” pediatric size intubating LMA (Fastrach™) will be produced. This would require that the curve be re-configured to fit the airway of the small child. If ultimately successful, a pediatric fiberoptic intubating LMA (CTrach™) should follow. These advances would no doubt revolutionize the visualization and management of the normal and abnormal pediatric airway.

Other Suprglottic Devices:

Priti Dalal, MD, FRCA

Besides the Laryngeal Mask Airway and its related devices there are a wide variety of airway devices that are now available and can be added to the armamentarium of the anesthesiologist. The characteristics features of two of these 'non-LMA' supraglottic airway devices are mentioned below.

A) The Laryngeal Tube® (LT, VBM Medizintechnik, Sulz and Neckar, Germany or King LT™, King Systems Corp; Noblesville, IN)

Priti Dalal SPA 2006

Product information: This is a latex-free, single-lumen silicone tube, which is closed at the distal end. It has two high volume-low pressure cuffs – a large proximal oropharyngeal cuff and a smaller distal esophageal cuff. Both the cuffs can be inflated simultaneously via a single port. Once inserted, it lies along the length of the oropharynx with the distal tip lying in the upper esophagus. It also has markings that indicate the correct positioning of the device when aligned with the upper incisors. It has two ventilatory outlets that facilitate ventilation. Six sizes are planned (sizes 0 – 5, neonates to large adults) but currently only sizes 3,4 and 5 are available in US.

Comparison with the LMA: Significantly higher airway leak pressures compared to the LMA-classic in adults but no gastric insufflation in contrast to the LMAclassic. Airway leak pressures achieved however were comparable to the LMA-ProSeal in the adult population.

Use in Pediatric population: Limited data available in children. In one observational, non-comparative clinical trial in 2 –12 years age group, the laryngeal tube was shown to provide a rapid, patent airway with a low complication rate.

References:

Ocker H, Wenzel V, Schmucker Pet al. A comparison of the laryngeal tube with the laryngeal mask airway during routine surgical procedures. Anesth Analg 2002; 95:1094-1097

Genzwuerker HV et al. Ventilation with the laryngeal tube in pediatric patients undergoing elective ambulatory surgery. Pediatric Anesthesia 2005; 15: 385-390

B) Cobra PLA™ (Engineered Medical Systems, Indianapolis, IN)

Product information: The CobraPLA is a perilaryngeal airway device. It is termed perilaryngeal because the distal end, which appears like a cobra-head, abuts the aryepiglottic folds and thus directly seats on the entrance of the glottis. It is designed so as to be positioned in the hypopharynx where it abuts the structures of the laryngeal inlet. It is available as a large inner diameter, single lumen breathing tube with low pressure-high volume cuff. Inflation of the cuff occludes the nasopharynx pushing the tongue and soft tissue forwards and preventing air leakage. It has a standard 15mm connection at the proximal end whereas the distal ventilatory end has a unique design such that the slots prevent the ventilatory hole from being obstructed by the soft tissue and the epiglottis. It is available in eight sizes from paediatric to adult (1/2 to 6).

Comparison to the LMA: Can be used as a conduit for endotracheal intubation like the LMA. Cook et al evaluated the performance of the Cobra Perilaryngeal Airway in a cohort study and in a randomized, controlled, crossover comparison study with the Classic Laryngeal Mask Airway. After studying 29 patients, both studies were suspended and later stopped after two cases of significant pulmonary aspiration had occurred in patients whilst using the Cobra Perilaryngeal Airway. These cases raised concern about both the design and the safety of the Cobra Perilaryngeal Airway, particularly during controlled ventilation.

Use in pediatric population: Although a range of sizes is available, no studies evaluating this device in children are currently available

References:
Cook et al. An evaluation of the Cobra Perilaryngeal Airway: study halted after two cases of pulmonary aspiration. Anesthesia 2005; 60(8); 791-796.

Agro et al**.** The CobraPLA™ in 110 anaesthetized and paralyzed patients: what size to choose? British Journal of Anaesthesia, 2004, Vol. 92 (5): 777-778

Alternatives to Direct Laryngoscopy

A. Lighted Stylets:

David Young MD

There are two main types of stylets:

A. Lighted stylets: (Trachlight and Trachlite)
B. Intubating fiberoptic stylets: (Shikani Optical Stylet)

Indications for lighted stylets:

1. Anticipated difficult airway or history of difficult airway in a patient where fiberoptic intubation predicted to be difficult (i.e. increased airway secretions from blood).

Contraindications for lighted stylets:

1. Airway or oropharnygeal lesions such as tumors, infections, and foreign bodies.

   A. Lighted stylets:

      1. Based on external transillumination of neck; less stimulating than direct laryngoscopy.
      2. Inexpensive, portable, lightweight device; stylet with built-in light source.
      3. Select appropriate stylet based on ETT selection (infant, pediatric, and adult stylets available).
      4. Dim operating room lights before stylet insertion.
      5. Perform jaw-lift, insert stylet, and stay in midline.
      6. Look for bright glow of light in center of neck; does not require visualization of larynx.
      7. Light may dim if stylet passed into esophagus but this is less reliable in pediatric and infant patients!
      8. After bright glow obtained, slide ETT off into trachea; verify ETT placement.

   B. Intubating fiberoptic stylets:

      1. Based on visualization of larynx; less stimulating than direct laryngoscopy; may be used in place of fiberoptic bronchoscopy.
      2. Less expensive than fiberoptic bronchoscopy; portable, lightweight; shapeable stylet with built-in fiberoptic scope and light source.
      3. Adult and pediatric sizes; oxygen insulflation port present.
      4. Perform jaw- lift; insert stylet, stay in midline, advance slowly.
      5. Identify base of tongue, epiglottis, and then larynx.
      6. Advance ETT over stylet into trachea; can visually confirm location of ETT with fiberoptic stylet.
      7. Relative contraindications similar to fiberoptic bronchoscopy (i.e. excessive secretions).

B. Bullardscope:

Bullardscope combines the benefits of rigid direct laryngoscope and fiberoptic intubation. It is helpful in patients with restricted mouth opening as well as restricted cervical motion. It is available in pediatric and adult sizes.

C. Fiberoptic Intubation:

Sharma Anshuman MD, FFARCSI.

Fiberoptic Intubation remains the mainstay of difficult airway management. It allows intubation under vision without requiring to distorting the airway anatomy. It is also expected to be less traumatic. It is estimated that one needs to perform about twenty fiberoptic intubations to gain proficiency in this technique. When the difficult airway is anticipated, fiberoptic laryngoscope should be used earlier as an aid because the presence of secretions or blood in the airway severely limits its use.

Equipment:
Different size fiberscopes are available for different age groups. The neonatal scope is 2.2mm in outer diameter and can be used for both premature, newborn as well as infants. Infants. The pediatric scope has an outer diameter of 2.9-3.1 mm. These are the most versatile scopes as they can be used for newborns, infants as well children up to 6-8 years of age. For older children and adolescents, fiberoptic scopes ranging from 4.0 mm to 5.6 mm are available. The discrepancy between outer diameter of the scope and internal diameter of the endotracheal tube should be kept to the minimum. This prevents endotracheal tube from getting stuck at the arytenoids cartilages. Smaller scopes have fewer optical fibers and deliver poorer quality of image. Pediatric scopes lack the working channel that can generate adequate suction. These ports, however, can be used to insufflate oxygen during intubation. It is better to have all the desired equipment on a designated difficult airway cart. An experienced assistant can provide help with jaw thrust, tongue retraction and monitoring.

Technique:
Fiberoptic can assist with both oral and nasal intubations. During oral intubation in newborns and infants, because of the anterior position of larynx, fiberscope needs to make an acute anterior bend to approach the laryngeal inlet. This problem is mitigated during nasal approach. It is easy to forget that vocal cords in infants and newborns are positioned in a way that anterior commisure is lower that posterior commisure. Advancing the scope forward will always cause the scope to hit anterior commisure. It is best to approach the anterior commisure and make an acute posterior deflection to enter the trachea. After positioning the scope just above the carina, tube should be advanced over the scope. While advancing the tube, any slack in the scope should be removed. If resistance is met, ETT should be withdrawn and twisted ninety degree in counter clockwise direction. This maneuver will free the tip of tube from aretynoid cartilage. Using reinforced endotracheal tubes can minimize this problem.

D. Use of the GlideScope®

Cheryl K. Gooden, M.D.

Objective: Participant will have a better understanding of how the GlideScope® works and practice hands-on using mannequins.

Various techniques exist for intubating the difficult pediatric airway. The GlideScope® Videolaryngoscope (GVL; Saturn Biomedical Systems, Inc., Burnaby, BC, Canada) is an airway device that can be used in the normal or difficult airway.

The GVL consists of a laryngoscope blade that contains a digital video camera and light source embedded along the inferior border. The blade has a 60° angle, and with its camera provides outstanding views of the supraglottic airway and adjacent structures. The airway image is captured on a 7-inch display unit that can accompany this system, or interface with other compatible designs. The end result is that the GVL provides a video assisted intubation.

On account of the design of the laryngoscope blade, the GVL can provide an unobstructed view of an anterior epiglottis. The GVL is an excellent teaching tool. Primarily, because everyone present in the room can view the patient's airway and the airway anatomy can be easily demonstrated. Patient preparation and intubation are usually brief. The skills involved in the use of the GVL are relatively easy to learn but do require practice.

Points for Successful Use of the GlideScope®:

1. Practice on the mannequin is helpful when available
2. Acquire the skills on normal airways first
3. Midline approach is essential
4. A styletted endotracheal tube will provide the needed curvature

Suggested Readings:

1. Cooper RM, Pacey JA, Bishop MJ, McCluskey SA. Early clinical experience with a new videolaryngoscope (GlideScope®) in 728 patients. Can J Anesth 2005;52:191-198.
2. Doyle DJ. GlideScope-assisted fiberoptic intubation: a new airway teaching method. Anesthesiology 2004;101:1252.
3. Gooden CK. Successful first time use of the portable GlideScope® videolaryngo- scope in a patient with severe ankylosing spondylitis. Can J Anesth 2005;52:777-778.
4. Rai MR, Dering A, Verghese C. The GlideScope system: a clinical assessment of performance. Anaesthesia 2005;60:60-64.

E. Invasive airway access in the pediatric patients.

Veronica Swanson MD

Difficult airways are unavoidable. Every anesthesiologist will encounter them if he or she practices long enough. As anesthesiologists, our tools include the various pathways of the difficult airway algorithm[1]. Eventually, we encounter the only remaining option in the pathway: emergency invasive airway access. A survey of residency programs revealed that the number of invasive airway techniques used by residents during their training was one to two encounters[2]. Because this avenue is one we face very infrequently, our skills may become rusty. But our patients' lives depend upon our being facile with these techniques. This workshop will re-familiarize you with the equipment and practice of emergency cricothyrotomy, transtracheal needle jet ventilation, and retrograde intubation via hands on use of the equipment.

1. *Practice guidelines for management of the difficult airway: an updated report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway.* Anesthesiology, 2003. **98**(5): p. 1269-77.
2. Hagberg, C.A., et al., *Instruction of airway management skills during anesthesiology residency training.* J Clin Anesth, 2003. **15**(2): p. 149-53.
3. Butler, F.S. and A.A. Cirillo, *Retrograde tracheal intubation.* Anesth Analg, 1960. **39**: p. 333-8.