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Pediatric laryngospasm

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Summary

Pediatric laryngospasm is an anesthetic emergency. It is a relatively common phenomenon that occurs with varying frequency dependent on multiple factors. In view of this and the clear risks to the patient when it occurs, a consensus committee has been established to determine the evidence based management of this condition. This article will cover the definition, causes and recognition of laryngospasm and the evidence behind a proposed algorithm for its' management.

Keywords: pediatric; laryngospasm; algorithm

Introduction

Currently there is a lack of a nationally agreed algorithm for the management of pediatric laryngospasm.

The national collaborative pediatric simulation project, Managing Emergencies in Paediatric Anaesthesia (MEPA), has led to the need for an evidence based algorithm. MEPA is designed to provide simulator based exposure to pediatric emergencies and is supported by The Royal College of Anaesthetists and The Association of Paediatric Anaesthetists (1).

The MEPA committee is a national group, made up of pediatric anesthetists with experience in simulation. Their aim has been national consensus on the theory behind the treatment of emergencies in pediatric anesthesia. This has been achieved by a review of the available literature and discussion to form an algorithm that is evidence based and educationally fit for use in crisis management.

The authors present a review of the literature and the algorithm agreed by MEPA committee in 2006 for the management of pediatric laryngospasm. This will hopefully allow a structured approach to this common problem to be taught and developed in simulation centers and subsequently in operating theatres.

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Definition

Laryngospasm can be defined as glottic closure due to reflex constriction of the laryngeal muscles; it can be complete or partial. Sumner and Hatch (2) define True Laryngospasm as 'complete closure of the larynx caused by external stimulation'. Here the ventricular cords (false vocal cords) are tightly occluded, the paraglottis (intralaryngeal part of the epiglottis) moves posteriorly and the arytenoids cartilages both perform a ventral movement thus effectively sealing the larynx.

They describe glottic spasm as different from true complete laryngospasm. In partial spasm both vocal cords are firmly pressed against each other, leaving a small lumen open at the posterior commissure which allows minimal ventilation by an anesthetist.

As it is difficult to distinguish between true laryngospasm and glottic spasm most clinicians describe both as laryngospasm. Therefore clinically it seems more useful to define laryngospasm as complete or partial (3).

Complete laryngospasm – chest movement but silent with no bag movement and no ventilation possible.

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Partial laryngospasm – chest movement but stridulous noise with a mismatch between the patients' respiratory effort and the small amount of bag movement.

Incidence

Laryngospasm occurs more commonly in pediatric anesthetic practice than in adults. The incidence is twice that of adults in older children and three times that of adults in younger children (4). This correlates to 17 events in 1000 anesthetics in children up to 9 years. This increases to 64/1000 in children with obstructive lung disease and 96/1000 in those with acute upper respiratory tract infections. This latter incidence can last for up to 6 weeks following acute infection (5).

Other studies support this but also show that young age and supervision by less experienced and non-pediatric anesthetists, increases the incidence of laryngospasm (6). Those children passively exposed to cigarette smoke also show increased incidence (7,8).

Cause

Laryngospasm occurs during anesthesia for two reasons: firstly, a lack of inhibition of glottic reflexes because of inadequate central nervous system depression and, secondly increased stimuli (2).

Causes of stimulation at an inappropriate depth of anesthesia include extubation, secretions or blood irritating the vocal cords, stimulation of the airway by an artificial airway, laryngoscope or suction catheter.

Recognition

Laryngospasm is identified by varying degrees of airway obstruction with paradoxical chest movement, intercostal recession and tracheal tug. A characteristic crowing noise may be heard in partial laryngospasm but will be absent in complete laryngospasm.

Management

There are a number of ways reported to reduce the incidence of laryngospasm (9). These include IV lignocaine and topical lignocaine to the vocal cords (10–14), magnesium sulphate (15), acupuncture (16) and the use of 5% carbon dioxide for 5 min prior to extubation (17). However, none of these methods has been shown to abolish laryngospasm completely.

To manage laryngospasm effectively it first needs to be recognized. Once recognized, most agree a similar protocol although there are a number of reports that are not common place. Of less frequently used techniques there are two worthy of note.

Pressure in the laryngospasm notch

The notch is found behind the lobule to the pinna of each ear bounded anteriorly by the ascending ramus of the mandible adjacent to the condyle, posteriorly by the mastoid process and cephaloid by the base of the skull (18,19). The technique involves firm pressure at this clearly defined point that causes pain over the styloid process. The afferent input is thought to cause relaxation of the cords by a poorly defined mechanism. This maneuver may also open the airway.

Pull of Mandible

This technique can be used when true spasm cannot be broken (2). It involves a vigorous forward pull of the mandible. This causes a painful stimulus and stretches the geniohyoid muscle to ventralise the paraglottis. Rapid bagging through a now partially open larynx will break most cases of laryngospasm.

Although both of these techniques may have their place, they seem hard to support as a sole technique. They may be able to be incorporated as an appendix to an algorithm for use in the management of laryngospasm.

Superior laryngeal nerve block has been reported as a method to treat laryngospasm but has not been adopted by many (20). Topical cocaine has been trialled after GA for endoscopy (21).

Of the more accepted protocols for the management of laryngospasm options include maintaining a clear airway while administering 100% oxygen with CPAP and avoiding further instrumentation of the airway until the cords relax (2,3). Attempts to provide intermittent positive-pressure ventilation with a face mask may distend the stomach, splinting the diaphragm and make subsequent resolution of hypoxia more difficult (2).

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The next step in management depends on whether there is complete or partial laryngospasm. If there is no bag movement then complete laryngospasm is present and some of the maneuvers above may be useful. In complete spasm CPAP may make the situation worse by forcing the area just above the false cords against each other closing the entrance to the, larynx (2,22,23). Therefore if complete spasm cannot be broken early IV agents should be considered.

The gold standard still seems to be Succinylcholine (1–2 $mg \cdot kg^{-1}$) with Atropine (0.02 $mg \cdot kg^{-1}$) if there is bradycardia. Some authors have recommended a smaller dose of Succinylcholine (0.1 $mg \cdot kg^{-1}$) be used (24). The other main intravenous agent that can break laryngospasm is Propofol (0.5–0.8 $mg \cdot kg^{-1}$) (25–27). Most studies have not used Propofol in the younger age groups (<3 years) and its role to break complete spasm when bradycardia is present has not been defined. If the stimulus is a painful one perioperatively then the use of a short acting opioid such as Alfentanil can be used (28). However, this may also lead to apnoea with less optimal intubating conditions than following Succinylcholine.

Other IV agents reported in the literature include doxapram (5 patients) (29) and nitroglycerine (2 patients) (30). The low patient numbers in these studies here exclude them from this protocol.

Management of laryngospasm that fails to improve with simple measures appears fairly simple to treat when IV access is available but becomes more of an issue when no cannula is available. For complete laryngospasm where there is no ability to increase the depth of anesthesia with a volatile agent some authors advocate immediate laryngoscopy and intubation without relaxants (3,31). If intubation fails then repeat laryngoscopy and intubation is advocated after topical lignocaine is applied to the cords. While these measures may provide an airway to re-oxygenate the child they can prolong the hypoxic episode and cause a variable amount of trauma. Roy and Lerman present two algorithms, one for complete spasm and one for partial (incomplete) spasm. However, of note is the absence of the use of intramuscular (IM) Succinylcholine when the intra-venous route is not available (32,33).

IM Succinylcholine (4 $mg \cdot kg^{-1}$) (32,34) in to a large muscle bulk such as the quadriceps has been shown to produce 90% twitch suppression in 295 s. If this is given via the submental route this reduces to 265 s which can be reduced to 133 s if the intralingual injection site is digitally massaged (35).

Although these times seem prolonged, the clinical effect to allow oxygenation is anecdotally reported to be much less than the time for 90% twitch suppression, which is more appropriate for intubation.

A recent editorial by Walker and Sutton concentrated on the use of Succinylcholine via intramuscular, intra-lingual, submental and intra-osseous routes. The intra-osseous route for administration of medication and fluids is widely accepted in the emergency setting. However, due to the lack of published evidence supporting its use in the treatment of laryngospasm, we have excluded this particular route in our algorithm (36) Figure 1.

We feel the development of one algorithm for the management of pediatric laryngospasm and understanding of the evidence that formed it is essential. Attention should be concentrated on airway assessment and the presence or absence of bag movement.

Conclusions

There is no level one evidence to support a definitive protocol for the management of laryngospasm. Most evidence is from small studies with small treatment groups and case reports. Protocols have to be adaptable to the causes of laryngospasm and be memorable to provide a clear thought process under stress.

Roy and Lerman (3,31) have previously provided two separate algorithms for partial and complete obstruction which may resolve laryngospasm. We feel that by combining them and incorporating additional points from the available literature, we have produced a single, logical and evidence based algorithm for the management of laryngospasm.

We hope this algorithm will become a useful tool for trainees and its use should be introduced through publication and simulator training on MEPA courses, with their emphasis on crisis management.

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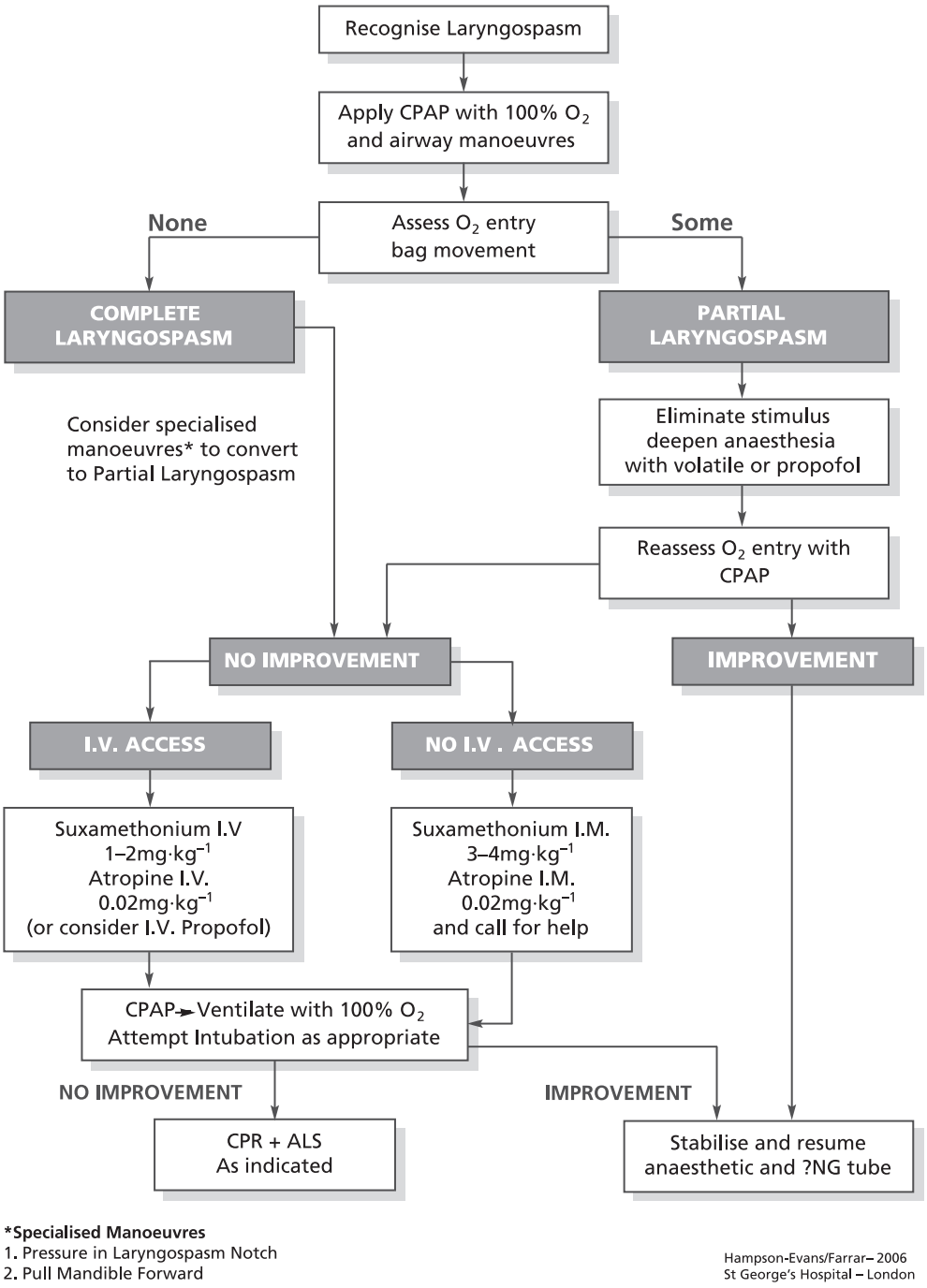

Figure 1
Laryngospasm treatment algorithm 2006.

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