International Journal of Pediatric Otorhinolaryngology 75 (2011) 1442–1445

Contents lists available at SciVerse ScienceDirect

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Anesthesia management in pediatric patients with laryngeal papillomatosis undergoing suspension laryngoscopic surgery and a review of the literature

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ARTICLE INFO

Article history:
Received 21 April 2011
Received in revised form 15 August 2011
Accepted 16 August 2011
Available online 9 September 2011

Keywords:
Laryngeal papillomatosis
Suspension laryngoscopy
Pediatric anesthesia

ABSTRACT

Objective: The excision of laryngeal papillomas poses a great challenge for both the anesthesiologist and the surgeon. The narrowness of the airways and the great variability of the pathological lesions necessitate close collaboration between the surgical and anesthesia teams to provide optimal operating conditions and ensure adequate ventilation and oxygenation. Our aim was to explore perioperative anesthesia management in pediatric patients during the excision of laryngeal papillomas with a suspension laryngoscope.
Methods: Fifty-eight pediatric patients suffering from laryngeal papillomas were included in this retrospective study. These patients had degrees of laryngeal obstruction from I to III and underwent suspension laryngoscopic surgery to excise laryngeal papillomas between January 2007 and December 2010. The American Society of Anesthesiologists (ASA) physical status of the patients ranged from I to III. Anesthesia was induced by intravenous administration. Once the child was unconscious, a 2% lidocaine aerosol solution was sprayed over the laryngeal area directly under the laryngoscope. For patients to tolerate suspension laryngoscopy, it is necessary to maintain spontaneous breathing and ensure adequate anesthesia depth. The airway was secured, and sufficient ventilation was established throughout a tracheal tube (ID 2.5 or 3.0) which was placed close to glottis and connected to Jackson Rees system. Hemodynamic parameters and pulse oxygen saturation (SpO_2) were closely monitored, and adverse events were recorded.
Results: Most of the patients 89% (52/58) were hemodynamically stable during the perioperative period. Laryngospasm and laryngeal edema occurred in several children during emergence from the anesthesia. Tracheal intubations were performed in six patients (10.3%). Tracheotomies were performed in two patients. One patient had to be sent to the ICU for comprehensive therapy.
Conclusion: The most important consideration for anesthesia during suspension laryngoscopy is (1) the maintenance of adequate ventilation, (2) to permit surgical exposure, and (3) to maintain suitable depth of anesthesia which relaxes the vocal band, avoids laryngeal spasms (reflex closure), reduces cardiovascular reaction and wakes up quickly after operation. Any factors that aggravate laryngeal obstruction and dyspnea should be avoided.

1. Introduction

Laryngeal papillomas are benign epithelial tumors that are caused by infection with the human papilloma virus (HPV). Although papillomas can occur at any age, they most commonly affect the larynx and the upper respiratory tract of children aged 1–4 years, resulting in hoarseness, stridor, obstruction of the airway and asphyxiation if left untreated. The leading cause of HPV infection in children is due to infection from the birth canal or the blood of the infected mother [1]. Mucosa injury, chronic inflammatory stimulation, endocrinopathy, deficiencies in the immune function, malnutrition, and unclean health habits can also lead to the disease. Although papillomas rarely become cancerous, their location and marked tendency for recurrence make the disease both dangerous and troublesome. Papillomas recur often and occasionally spread to the hypolaryngeal vestibules, the epiglottis, and occasionally the trachea and lungs [2], which may also lead to head-and-neck cancers [3]. Because of the exophytic growth of the papillomas in the narrow pediatric airway, severe laryngeal obstruction may repeatedly occur. Many children are treated as outpatients and require numerous procedures throughout their childhood to remove the tumors one to two times a month as they reappear [4].

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doi:10.1016/j.ijporl.2011.08.012

Table 1
Criteria for grading laryngeal obstruction preoperatively.

Grade	Clinical symptom	Chest auscultation	Heart rate (beats/min)
I	Dyspnea and inspiratory stridor appear only in exercise	Clear breath sound	Normal
II	Dyspnea and inspiratory stridor appear at rest and are aggravated by exercise; sleeping and eating are not influenced; no dysphoria	Throat conduction sound and bronchial breath sound	120–140
III	Obvious dyspnea and inspiration laryngeal stridor; signs of cyanosis in lips, fingers, and toes; signs of a concave supersternal notch and supraclavicular fossa; sleeping and eating are influenced; dysphoria	Breath sounds are clearly reduced	140–160
IV	Severe dyspnea, cyanosis, disorientation, coma, and exhaustion; reduction in blood pressure	Almost absent	Faint, low, blunt

To date, although human papilloma virus vaccinations [5], intralesional cidofovir [6], and propranolol [7] may serve as new adjunctive treatments in children with aggressive recurrent respiratory papillomatosis, there are no specific and effective treatments for recurrent pediatric laryngeal papillomatosis. Surgical removal of tumors at frequent intervals to relieve the symptoms of airway obstruction remains the primary choice of management [8]. Some children with severe airway obstruction may even need a tracheotomy. The most important consideration for anesthesia is to maintain a patent airway during surgery and assure adequate ventilation and surgical exposure. As such, the excision of laryngeal papillomas poses a great challenge for both the anesthesiologist and the surgeon. Because anesthesia and surgery share the same airway, establishing an effective airway for both anesthesia and surgery is very difficult. The special measures necessary for securing the airway include thorough preoperative airway evaluation, the appropriate choice of the anesthesia induction method, and careful intraoperative and postoperative airway management.

In this report, we review the techniques and strategies used for preoperative airway management in pediatric patients with laryngeal papillomas undergoing suspension laryngoscopic surgery at our institution between January 2007 and December 2010.

2. Patient information

The anesthesia and surgical records of fifty-eight patients were reviewed. Approval was obtained from the hospital's Human Research Committee. Informed consent was obtained from parents or legal guardians before the anesthetic and surgical procedures. The patient group consisted of 33 boys and 25 girls, with ages ranging from 2 months to 10 years (<1 year, 4 cases; 1–3 years, 18 cases; 3–6 years, 26 cases; >9 years, 10 cases, with an average age of 4.04 ± 2.05 years) and weights ranging from 6 to 22 kg (with an average of 14.2 ± 2.1 kg). Degrees of laryngeal obstruction [8] (Table 1) were found in 30 cases with Grade I, 17 cases with Grade II, 6 cases with Grade III tumors, and 5 cases with Grade IV tumors. Degrees of tonsil hypertrophy (Table 2) were found in 5 cases with Grade I, 7 cases with Grade II, and 3 cases with Grade III. The operation frequencies in patients were as follows: 1 patient had 4 operations, 3 patients had 3 operations, 20 patients had 2 operations, and 31 patients had 1 operation. The operation time ranged from 15 to 70 min (with an average of 40.5 ± 5.6 min). Most patients presented with different degrees of hoarseness or aphonia, significant laryngeal stridor, and dyspnea. No tracheotomies were performed before surgery.

Table 2
Criteria for tonsil hypertrophy.

Grade	Clinical symptom
I	Tonsils do not exceed the pharynx palatal bow
II	Tonsils exceed the pharynx palatal bow
III	Tonsils exceed the posterior midline wall

3. Anesthesia methods

The aim of this study was to determine how to maintain spontaneous respiration in combination with topical anesthesia of the upper airway to allow the surgeon complete access to the upper airway without interference from trachea intubation or interruption for oxygenation [9]. Anesthesia was induced by midazolam (0.1 mg kg^{-1}), sufentanyl (0.1–0.2 μg kg^{-1}), and propofol (1–2 mg kg^{-1}), intravenously administered after preoxygenation. Laryngeal obstruction should be attached great importance after anesthesia induction because of the laryngeal muscle relaxation, papillomas prolapse and increased secretion. Five minutes later, when the depth of anesthesia was appropriate (as determined by the presence of rapid shallow respirations and small central pupils) and the SpO_2 were kept stable and safe enough, a 2% lidocaine aerosol solution was sprayed over the laryngeal area under direct laryngoscopy. The spray frequency was synchronized with the patient's spontaneous breathing to ensure the effectiveness of the local anesthesia. At this stage, periods of laryngospasm [10] or apnoea were treated by an additional propofol injection and successful manual mask ventilation. Then, the suspension laryngoscope was slowly placed into position while maintaining a low flow (1–2 l min^{-1}) of oxygen through a tracheal tube (ID 2.5 or 3.0) which was placed close to glottis and connected to the Jackson Rees ventilation system. Oxygen provision and auxiliary breathing could be guaranteed by this method. The airway was secured safely. Anesthesia was maintained with a target-controlled infusion of propofol (6–8 mg kg^{-1} h^{-1}). If the operation time lasted for more than 45 min, a target-controlled, moderate infusion of remifentanil (1 μg remifentanil:1 mg propofol) was preferred.

The patient was still deeply anesthetized at the end of the surgical intervention. The suspension laryngoscope was removed while the patient was under anesthesia. In the recovery room, humidified oxygen was administered to the patient via a face mask. The patients were sent to the recovery ward until they fully regained consciousness, sufficient spontaneous breathing, active deglutition, and a cough.

4. Monitoring

Electrocardiograms, noninvasive blood pressure measurements, and pulse oximetry were continuously recorded with a Datex-Ohmeda surgical monitor. In addition, the ventilation was observed clinically by auscultation of the lungs, skin color, and observation of thorax excursions. Side effects, such as laryngospasm and pulmonary hypertension due to upper airway obstruction, were also recorded.

5. Statistical analysis

All data are expressed as the average value ± standard deviation. All data were analyzed with SPSS for Windows 13.0 using a one-way analysis of variance (ANOVA) and the Bonferroni correction for