Laryngeal Surgery in Children

6

Frederik G. Dikkers, Niels Rasmussen, and Patrick Froehlich

Core Messages

- Laryngeal surgery in children is different from laryngeal surgery in adults and optimally requires a specialized team or staff dedicated to the treatment of children. The anesthesiological approach is related to the age of the patient and is of decisive importance.
- Maturation of the vocal folds is a delicate process, and superficial and intermediate layers are well defined with a mature vocal ligament by age 16.
- *Congenital or acquired cysts* are mostly supraglottic retention cysts.
- Neonates who have been intubated for a long time can have difficulties with detubation due to *intubation granulomas.*
- Congenital laryngeal webs and laryngeal atresia cause stridor. However, *smaller webs* cause hoarseness and breathiness.
- *Subglottic hemangiomas* progressively obstruct the airway within the first few months of life.
- In rare cases, stridor is due to *congenital laryngeal paralysis*, which may be unilateral or bilateral. It can worsen during infancy but may be well tolerated even when bilateral.
- *Juvenile onset of recurrent laryngeal papillomas* is rare but may be suspected in conjunction with progressive dysphonia. Papillomatosis is exceptional before the age of 1 year.
- *Sulcus glottidis* in children seems to be a congenital lesion that deteriorates with increasing age.
- Vocal abuse is frequent in children. The important question is whether the voice problem is the child's problem.
- Gastroesophageal reflux (GER) may cause roughness. The precise pathogenetic role of laryngopharyngeal reflux has not yet been established.
- The preoperative assessment in patients presenting with stridor is important.
- Progressive stridor in infants, degree of suprasternal retraction, and failure to thrive are elements that lead to the decision for performing endoscopy under general anesthesia. Some give antacids at least for as long as stridor is not controlled and/or appropriate surgical treatment has not been performed.

6.1 Introduction

This chapter deals with the indications for surgery and surgical treatment of benign pathology of the larynx excluding congenital laryngeal lesions with stenosis and laryngomalacia, which is dealt with in chapter XXX. Laryngeal surgery in children is different from laryngeal surgery in adults. It optimally requires a specialized team of staff dedicated to the treatment of children.

F. G. Dikkers (✉)
Department of Otorhinolaryngology, University Medical Center Groningen, University of Groningen,
P.O. box 30001, 9700 RB Groningen, The Netherlands
e-mail: f.g.dikkers@kno.umcg.nl

M. Remacle, H. E. Eckel (eds.), *Surgery of Larynx and Trachea,*
DOI: 10.1007/978-3-540-79136-2_6, © Springer-Verlag Berlin Heidelberg 2010

Diagnostic procedures, expected pathology, and treatment depend on the age of the patient. The possibilities for communicating with the child and the use of more sophisticated examination procedures increase with age. In relation to the surgical procedures, the anesthesiological approach is related to the age of the patient and is of decisive importance; it is dealt with in further detail later. When delineating the indications for surgery, the small size of the larynx in small children must, of course, be taken into account. The total vocal fold length is 6–8 mm in the infant; it increases to 12–17 mm in the adult woman and to 17–23 mm in the adult man [8].

Maturation of the vocal folds is a delicate process. Superficial and intermediate layers are well defined with a mature vocal ligament by age 16 [5]. This has consequences for the pathology or the importance of the pathology depending on the age of the patient. Voice mutation is most active between ages 12 and 14 and is usually complete in both sexes by age 15 [9].

6.2 Indications

Children considered for elective laryngeal surgery are patients with hoarseness and/or increasing stridor. These symptoms may be caused by a number of lesions and must be distinguished from nonorganic conditions due to improper use of the voice.

Congenital or acquired cysts can cause hoarseness. Pediatric cysts, especially in the young infant, are mostly supraglottic retention cysts. In the older infant (from the age of approximately 6 years), epithelial cysts and retention cysts on the vocal folds do exist (Fig. 6.1). Subglottic cysts in premature children can cause distress after several months, especially when intubation was necessary during the neonatal period.

Neonates who have been intubated for a long time can have difficulties with detubation owing to *intubation granulomas* (Fig. 6.2). These granulomas must be addressed when the laryngeal pathology is what is hampering detubation.

Congenital laryngeal webs and laryngeal atresia cause stridor (see Chapter XXX), and *smaller webs* (Fig. 6.3) cause hoarseness and breathiness. They may easily be overlooked during flexible laryngoscopy. This makes it a not uncommon finding during elective direct laryngoscopy under general anesthesia.

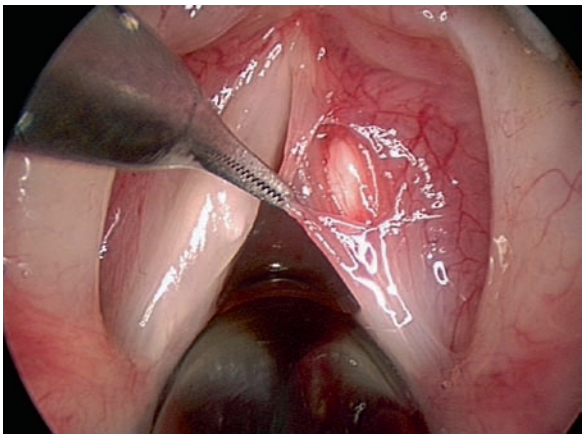

Fig. 6.1. Subepithelial cyst in a 12-year-old boy. Epithelium is held with a small alligator forceps angled to the right

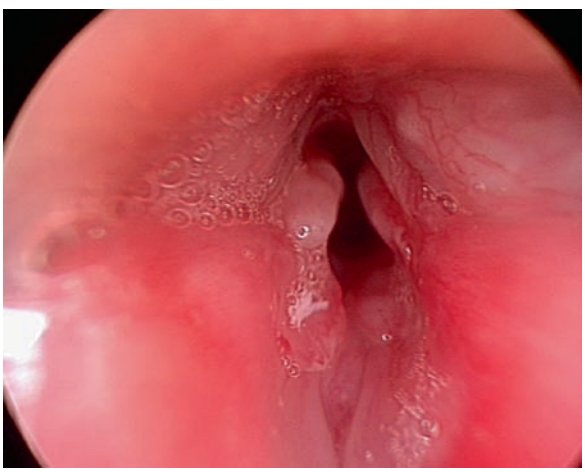

Fig. 6.2. Intubation granulomas in a 3-month-old boy immediately after detubation

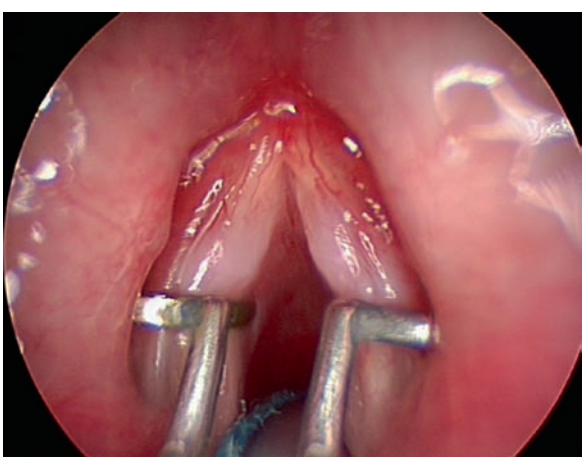

Fig. 6.3. Microweb in an anterior commissure in a 6-year-old boy. The vocal folds are spread using the anterior commissure retractor

Subglottic hemangiomas progressively obstruct the airway within the first few months of life. They may be suspected in children presumed to have laryngitis within the first 3 months of life when episodes are repeated or persist. They can be associated with cutaneous hemangiomas. Beard-shaped hemangiomas, however, are almost constantly associated with laryngeal hemangiomas. Extension downward to the trachea or upward to the glottis and supraglottic region can limit surgical control.

In rare cases stridor is due to *congenital laryngeal paralysis*, which may be unilateral or bilateral. It can worsen during infancy but may be well tolerated even when bilateral. Stridor is associated with dysphonia. The diagnosis is difficult by fiberlaryngoscopy in the outpatient clinic owing to difficulties associated with cooperation with the patient. It may be difficult under general anesthesia as well, as it has to be performed without relaxation to be able to examine laryngeal motility.

Juvenile onset of recurrent laryngeal papillomas (Fig. 6.4) is also rare but may be suspected in progressive dysphonia. Papillomatosis is exceptional before the age of 1 year. In such early cases it appears to be correlated with the presence of condylomas in the genital region of the mother at the time of delivery. In these cases, increasing stridor is frequently the cause for examination and treatment. In children older than 2 years, stridor increasingly becomes a secondary sign as the progressive dysphonia itself usually brings the child to the laryngologist.

Sulcus glottidis (Fig. 6.5) seems to be a congenital lesion that deteriorates with increasing age. The sulcus, which runs parallel to the edge of the vocal fold, may be short or run the entire length of the vocal fold. It can be localized just below the edge of the vocal fold but may also appear on the horizontal part or the inferior part. It may occur together with *cysts* and *epithelial bridges* and may be unilateral or bilateral. It may cause hoarseness, breathiness, difficulty when singing due to high-pitch problems, and vocal fatigue. Frequently, the sulcus is not detected during videolaryngostroboscopy, as the sulcus may appear only as a faint line on the epithelial surface or may not be visible (when it occurs on the inferior aspect of the vocal cord). The indications for surgery are heavily debated as is whether it should be done during childhood or the growth development of the larynx should be finished before surgery [3].

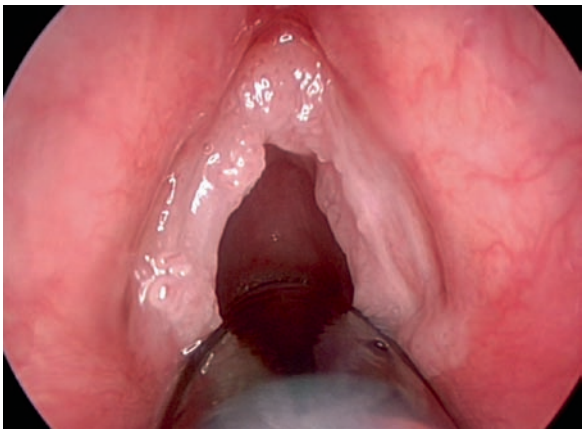

Fig. 6.4. Juvenile onset laryngeal papillomatosis in a 7 year old boy with many years of hoarseness that aggravated during the preceding 6 months, seen with the rigid telescope

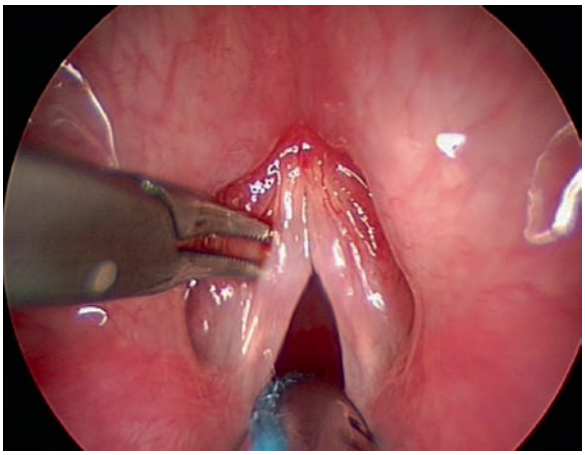

Fig. 6.5. Bilateral sulcus glottitis in a 6-year-old boy, with small alligator forceps to the right in the left sulcus

Vocal abuse is frequent in children. This may be due to a number of reasons, such as social background, family habits, participation in certain sports, and imitation of popular but noisy cartoon characters from television. If the child is unable to use the voice in a balanced quantity, the price may be hoarseness. In a number of cases, the condition leads to formation of *vocal fold nodules* (i.e., bilateral lesions on the border of the anterior and middle third of the vocal folds) (Fig. 6.6). Some children have a larynx that seems predisposed to the development of vocal fold nodules (Fig. 6.7). The coincidence of both an anterior commissure web and vocal fold nodules has been described in adults [2, 7].

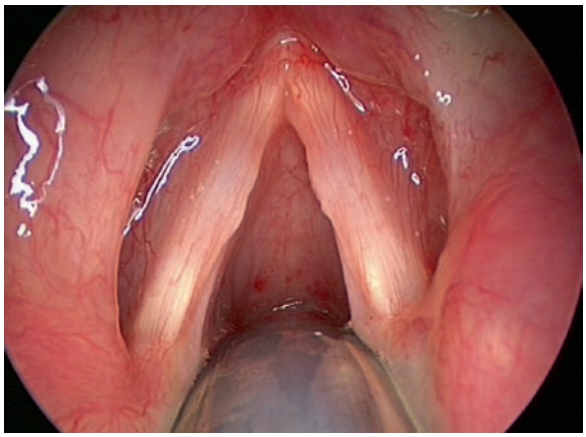

Fig. 6.6. Vocal fold nodules in an 11-year-old boy

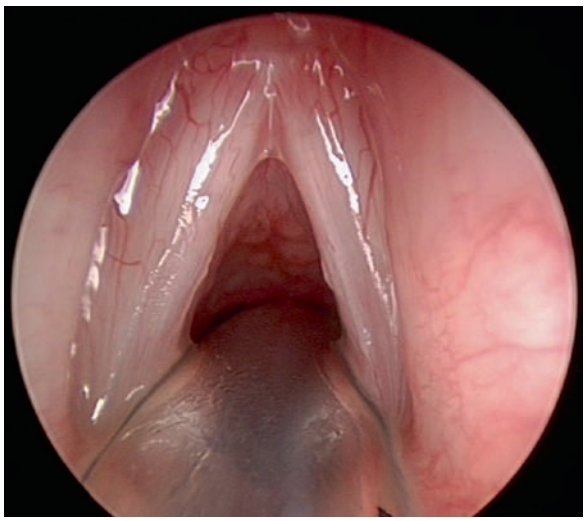

Fig. 6.7. Microweb in the anterior commissure and vocal fold nodules in a 5-year-old girl

Gastroesophageal reflux (GER) may cause roughness. A degree of physiological GER exists in infants. The prevalence of laryngopharyngeal reflux in hoarse children was calculated using the mode of presentation of the hoarseness, associated symptoms, endoscopic findings, laboratory testing, and therapeutic interventions and their outcomes [1]. The conclusion was that laryngopharyngeal reflux appeared to be a common cause of hoarseness in children. However, as with laryngeal disease in adults, the precise pathogenetic role of laryngopharyngeal reflux has not yet been established.

6.3 Preoperative Assessment

6.3.1 Patients Presenting with Stridor

Progressive stridor in infants, the degree of suprasternal retraction, and failure to thrive are elements that lead to the decision to perform endoscopy under general anesthesia. Depending on the local custom, a diagnostic approach may be made in the outpatient clinic by visualizing the larynx using a fiberlaryngoscope with a diameter of ≤ 2 mm.

Treatment of associated reflux varies among institutions. Some give antacids at least as long as stridor is not controlled and/or appropriate surgical treatment has not been performed. Ultrasonography, including assessment of the vascular flow, is useful for diagnosing tracheal compression due to vascular anomalies such as a double aortic arch or an innominate artery. Vascular anomalies such as a "vascular ring" can also be suggested by barium swallow radiography.

The use of endoscopy under general anesthesia depends on the efficiency of antacids and evolution of the stridor, on outpatient fiberlaryngoscopy, the age at which stridor developed, and its severity. Endoscopy can be useful to determine the diagnosis and for treatment.

6.3.2 Patients Presenting with Voice Problems

Preoperative assessment depends on the age of the child. The following age groups are relevant: sucklings and toddlers, infants 2–5 years old, infants 5–7 years old, children 8 years old to puberty (Table 6.1).

Sucklings and toddlers rarely need elective voice surgery, so the preoperative assessment has not been standardized. The second age group is the infant—old enough to give answers personally but too young to read and write. This age group is approximately 2–5 years old. The third age group consists of children learning to read and write but still young and easily frightened, approximately 5–7 or 8 years old. Preoperative assessment is limited in this group. The fourth and final age group consists of the older child, who can reason (approximately 8 years and older). The larynx should be considered as a pediatric larynx up to the time of voice mutation. Of course, the age groups may be adjusted.

Table 6.1. Preoperative assessment in children with voice problems, depending on the age group

Parameter	Sucklings and toddlers	Infants (2–5 years)	Young children (6–8 years)	Children (9–15 years)
History	+	+	+	+
Voice-related interests (e.g., choir, shouting during sporting activities)	–	–	+	+
GRBAS	–	–	+	+
Posture of patient, breathing pattern, resonance, articulation	–	+	+	+
Voice analysis on an extended vowel	–	±	+	+
Voice range profile	–	±	+	+
Phonation times	–	–	+	+
Investigation of functional tasks	–	–	+	+
Rigid laryngostroboscopy	–	–	+	+
Ability to read and write	–	–	+	+

GRBAS is a psychoacoustic evaluation, where G refers to grade, R to roughness, B to breathiness, A to asthenicity, S to strain

History taking should include a description of the voice problem, voice use, previous voice training, and differences between the speaking and singing voices. The important question is whether the voice problem is the child's problem (one cannot understand the child), the teacher's problem (difficulties at school), or the parent's problem (feeling ashamed of the child's voice). When and why did the problems start? Have intubations been performed—how many and when? What irritating factors are present (passive smoking, allergy)?

All external factors negatively influencing the voice can be captured under Voice Related Interests (Table 6.1). These interests can be clear and obvious (i.e., the child is a lead singer in the school's musical) or hidden (i.e., the child is the third child in a family with a handicapped sibling who receives major parental attention). Of course, sporting activities (Is the child captain of the soccer team?) should be included in the history taking.

GRBAS is depiction of the psychoacoustic evaluation [4]. G refers to grade, R to roughness, B to breathiness, A to asthenicity, S to strain. All qualities can be scored 0 (normal) to 3 (extremely abnormal). GRBAS is scored by the speech and language therapist (SLT). For this assessment, the international GRBAS score is used while the patient is reading a standard text loudly as well as during spontaneous speech. The posture of the patient, the breathing pattern, resonance, and articulation are described by the SLT.

An electronic voice analysis is done by examining the signal produced when singing an open //a// ("extended vowel") and calculating a number of measures such as perturbation factors: jitter and shimmer. Ideally, the assessment continues by creating a Voice Range Profile (Phonetogram) in which dynamic and melodic ranges are reproduced graphically. Measuring the Phonation Time (s) is performed on /aa/, /zz/, and /ss/. Finally, various functional Voice Tasks are investigated to determine if any change in voice quality can be heard. This is performed to predict the potential learning ability of the patient concerning speech therapy.

Rigid laryngostroboscopy can be performed in most children ≥ 10 years of age. Depending on the level of confidence of the child in the physician, laryngostroboscopy can be tried in children as young as 6 years, sometimes even younger. Using modern recording devices, a fair description of the larynx can be provided in an image of <1 second. Of course, an optimal laryngostroboscopic examination requires a much longer recording time. New devices associating stroboscopy and fiberscopy are now available.

The ability of the child to read and write is assessed indirectly. At some clinics, all elective interventions are postponed until the child is able to write so the child is able to communicate during the immediate postoperative period without using the voice.

6.4 Anesthesiology Considerations

The preferred anesthesiology technique depends on the local anesthesiology teams. All techniques have advantages and disadvantages for the surgeon. Typically, elective surgery on the larynx in the pediatric patient takes place under general anesthesia. Patients are exposed to

routine monitoring (body temperature, pulse oximetry, capnography, electrocardiography, respiratory rate). Venous access is applied.

Hemodynamic and respiratory data as well as ventilator settings are recorded. Induction and maintenance of anesthesia are accomplished through the airway and intravenously. During the induction of anesthesia the laryngologist is in the operating theater to secure the airway in case of emergency. Depending on local routines and the specific setting determined by the clinical problem, dynamic evaluation of the airway is performed at that phase. This can be accomplished with a fiberscope or under direct vision, allowing a diagnosis to be made, (i.e., supraglottic obstruction and laryngeal mobility). Laryngeal mobility may also be evaluated at the end of endoscopy as the child wakes up.

The airway is sprayed with lidocaine 4% (with a maximum of 4 mg/kg) by the laryngologist when a profound level of anesthesia has been attained. A first assessment of the intubation possibilities can thus be obtained. If a standard orotracheal intubation is performed, the tube is moved to the left corner of the mouth. Anesthesiology tubes and cables are kept on the left side of the patient, as the typical setting has the surgical team on the right and the anesthesiology team on the left (Fig. 6.8).

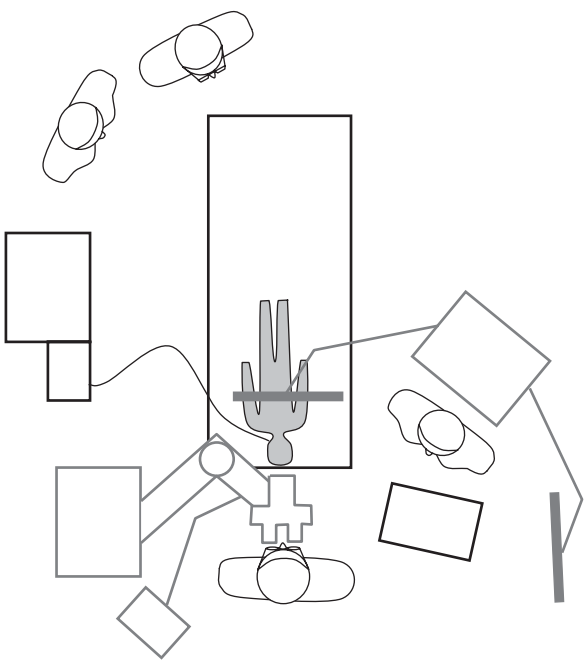

Fig. 6.8. Typical setting during elective laryngeal surgery in children

6.4.1 Spontaneous Ventilation Technique

Surgery on patients with an airway problem should be performed with a so-called dynamic airway. The patient is asleep but breathes spontaneously. Anesthesiology requirements are presented in Chapter XXX. Spontaneous ventilation allows a full endoscopic view of the airway for both stridor and voice problems. It has the advantage of allowing endoscopic surgery of the larynx on all areas and using several tools in the field. It requires an anesthesiology team that is specifically trained and remains familiar with the technique. Maintaining spontaneous ventilation can be difficult in neonates of low weight and in premature infants. Intermittent apnea can occur when obstruction makes ventilation difficult. A first step of ventilation through a bronchoscope or an endotracheal tube can help make spontaneous ventilation feasible.

6.4.2 Endoscopy with Endotracheal Intubation and Relaxation

The conventional orotracheal tube may be preferred when the patient suffers from heart-lung disease, making a closed ventilation circuit desirable; when access to the larynx is difficult; or when complications causing prolonged ventilation are anticipated. If necessary, the orotracheal tube can be elongated. For this purpose, the proximal end of a small tube can be inserted in the distal end of a tube two sizes larger (e.g., a 3.5 tube in a 4.5 tube). Detubation should be performed before cough reflexes return. A technique called “deep detubation” may be applied. Here, the patient remains paralyzed and ventilated, and the tube is removed by the surgeon under direct vision. In this way, manipulation of the vocal fold with the cuff of the endotracheal tube can be controlled by the surgeon. After removing the tube, mask ventilation is resumed until the patient awakes without phonating or coughing.

6.4.3 High-Frequency Jet Ventilation

The technique of high-frequency jet ventilation (HFJV) may be used in all cases other than those already discussed. It has the advantage of giving the surgeon more working space inside the larynx, especially in relation to

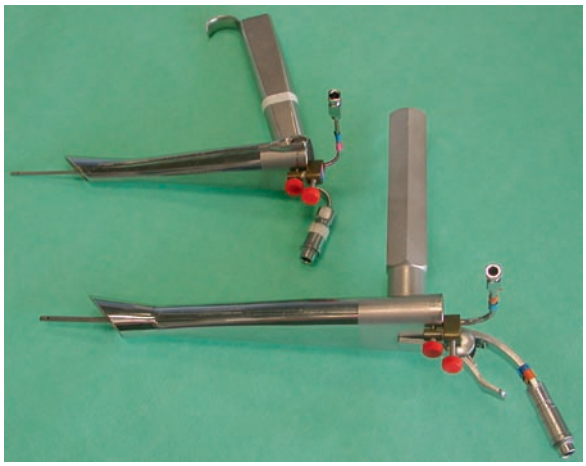

Fig. 6.9. Example of jet ventilation laryngoscopes with a steel tube that is passed through the glottis. The two laryngoscopes (one for children and one for adults) are sufficient to cover all age groups

the posterior commissure. It can be performed using a thin catheter introduced through the nose and passed through the larynx by the anesthetist; or it may be performed using a thin steel tube mounted inside the laryngoscope (Fig. 6.9) and inserted by the laryngologist. The steel tube may be passed through the glottis or be positioned with the end placed inside the laryngoscope. Using a steel tube has two advantages. First, it makes it easier to keep the tube away from the pathology to be operated on. Second, it is nonflammable when using laser. The HFJV technique does not prevent blood, mucus, or other debris from entering the trachea from the larynx, but the air stream blowing from the trachea through the larynx limits this problem in most cases. In patients with severe GER, HFJV may not be suitable owing to the risk of aspiration of gastric juices to the unprotected lower airways. However, as there is no cuff, HFJV eliminates the possibility of accidental puncture of the cuff during laser surgery and manipulation of the vocal cords with the deflated cuff during detubation.

6.4.4 Intermittent Apnea Technique

The intermittent apnea technique may be used in cases of foreign bodies or pathology that can be easily removed under direct vision. In cases of impossible detubation due to suspicion of intubation granulomas, inspection may reveal that these granulomas are the only probable cause for the detubation difficulties.

6.5 Instrumentation

Surgical instruments used for elective laryngeal surgery in children are similar, but smaller, than the instruments used in adults. However, frequently adult laryngoscopes can be used in young patients from the age of 4–5 years, which makes instrumentation easier. For stridor surgery, laryngoscopes that are open on one side make it easier to introduce the instruments into the field. Several models are available with a ventilation canal. It allows administering the anesthetic gas at the tip of the laryngoscope, close to the larynx. Various sizes are available, from those that are appropriate for neonates to others that can be used in teenagers. One should be equipped with a wide range of laryngoscopes, appropriate for each age group. Many fine laryngoscopes have been developed, and many surgeons prefer their own laryngoscopes, so no names of instruments are mentioned here. A sufficient number of telescopes should be readily available for documentation.

The laryngoscope is suspended using a chest support, which should be mounted on a table just above the chest of the patient (Fig. 6.10) so it does not hamper chest excursions during ventilation.

Fig. 6.10. Chest support is mounted on a table just above the patient's chest

Surgery takes place with a surgical microscope or with a telescope and a video monitor. The magnification can be calculated as

$$M_t = (F_{tub}/F_{obj}) \times M_{factor} \times M_{eyepiece}$$

where M_t = the magnification total; F_{tub} = the focal length of the tube; F_{obj} = the focal length of the objective; M_{factor} = the factor of magnification of the zoom; $M_{eyepiece}$ = the magnification factor of the eyepiece.

Standard values are F_{tub} = 170 mm, F_{obj} = 400 mm, M_{factor} = 2.4, and $M_{eyepiece}$ = 12.5. Using this calculation, a total magnification of 12.75 can be obtained. However, progress in the development of telescopes and the quality of cameras—digital cameras and high-definition cameras—are progressively changing habits in laryngeal surgery for stridor. They might replace or complement the microscope and give a higher quality image on the video screen in combination with greater mobility around the surgical field.

6.5.1 Cold Instrumentation

For the surgery proper, it is necessary to have a basic set of surgical tools.

- Adequate suction (tubes 1, 2, and 3 mm diameter, with side holes distally to prevent aspiration of tissue)
- Small alligator forceps, angled to the left and to the right
- Open heart-shaped forceps, angled to the left and to the right
- Scissors, straight and angled to the left and to the right
- Elevators, 1 mm wide, angled 15 (“degrees”) to the left and to the right
- Elevators, 1 mm wide, angled 90 (“degrees”) to the left and to the right
- Disposable endolaryngeal knives
- Anterior commissure retractor

6.5.2 Lasers

Several lasers are available, CO_2 lasers being the most frequently used in pediatric laryngeal surgery. Soft fibers are now available for CO_2 lasers. Its limitations are due to diffusion and the size of the spot. YAG and KTP lasers have fewer applications in children and have induced subglottic and supraglottic stenosis. New lasers, such as the thulium laser, with soft fibers are under evaluation.

6.5.3 Microdebriders

Microdebriders with specific laryngeal blades are available and have been proposed for excision of tumors (papillomas, hemangiomas, cysts). They allow excision and suction with the same instrument and have been shown to be highly effective. The technique requires careful use so it does not damage normal structures (i.e., the basic structures of the vocal folds). Therefore, high-definition visualization of the operative field is necessary.

6.5.4 Drugs and Additional Endoscopic techniques

Drugs have been proposed to be applied endoscopically in association with other steps of surgery or as sole use during endoscopy. Topical mitomycin has been used at the end of surgical procedure to limit the risk of scarring and subsequent stenosis. Cidofovir is a nucleoside analogue that is injected within the papillomas during endoscopy combined with excision of papillomas. Narrow-band imaging can be applied. This relies on the principle of depth of penetration of light, with the narrow-band blue light having a short wavelength (415 nm) penetrating into the mucosa and highlighting the superficial vasculature [6].

6.6 Surgical Intervention

Various surgical approaches are available for stridor. When several methods are available for treating stridor with comparable results, a preference is made to avoid tracheostomy and postoperative intubation if possible. Endoscopic methods have been developed in recent years to reach this goal. New tools have been found useful and are part of the explanation for a revival of endoscopic laryngeal surgery.

6.6.1 General Aspects

The patient is lying in a supine position. Essentially, the intervention is carried out as in adults. The patient is under general anesthesia. The head is put in a raised and extended position, also called the sniffing position. The patient's head is in line with the end of the operation table. The back of the head is placed in a surgical cushion, and the neck is supported with a roll. The teeth are protected with a teeth protector, and the laryngoscope is introduced. The laryngoscope is then fixed with a chest support on a table (Fig. 6.10). The camera or the microscope is focused on the larynx, with maximum magnification as indicated earlier. Mucus is sucked away, and appropriate pictures can be taken.

The intervention continues with palpation of the vocal folds, using blunt instruments as well as the anterior commissure retractor (Fig. 6.3). Instruments should be kept in the contralateral hand: scissors curved to the right should be kept in the left hand, and vice versa. Suction should be performed with tubes of 1 or 2 mm diameter. The side holes distally prevent aspiration of tissue.

6.6.2 Subglottic Hemangioma

Several options have been developed to control a *subglottic hemangioma* avoiding a tracheotomy. Endoscopic reduction of hemangiomas was first proposed using CO_2 laser. It proved useful for small lateral hemangiomas but could induce subglottic stenosis in larger ones. Open surgical excision was then developed until other lasers (i.e., KTP and thulium lasers) became available. Microdebriders have also been used to excise hemangiomas under spontaneous ventilation without postoperative intubation or short-term intubation. Whatever technique is proposed, it should limit the risk of adding stenosis. Mitomycin can be applied at the end of the procedure to try to limit this risk.

6.6.3 Bilateral Paralysis

Bilateral paralysis can be critical for the airway. Open laryngoplasty with posterior cricoid graft has given excellent results, which have also been obtained through an endoscopic approach consisting of unilateral or bilateral posterior cordectomy. The debate remains on when to choose a surgical option as spontaneous recovery can be observed during the first years of life. Some teams prefer to wait for this with a tracheotomy in place. Comparison of the morbidity associated with a tracheotomy and that of the various procedures is part of the debate.

6.6.4 Recurrent Papillomatosis

Recurrent papillomatosis of the larynx is managed in different ways from one center to another. Excision can be performed with cold instruments, CO_2 laser, or microdebriders. As the recurrence rate is usually high, one should preserve the vocal cords as much as possible. Cidofovir has been used with interesting short and midterm results without damaging the normal tissues and, in the best cases, allowing the larynx to return to normal. No curative treatment is available so far.

6.6.5 Small Anterior Webs

Small anterior webs can be divided endoscopically. Recurrence of the web may be limited by application of mitomycin at the end of the procedure.

6.6.6 Vocal Fold Nodules and Polyps

Epithelial pathology is cut off using a heart-shaped forceps to the ipsilateral side and a knife or scissors to the opposite side, taking care not to damage the anterior commissure. The intervention can then be terminated.

6.6.7 Cysts, Epithelial Bridges, and Sulcus Glottidis

Subepithelial pathology is removed by performing chordotomy with a disposable knife. Injection of saline

or saline with a vasoconstringent such as epinephrine in Reinke's space may be useful. A cyst can be bluntly dissected and displayed nicely (Fig. 6.1). The safest way to treat a sulcus appears to be by simple removal of the deep, adherent part of the sulcus. After chordotomy, the epithelial flap may be glued back using fibrin glue or left to heal spontaneously depending on the extent of loose epithelium.

6.6.8 Intubation Granulomas

Intubation granulomas (Fig. 6.2) may be left to disappear spontaneously, but if their size hampers a free airway—especially during an attempt to extubate—these granulomas should be removed with the intermittent apnea technique. Using the intermittent apnea technique, it is possible to administer mitomycin C. Small pads soaked in mitomycin C (5 mg/ml) are held on the wound for 2 minutes. The patient is then ventilated again, and after reoxygenation the wound is cleaned with pads soaked in 0.9% saline. After this apneic period the patient is awakened.

6.7 Postoperative Care

After surgery for obstructive airway, antacids are generally used to cover at least the healing period. If postoperative intubation was avoided but there is residual stridor, epinephrine and steroids can be given.

After a phonosurgical intervention the patient is generally put on voice rest. The definition of voice rest is under discussion, as is the application. For the first author of this chapter, voice rest means total silence: no speaking, whispering, laughing, or crying. The patient and parents are counseled on total postoperative silence twice: when the indication for intervention is made and the day before the intervention. The child is aware of this, and takes paper or a laptop with him during admission in the hospital. Postoperatively, the child is informed about the surgical findings and is shown pictures made during the intervention; the importance of voice rest is stressed again.

The duration of voice rest depends on the surgical technique applied. In the case of an epithelial intervention there is a small wound, which heals fast. Voice rest is applied for the day of the intervention and the first 2 days afterward. In the case of a subepithelial intervention there is a larger wound, which heals more slowly. In these cases, voice rest is applied for the day of the intervention and the following 5 days.

Two weeks after the intervention the patient is interviewed and seen at the Voice Clinic, where videolaryngostroboscopy takes place. The patient is encouraged to use the voice normally again but is discouraged from using the voice for singing or during sporting activities for an additional 2 or 3 weeks. Typically, no voice therapy is prescribed.

In contrast, the second author believes that there is no age limit for performing elective surgery, and the child and parents are only instructed to speak as little as possible, preferably pointing or gesturing to ask for something, during the same periods mentioned above according to the degree of the pathology. This is because it is presumed that children are basically unable to refrain completely from speaking unless they are strictly brought up. Thus, the patient might feel guilty if the operation is not successful and believe that it was due to him or her speaking. (There is no literature proving the effect of complete voice rest postoperatively.) As with adults, they are also instructed not to shout or whisper during the above-mentioned immediate postoperative period. Singing and/or returning to school should be postponed until complete healing has taken place, which varies from 10 days for small lesions up to 3 weeks for large lesions. Voice therapy may be applied when the healing is complete in cases where vocal abuse is presumed to be of pathogenic importance, such as with the formation of vocal nodules or in patients with continuing hoarseness despite a normal appearance of the vocal cords.

The patient is asked to return 3–4 months postoperatively for the final visit. At that time extensive postoperative voice rating is conducted by the speech and language therapist, comparable to the tests performed preoperatively (Table 6.1).

6.8 Tips and Pearls

- Surgical instruments used for elective laryngeal surgery in children are similar, but smaller, than the instruments used in adults. One should be equipped with a wide range of laryngoscopes, fitted for each age group.

- For the surgery, it is necessary to have a basic set of surgical tools, which have been described in detail in chapter 6.5.1.
- Several lasers are available, with CO_2 lasers being the most frequently used in pediatric laryngeal surgery.
- Microdebriders have shown to be highly effective. The technique requires careful use so normal structures are not damaged.
- After surgery for an obstructed airway, antacids are generally used to cover at least the healing period. If postoperative intubation was avoided but there is residual stridor, epinephrine and steroids can be given.
- After phonosurgical intervention the patient is generally put on voice rest.

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