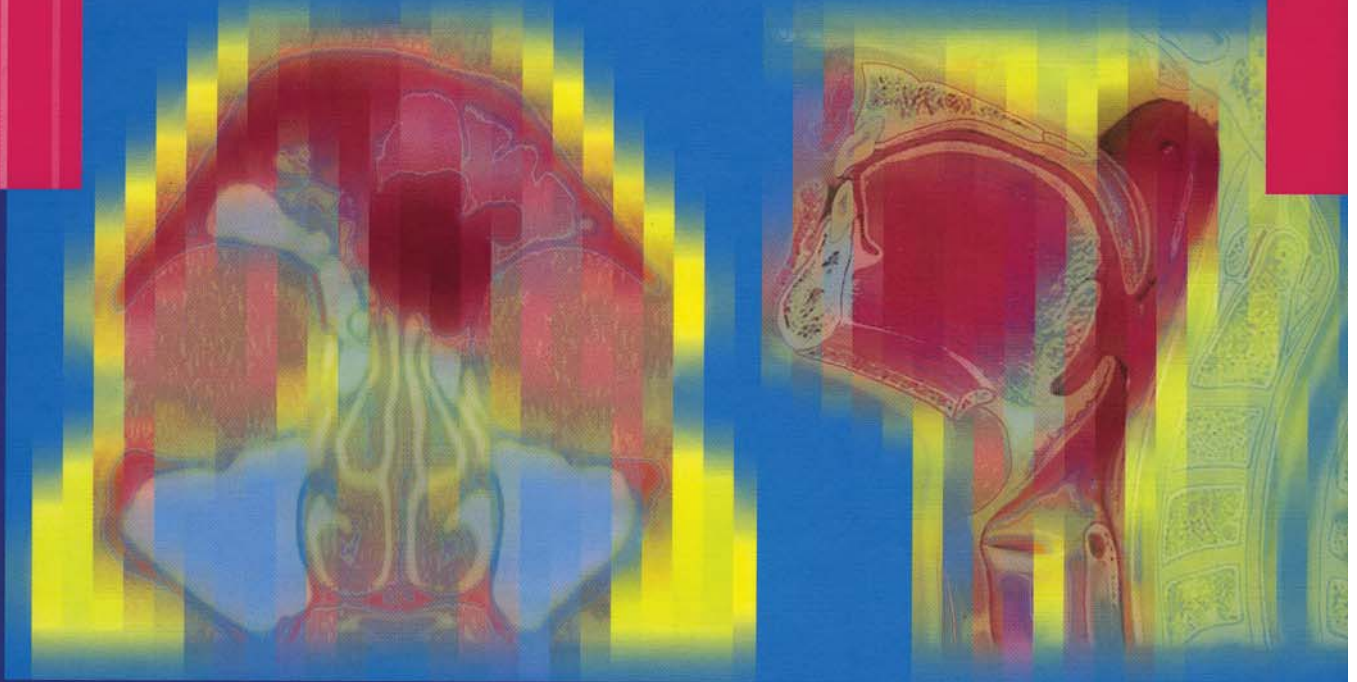Stilianos E. Kountakis
Metin Önerci
Editors

Rhinologic and Sleep Apnea Surgical Techniques

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Surgical Treatment of Children with Obstructive Sleep Apnea

43

Elisabeth Hultcrantz

Core Messages

- For children every apnea of obstructive origin is pathological.

- Snoring and apneas for an infant always require special investigations including polysomnography.

- Habitual snoring occurs in 6–10% of preschool children and obstructive sleep apnea in 1–2.5%.

- The purpose of surgery is to increase the diameter of upper airways and if necessary stabilize hypotonic muscles, thereby allowing for nasal breathing, which is the prerequisite for future normal growth and development.

- The most prominent symptom of obstructive sleep apnea is snoring in combination with oral breathing.

- The open mouth posture may cause underdevelopment of the maxilla with bite abnormalities.

- Increased daytime sleepiness is often noticed as hyperactivity and/or restlessness.

- Primary and secondary enuresis is common among children with sleep-disordered breathing. For very small children, "failure to thrive" is seen.

- Consider pulmonary hypertension in patients with organic heart disease.

- Adenoidectomy solely or in combination with partial reduction of the tonsil is in most cases the first surgical choice.

- Full tonsillectomy is only indicated if a history of multiple infections exists together with obstructive apneas.

- Avoid electrocoagulation in the tonsillar fossae, which causes unnecessary pain and an increased risk for delayed bleeding.

- Conservative uvulopalatopharyngoplasty with closing of the fossa supratonsillaris and partial resection of an elongated uvula are effective in children with a narrow nasopharynx, or in patients with muscular hypotonia.

- Primary or secondary orofacial skeletal deviations are treated in collaboration with orthodontics and/or maxillofacial surgeons if oral breathing and/or apneas continue after adenotonsillectomy. Distraction treatment of the mandible and/or expansion of the maxilla are effective in these patients.

- Long-term tracheostomy is rarely indicated, but may be preferred to extensive surgery in early childhood.

Contents

What Is Obstructive Sleep Apnea in Children?

Definition

All obstructive apneas in children are pathological. The definition of obstructive sleep apnea (OSA) in adults is not valid for children. Instead of speaking about children with sleep apnea, we should instead use the term sleep-related breathing disorder.

Etiology

Children snore when their upper airways are too narrow with lower than usual negative pressures secondary to a Bernoulli effect. When these patients have sleep-related muscular hypotonia, the breathing will cause audible vibrations. As in adults, the most common anatomy that contributes to the snoring sound is the soft palate and uvula. The level of obstruction in patients with apneas is usually at the level of the base of the tongue.

Children who snore at birth or before the age of 1 year usually have some congenital anatomical obstruction as a part of a congenital syndrome such as Pierre Robin syndrome, or are abnormally muscular hypotonic as in Down syndrome. When the snoring sound and apneas are produced in the laryngeal entrance, laryngomalasia is included in the differential diagnosis. Snoring and apneas in an infant always requires special investigation including polysomnography.

Epidemiology

Waldeyer's ring is poorly developed at birth, but then starts to grow, as a consequence of a normal immunological development. At the age of 2 years, the adenoid is usually well developed and can create breathing problems for children with a narrow face. At the age of 4 years, many children also have a relative hyperplasia of the pharyngeal tonsils. These organs are necessary as a first line of defense both for the breathing and eating functions and for the development of B and T cells. In spite of the relative narrowing of the airway, not all children snore; they maintain airway patency during sleep because of increased upper-airway neuromotor tone and an increased central ventilatory drive compared with adults [19].

Differences in muscular tone during sleep and in genetically influenced dimensions of the airway can make a difference such that one child develops OSA and another does not. All obstruction which increases the breathing effort in children should be evaluated for treatment. Between 6 and 10% of preschool children are habitual snorers and 1–2.5% develop OSA [5, 10].

Symptoms

Snoring in infants does not necessarily cause loud noise: small children do not have the volume of muscles and size of the lungs which are necessary for strong sounds. The most prominent symptom is, however, snoring in combination with oral breathing. The open mouth posture may in the long run cause abnormal development of the maxilla and mandible owing to the muscular influence and bite aberrations, since the tongue in the closed mouth normally acts like a mold for facial development [20].

When snoring becomes an effort, the child usually also develops increased daytime sleepiness, which is very often noticed as an increased difficulty in concentration and hyperactivity. Primary and secondary enuresis is common, and for very small children, a noticeable failure to thrive (which means low increase of length and weight irrespective of eating habits) because of influenced output of growth hormone during the disturbed sleep. The children are usually also slow eaters and have a poor appetite. Most often these symptoms momentarily vanish after treatment [1, 2]. As the condition continues to slowly develop, the parents do not always notice the problems as do visitors/ grandparents or day care personnel. In severe long-lasting OSA, funnel chest or other deformities of the thorax may develop (Fig. 43.1c, Video 43.1).

How to Examine a Child with Suspected OSA

- Listen to the parents' spontaneous story about the child's sleep and their concerns.
- If possible, ask the parents to bring a video tape of their sleeping child.
- At the physical examination notice the child's general behavior: sleepy, alert or restless?
- Look at general physical development. Breathing with open mouth? Audible breathing? Running nose? Any deformities of the rib cage, such as "funnel" chest? Overweight? Failure to thrive?

- Examine the oral cavity with respect to bite and teeth. Open mouth posture, open bite, overbite and cross bite? Narrow/high or normal hard palate? Small mandible? These signs often confirm the case history of a long period

Fig. 43.1. A 12-year-old boy with sleep apnea. **a** Severe obstructive sleep apnea due to mandibular hypoplasia. Primary enuresis, hypersomnia. **b** Pronounced funnel chest which had developed postnatally. **c** Throat preoperatively. Notice the web-like edge of the soft palate. **d** Throat after uvulopalatopharyngoplasty (*UPPP*). Good passage to the nasopharynx. No snoring, no enuresis, alert and considerable weight gain

of breathing obstruction, although a genetic-component most often also exists. Look at the accompanying parents and ask about their snoring history in childhood and later.

- What is the size of the tonsils in relation to the diameter of the throat during rest with a limp tongue and at provocation when the impact of the lower pole of the tonsils is evaluated?
- If possible, examine the nasopharynx with a mirror or optics but never palpate the nasopharynx either with a mirror or with a finger in a nonanesthetized child. If examination with a mirror is not possible, a lateral X-ray may be necessary in children from 7 years and older. Younger children can always be expected to have an adenoid pad, which at least adds to the obstruction of large tonsils

When the history and clinical examination both suggest sleep-disordered breathing in an otherwise healthy, normally developing child, it is not always necessary to perform polysomnography before making a decision about whether or not to perform surgery.

However, if the history suggests severe disease or you do not find large tonsils or an occluding adenoid pad, partial polysomnography is necessary to verify the condition. In some cases, the sleep study is "therapeutic" as you can calm the parents that the child's breathing is normal despite some snoring. In all cases where preoperative polysomnography has demonstrated apneas/hypopneas and/or oxygen desaturation, a control postoperative polysomnography should be performed.

All parents should also be informed that during further growth and development of the child, snoring and apnea may reoccur and in that case the

child should be followed up for further investigation and treatment.

A partial polysomnography should include:

- Oximetry.
- Registration of apnea/hypopnea either through an electrostatic mattress or pressure transducers in the nostrils. Thermistors for apnea registration are not as reliable.
- Most children can accept electrodes measuring the electric impedance and the sleeping position. These are valuable tools for evaluation of the breathing effort.
- A full polysomnography is rarely necessary and in most places difficult to achieve for the pediatric population.

For infants the registration should be as unintrusive as possible, which often means only the electrostatic mattress and an oximetry probe in combination with video. Very often the recording can be done at home after meticulous instruction of the parents. For children under 2 years and for children with severe symptoms, the registration should, however, be done in a sleep laboratory for accurate study.

The Goal of Surgery in Children with OSA and the Methods Used

The goal of surgery in children with OSA is to increase the diameter of the upper airway in order to decrease the tissue collapse by the Bernoulli effect and thereby resolve snoring and other obstructive symptoms. The surgery should always allow for normal future growth and development.

Tips and Pearls

- In most children improvement is achieved by only performing an adenoidectomy or an adenoidectomy plus some kind of reduction of the volume of tonsillar tissue.
- When abnormal hypotonia exists during sleep (as, e.g., with Down syndrome) conservative uvulopalatopharyngoplasty (UPPP) may be considered: increase of the airway through tonsil reduction and partial uvulectomy plus stabilizing of the hypotonic muscles by suturing the tonsillar pillars together at the level of fossa supratonsillaris.
- When skeletal abnormalities narrow the airway, the adenotonsillotomy procedure should

be tried first and later orthodontic/maxillofacial surgery can be involved, if necessary. Distraction treatment of the mandible and expansion of the maxillary suture are often very effective treatments in children (Fig. 43.2) [3, 21].
- When laryngomalasia causes the breathing obstruction, as diagnosed by direct laryngoscopy, redundant tissue can be removed by laser treatment.
- Long-term tracheostomy may be indicated in infants until they grow wider airways and/or reduced hypotonia.
- As a rule, try continuous positive airway pressure (CPAP) before resorting to surgery.

1. Snoring and sleep apnea in children may primarily be caused by: Stuffed nose (infections, allergy, foreign body)
2. Adenoid hypertrophy
3. Tonsillar hypertrophy
4. Normal-sized adenoid in children with a genetically "narrow" airway
5. Normal-sized adenoid plus normal tonsils in children with a genetically "narrow" airway
6. Muscular hypotonia
7. Maxillofacial abnormalities narrowing the upper airway

   (a) Mandibular hypoplasia (Pierre Robin syndrome)
   (b) Underdevelopment of the maxilla (Down syndrome)
   (c) Partial atresia of the choanae
   (d) Septal deviation or other nose deformities
8. Laryngomalasia
9. Different combinations of all the above conditions

Snoring and sleep apnea may cause:

- Failure to thrive
- Pulmonary hypertension with cor pulmonale
- Funnel chest
- Abnormal bite (open bite, cross bite)
- Primary or secondary enuresis
- Daytime tiredness with/without hyperactivity
- Difficulties in concentrating

Treatment involves:

- Treatment of infections and allergies
- Adenoidectomy
- Partial tonsillectomy ("tonsillotomy")
- Tonsillectomy

43
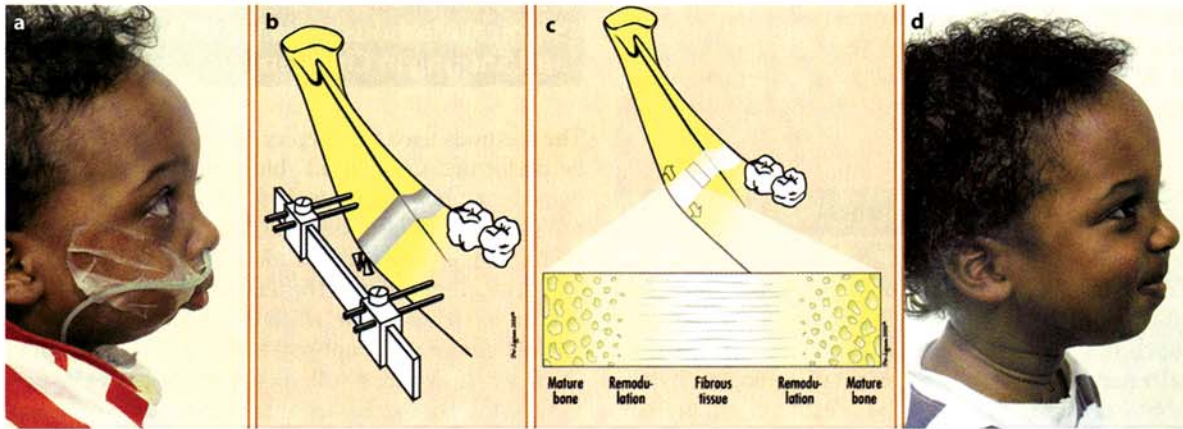
Fig. 43.2. A 2-year-old boy with severe sleep apnea **a** Mandibular hypoplasia, due to purulent infection in mandibular joints. **b** Distraction treatment with 1 mm widening each day. **c** New bone is formed in the "artificial" fracture. **d** The boy 4 months later – decannulated and symptom-free

- Specific treatment with orthodontic correction/distraction and expansion treatment or maxillofacial surgery
- CPAP
- Control of weight (let the child "grow into its weight")
- Different combinations of all the above
- Tracheostomy in special cases where none of the above treatments work, or are applicable.

Special Features of OSA According to the Age of the Child

Children Under 2 Years

Children with breathing difficulties early in life are special cases and have to be treated with that in mind. A birth trauma resulting in luxation of the nasal septum can create breathing problems and the septum should be lifted into position as soon as possible.

Pierre Robin syndrome and Down syndrome and other genetic syndromes often exhibit breathing problems early in life. In those cases, CPAP may be a good solution until the child has grown enough. A temporary tracheostomy may be life-saving, especially if organic heart disease coexists.

Laryngomalasia produces, as does tracheomalasia, an increased breathing effort and may cause apneas. With mild symptoms, no treatment is indicated as the softness will grow away and the symptoms disappear after the age of 2 years. However, suction of the inner parts of the larynx may result in redundant tissue in the laryngeal entrance which successively increases the child's problem with apneas and desatura-

tion. CPAP does not help in these cases, and can instead worsen the obstruction. Removal of the redundant tissue using a laser and leaving the surface open to heal seems to stiffen up the laryngeal entrance and cure the child's breathing and concomitant eating problems.

Children Between 2 and 4 Years

A child who starts to develop obstructive problems between 2 and 4 years of age usually has a hypertrophied adenoid as the main cause of obstruction and an adenoidectomy helps in most cases. Even if the tonsils are large (which they rarely are at that age), a full tonsillectomy is not recommended in the same surgical setting. The child needs the immunologically active tissue and the breathing problems will be at least partially resolved with the adenoidectomy. A small child with its smaller blood volume is also at greater risk from postoperative bleedings if both surgical procedures are performed together.

If the tonsils are voluminous, a partial resection can be performed. Another reason to avoid a full tonsillectomy is that when it is performed in early age, Waldeyers' ring will compensate by hypertrophy of the lingual tonsils. That may result in a later recurrence of the OSA, which is more difficult to treat [15]. The only reason for a full tonsillectomy would be recurrent tonsillar infections or peritonsillitis, which, however, are unusual in this age group.

Distraction treatment is possible at this age as shown in Fig. 43.2 [21]. This 2-year-old boy had suffered from sepsis postnatally with purulent infections in both mandibular joints, causing retarded growth of the mandible and a progressive OSA. After distract-

ion treatment, he was decannulated, but still needed CPAP for an additional 2 years. Today, at the age of 10 years, he has no apneas or snoring and a normal bite.

Children from 4 to 10 Years

Children who start to snore or get worse between 4 and 10 years of age usually have large tonsils as a result of subclinical or clinical infections or owing to a genetically narrow airway and a normal physiological hypertrophy of Waldeyer's ring. The adenoid is still present, but usually diminishes in size before the age of 10 years. Primary enuresis and oral motor dysfunction can be the symptoms, in addition to the snoring and sleep disturbance. At the age of 4 years, there can be bite aberrations which can be related to the oral posture [17]. The earlier the condition is relieved the better is the prognosis for maxillofacial development [8].

From 11 to 18 Years

During this period, children who were adenoidectomized in early childhood may start to snore again. This often begins in connection with an acute throat infection (strep throat or mononucleosis), but they then continue to snore after the acute situation has been resolved. Recurrent infections are more common than among younger children and the obstruction/OSA is usually a major problem only during these occasions. The parents are not bothered by the snoring as much since the youth sleeps alone. Daytime sleepiness is common, but may be related to several other reasons. Friends are commonly the ones who complain about the snoring during camp stays or stay-overs.

The maxillofacial development progresses up to puberty. If an open mouth posture has existed up to that time, the bite aberrations may be severe [6]. It is important that the orthodontists who treat the children address the snoring and breathing problems and that they do not only try to correct the bite. Distraction or expansion treatments can still cure the OSA and improve the bite. However, since the OSA often has created secondary effects in the pharynx with redundant tissue, a conservative UPPP is also indicated even for cases without large tonsils [7] (Fig. 43.1, Video 43.1).

A special group of adolescents are those who had cleft-palate surgery during early childhood. A poor nasal passage and pharyngeal opening predict snoring and OSA, and the treatment has to be balanced between breathing and speech difficulties.

Surgical Methods Used for OSA and Snoring in Children

The methods used for surgery of OSA in children can be performed using "cold" blunt dissection, a microdebrider or hot-energy tools (cautery, electrosurgical, radiosurgical or laser devices). The tissue damage and therefore the postoperative morbidity is related to the mechanical trauma and the temperature involved. The author has chosen the ellman 4.0-MHz Surgitrone® dual RF device as the optimal tool in this context but in the few cases where a full tonsillectomy has to be performed the microdebrider or coblation device are used before other electrosurgical tools [24].

Adenoidectomy

The child should be under general anesthesia, orally intubated or with a laryngeal mask.

Two catheters are pulled through the nose out through the mouth by which the soft palate is pulled forward. A mirror is placed so that the nasopharynx can be easily viewed. The widest curette is placed as close to the nasal septum as possible and with pressure the adenoid is removed. An extra catheter is placed through the nose for suction of the blood. A cotton swab is pressed for hemostasis for at least 5 min after removal of all visible tissue, and inspection with the mirror completes the procedure.

With use of the radiofrequency technique (ellman Surgitron®), the procedure is performed approximately in the same way, but without pressure and with reduced blood loss [22]. With coblation or use of the microdebrider, the adenoid is removed slowly without blood loss, but the duration of the procedure depends on the experience of the surgeon [4, 23].

Tips and Pearls

- It is important to perform adenoidectomy with full visualization of the nasopharynx, instead of using earlier-practiced blind procedures.

Partial Intracapsular Tonsil Resection (Tonsillotomy)

When the child's main problem is caused by hypertrophied tonsils possibly in combination with hypertrophy of the adenoid, one should always consider how much of the tonsils have to be removed:

1. What degree of reduction of the size of the tonsils is enough for the specific child?

43

2. Which technique is most suitable for the purpose?
3. Are there differences in the outcome of different surgical techniques?

For consideration 1:

- Most children up to their teens are operated on solely for obstructive symptoms. In those cases there is no reason to remove more of the tonsils than necessary.
- Long-term follow-up studies are available concerning the use of the CO_2 laser (7 years) [14], coblation (2.5 years) and radiofrequency (3 years) to perform partial tonsillectomy, indicating a very low risk for recurrence of the tonsillar hypertrophy, and good long-term resolution of snoring.
- If tonsillar tissue regrowth occurs, it is likely that a repeat tonsillotomy will be sufficient, but thus far a full tonsillectomy is almost always proposed.
- A child with tonsillar hypertrophy and with suspected hypotonia as the cause of breathing difficulties may not be helped by a full tonsillectomy as the empty muscular hypotonic fossae may grow together and the distance between the base of the tongue and the posterior pharyngeal wall be decreased. Remaining tonsillar tissue within the fossa may act to keep the pharynx more open.

For consideration 2:

- The best technique is the one the surgeon is most familiar with.
- Bleeding after tonsillectomy is reported with all full tonsillectomy techniques [25]. When partial tonsillectomy is performed, bleeding is not an issue since no major blood vessels are situated within the tonsillar tissue.
- The surgeon should be familiar with the special features of all energy-related instruments available for tonsillectomy.

For consideration 3:

- All different techniques where some tonsillar tissue is left in the tonsillar fossa demonstrate a quicker recovery and much less postoperative pain compared with full extracapsular tonsillectomy [11–14, 16].
- One would suspect an increased risk for throat infections with partial tonsil resection com-

pared with complete tonsillectomy. However, studies have not reported any differences with regard to treatment with antibiotics for throat infections between tonsillectomized and tonsillotomized children.

How I Do It

Intracapsular Partial Tonsillectomy with the ellman Surgitron® dual RF 4.0 MHz Device

The ellman Surgitron® dual-RF 4.0 MHz device is shown in Fig. 43.3 and the procedure is demontrated in Video 43.2.

The patient is anesthetized, orally intubated and a David–Meyers mouth gag inserted to get a good overview of the tonsils all the way down to the lower pole Two neutral electrodes (antennas) are placed one under each shoulder. One of the electrodes is connected to the machine.

The tonsils are inspected and checked for superficial blood vessels. On the posterior side you should also check to see if there is a cleft between the tonsil and the posterior pillar and how deep it is. Local anesthesia including a vasoconstrictor (0.25% Marcain-epinephrine) is injected into the tonsillar tissue. It should be injected slowly in order to avoid leaking of the solution out through the crypts. Depending on the child's age and the tonsil size, 2–5 ml is used in each tonsil (Fig. 43.4a). Surgery is begun on the side where the antenna is connected.

A 2-cm-wide gauze strip is placed into the grove between the tonsil and the posterior pillar in order to protect the posterior pillar (Fig. 43.4b). A needle electrode is attached and the Surgitron® is activated. You should look for superficial vessels and coagulate these using 10-W coagulation mode.

Change to cutting mode and increase the output to 15 W. Make an incision parallel with the anterior pillar without holding/pulling the tonsil. Try to go over the upper pole (Fig. 43.4c). Pull on the tonsil with forceps so the incision opens up a little.

Change to cut/coagulation mode with 40 W and cut through the tonsil with a smooth movement down to the gauze which protects the pillar (Fig. 43.4d). If there was no grove between the tonsil and the posterior pillar to push the gauze strip into, cut through half of the tonsil first, stop, lift it upwards and do the final cutting from behind. Take an ordinary tonsillar swab and press for about 1 min against the remaining tonsillar surface.

Use the needle electrode and lower power setting when close to the muscles. Be careful – avoid removing too much tonsillar tissue and keep to the first inci-

Fig 43.3. Surgitron® dual-frequency 4.0-MHz device (Ellman, New York, USA). **a** Device console. **b** Electrodes used for tonsillotomy and conservative UPPP

sion line. If there is bleeding, put a new swab in place and do the other side after changing to the other antenna. Remaining bleeding small vessels are coagulated using a needle or the ball electrode (Fig. 43.4e)

Conservative UPPP

43

The indication is narrow maxilla with a sharp angle between the tonsils and in cases where muscular hypotonia during sleep is the major problem. Children with Down syndrome are always candidates.

Perform a tonsillectomy or if there is a fossa supratonsillaris a partial intracapsular tonsillectomy (Fig. 43.5). Remove the mucus membrane in the fossa supratonsillaris all the way to the root of the uvula. Ex-

tirpate a half-moon-shaped piece of the mucus membrane above the uvula (Fig. 43.5c).

Remove redundant tissue from around the uvula. Do not damage the posterior pillars or the membranous lining of the uvula. Suture the upper part of the pillars (fossa supratonsillaris) together, thereby pulling the posterior pillar forward. Be careful to get the sutures through muscle. Use 00 Vicryl. Close the incision above the uvula, let the suture go into the muscle layer. Use 000 Vicryl (Fig. 43.5d).

Figure 43.5e shows the result 6 weeks after surgery. Notice the widening of the entrance to the nasopharynx and the fibrosis where the sutures were.
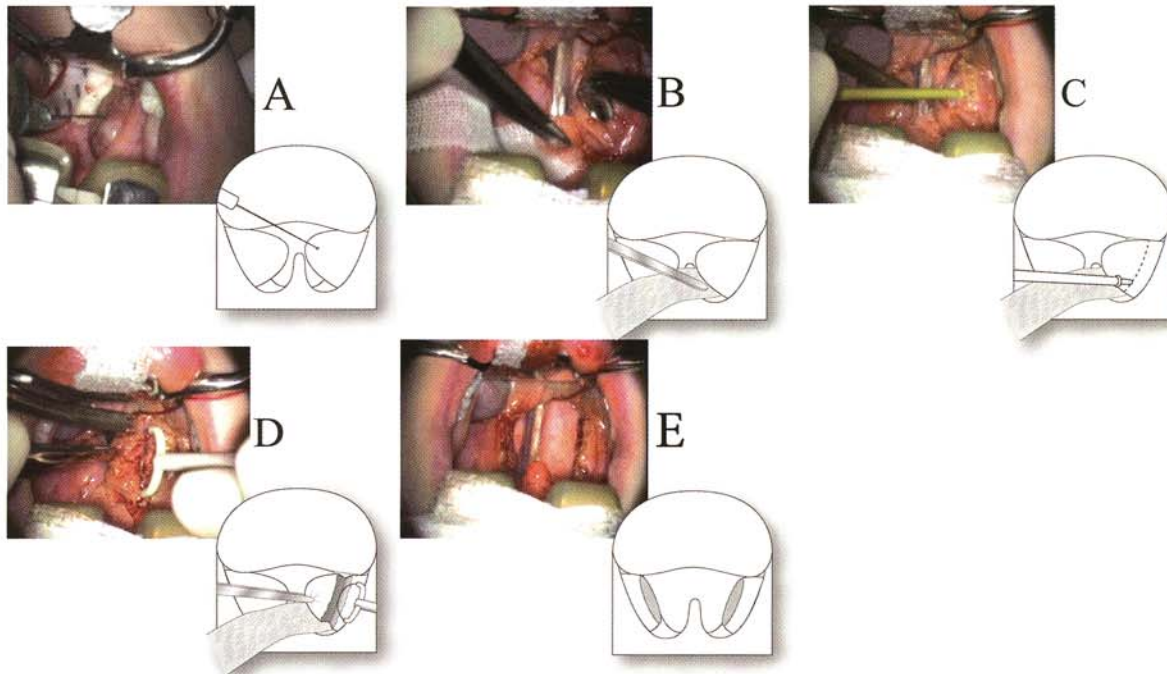
Fig. 43.4. Partial intracapsular tonsillectomy (tonsillotomy) with the Surgitron® dual-frequency 4.0-MHz device. **A** Injection of local anesthetics into the tonsils, to increase fluid content. **B** Application of a gauze strip through the fossa supratonsillaris to protect the posterior pillars. **C** Incision of the tonsil surface parallel to the anterior pillar **D** Cutting through the tonsil with the HTZ electrode **E** End result: small, normal-sized tonsils
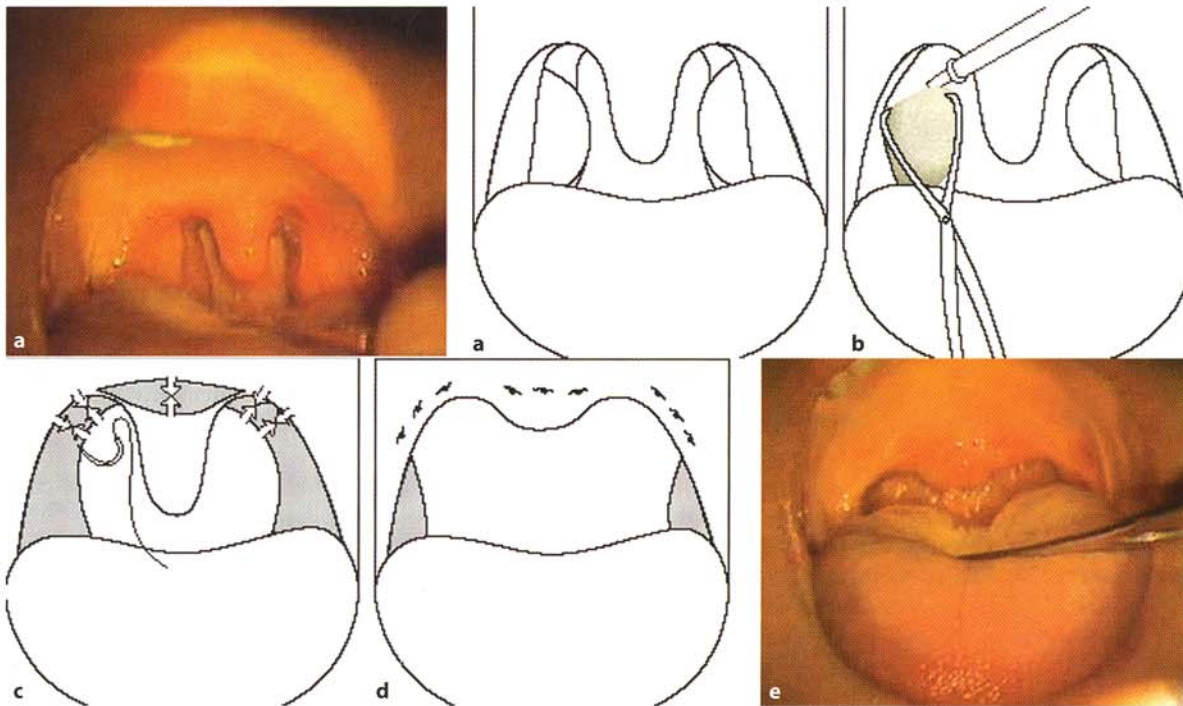
Fig. 43.5. Conservative UPPP. **a** Preoperative status in a 12-year-old boy with severe obstructive sleep apnea due to muscular hypotonia during sleep. Hypersomnia, hyperactive, loss of concentration, poor school performance. **b** Full tonsillectomy. **c** Removal of mucosa in fossa supratonsillaris and an oval incision of mucosa over the uvula. **d** Deep sutures in fossa supratonsillaris as well as over the uvula. **e** *End result:* Note the fibrosis where the sutures were placed – normal sleep and alertness, improved grades in school

Tonsillectomy: Blunt Dissection

The child should be under full anesthesia, intubated or using a laryngeal mask. Sufficient premedication is used to reduce postoperative pain, but intravenous morphine is usually necessary.

Local anesthesia including epinephrine is applied under the mucus membrane of the tonsil medially of the anterior pillar. The tonsil is grabbed with tonsil forceps and pulled medially so that the mucous membrane can be incised at the bottom of the fossa supra-tonsillaris and the tonsil be freed outside of its capsule without damage to the anterior pillar.

Continue to dissect inferiorly in the plane between the tonsillar capsule and the tonsillar fossa. Clamp visible blood vessels successively in advance with fine arterial forceps if needed, but as you dissect along the tonsillar capsule you rarely have to ligate them. Leave as much as possible of the mucus membrane intact also on the posterior pillar, thereby minimizing the extracapsular wound. At the lower pole dissect the tonsil free. If the pharyngeal tonsil continues into the lingual tonsil, arterial forceps can secure the end and a suture ligature may be needed.

If there is bleeding, find the vessels and use fine arterial forceps and ordinary ligatures. Do not use diathermy in the tonsillar fossae because there is a higher risk for late postoperative bleeding [25] and pain.

Postoperative Care

Most children operated on for OSA can be sent home after a few hours of observation (6–8 h). The breathing obstruction will be immediately relieved after adenoidectomy and tonsil surgery. The risk for postoperative bleeding is decreased if partial tonsil reduction is performed and the time for the child to return to normal activity is shortened [12, 16].

Pain relief is the most important part of care responsibility for the parents, who should be given a written schedule for medication. Diclophenac in combination with paracetamol is usually sufficient initially [18]. The parents and children are instructed to evaluate the pain using a pain scale before meals and to withdraw the medication successively while keeping pain "below 3" on the 7-graded scale, where 0 is no pain and 6 the worst possible. Antibiotics or steroids are only indicated in selected cases.

No restrictions concerning food or activity are necessary.

Complications

As for all tonsil surgery, the risk for primary and secondary bleeding has to be considered [25].

The risk for bleeding is less in a calm and pain-free child:

- Minor bleeding can be stopped by the child sucking on ice cubes.
- Desmopressin given intravenously or as a nasal spray will often be sufficient, both in normal children and in ones with unsuspected coagulation abnormality.
- If fresh blood is oozing out of the mouth, a small child usually has to be taken back to the operating theatre for bleeding control.
- An older child can be treated locally by injection of local anesthetics containing epinephrine and coagulation of bleeding vessels can be done with silver nitrate sticks.
- If it is necessary to reoperate, identify bleeding vessels and ligate them. Do not use electrocoagulation.
- If the bleeding has stopped when the patient is anesthetized, try to estimate from which area the blood originated and apply hemostatic material in that location. Avoid placing sutures deep in the muscles to avoid injury to neighboring large blood vessels.
- If major bleeding occurs in a child, manually compress the vessels before attempting definitive treatment.
- If there is a secondary bleeding, an infection is often part of the cause and antibiotics should be prescribed

In children with an undiagnosed submucous cleft or genetic underfunction of the palatal muscles or short soft palate, an adenotonsillectomy may cause speech problems with air leakage through the nose. This complication can be avoided by preoperatively identifying the anomaly. Always suspect the condition if there is a bifid uvula. In such cases, a "high adenoidectomy" can be performed, which means that only the part of the adenoid covering the choanae and the ceiling of the nasopharynx is removed. The portion of the adenoidal tissue on the posterior wall of the nasopharynx is left intact, since it participates in the closing at phonation. In the child who has developed speech problems, speech therapy may be beneficial, but in the worst cases pharyngeal reconstruction may be necessary.

43

Recurrence

Although the symptoms are resolved after surgery, the parents should be informed that there is a risk that the snoring, apneas and other symptoms may recur and if this occurs they should again contact a physician.

The reasons for recurrence can vary:

- If the original surgery has not accomplished transition to nasal breathing, there is risk that negative maxillofacial development continues with recurrence of symptoms, either in the teens or in adulthood. The child who continues to have predominantly oral breathing should be evaluated with respect to additional treatment of rhinological problems (allergy) or be referred to an orthodontist, even if the snoring and apneas have improved after primary surgery.
- After isolated adenoidectomy, hypertrophied tonsils may contribute to worsening snoring and disturbed sleep. This problem can partly be avoided if partial resection of the tonsils is performed routinely with adenoidectomy.
- If both adenoidectomy and a full tonsillectomy have been performed, later development of lingual tonsils may create new breathing problems. This problem is avoided by never doing an adenotonsillectomy in infants.

Conclusion

Sleep apnea in adults is a chronic disease which can be treated symptomatically, but seldom cured permanently. If sleep apnea is diagnosed and treated adequately in early childhood most children will be cured. Some will experience a return of symptoms during their physical development [6], but there will still be an opportunity for improvement once again and for normal development if sufficient treatment is given early enough [8].

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