Ambulatory anesthesia aspects for tonsillectomy and abrasion in children
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Introduction
Tonsillectomy, with or without adenoid abrasion, is one of the most frequent surgical procedures done globally. In USA about 0.17% of the population will be subjected to these procedures every year [1] and in an Australian survey this was the most frequent procedure in the age groups from 3 to 14 years of age [2]. In a semi-randomized set-up comparing conservative treatment with tonsillectomy, Lock et al. [3] confirmed the impression of tonsillectomy as useful, in terms of less episodes of sore throat in a 2 year follow-up after inclusion. In a study of parents’ satisfaction and children’s quality of life, the tonsillectomy procedure resulted in deterioration at day 7 compared with baseline, but significant improvement at day 30 after the procedure [4].

Purpose of review
Tonsillectomy is a very common procedure, but with risks or challenges, both for the surgeon and anesthesiologist. Many places have considerable experience and expertise with this procedure, and a lot of clinical studies are continuously being presented.

Recent findings
Most preoperative aspects are covered, including indications, preoperative risk assessment, premedication, anesthetic induction and maintenance, as well as recovery function and side-effects; such as bleeding, agitation, pain, nausea and sleep apnea. Controversies exist as to ambulatory versus in-patient care, laryngeal mask airway versus endotracheal intubation, use of local anesthetic infiltration and use of glucocorticoids.

Summary
Preoperative evaluation should identify increased bleeding risk, potential airway problems, ongoing infection and symptoms of obstructive sleep apnea. Intravenous propofol is most often used for anesthetic induction, although inhalational sevoflurane is a valid alternative. Laryngeal mask airway or endotracheal tube may both be used safely and effectively; the choice will depend upon the routine and experience of the team. Paracetamol and NSAIDs are useful baseline medication for nonopioid multimodal postoperative pain treatment and prophylaxis. Similar with local anesthesia infiltration and dexamethasone medication, although somewhat more disputed. Dexamethasone is also useful for nausea/vomiting prophylaxis, together with ondansetron and also propofol for anesthesia maintenance.

Keywords
adenotonsillectomy, general anesthesia, postoperative agitation, postoperative nausea and vomiting, postoperative pain

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Indications: benefits on health and drawbacks
Of course, good results are based on proper patient selection and adequate preoperative handling. In the recent published US guidelines the evidence-based surgical indications for these procedures are lined up and specified: frequent infections, peri-tonsillar abscess and/or symptoms of obstruction [1]. Especially in the USA, there is a trend for more adenotonsillectomies being done due to obstruction in later years [5]. The simple observation of numerous episodes of oxygen desaturation of more than 1–2% for more than 10 s in pulse oxymetri during normal sleep was associated with benefits from subsequent tonsillectomy [6]. However, in terms of usefulness of surgery, it should also be remembered that the spontaneous tendency in nonoperated...
children is frequently positive, in terms of improvement [3*]. In a risk–benefit perspective, tonsillectomy is an elective procedure with more than average mortality, being estimated to be about 1 per 10–20 000 cases [1**,7**]. Causes of death are: bleeding, airway problems, anaphylactic reactions or postoperative hypoxemia.

**Inpatient or outpatient?**

In one study primary rebleeding occurred in 1.9%, whereas late rebleeding (usually day 4–7) occurred in 5.5% [8]. In a study with 2.9% primary rebleeding needing surgical intervention, 85% of the cases were handled with rapid sequence intubation, with 10% incidence of hypoxemia, 4% bradycardia and 2.5% hypotension [9*].

Whereas risk of primary rebleeding necessitates a postoperative hospital stay of at least 1–2 h after primary haemostasis, the risk of severe rebleeding some hours after surgery with noncomplicated hemostasis is very low and usually justifies these patients to be sent home within the same day. In an international survey of ambulatory surgery in 2005 the frequency of ambulatory tonsillectomy (in % of total) varied from 3 to 94% between different Western countries, with quite similar and substantial variation for the 2010 figures (Claus Toftegaard, personal communication). In the guidelines from Massachusetts Eye and Ear Infirmary, the recommendation is for children older than 3 years to be ambulatory, unless special co-conditions are present [10*]. Children less than 3 years of age are recommended to be in-patients, but this is mostly due to the increased risk of postoperative sleep apnea in this age group.

The secondary bleedings occur late, at days 4–7, and hardly any modern center will keep their patients in hospital for such a period. Thus, it is important to instruct the patients and parents about the urgent need to take contact with relevant healthcare providers if any rebleeding occurs. During the first 2 weeks after surgery, the patients should always be within reasonable distance (maximum 1 h of travelling) of a hospital with acute 24-h service of ENT and anesthesiology [11*].

**Surgical aspects**

Details on characteristics of different surgical techniques are beyond the scope of this survey. Still, there is a general distinction between superficial methods, such as laser ablation, starting at the surface and evaporating the tonsil tissue [12]; compared with the different techniques of removing the intact tonsils by dissection from their fixation to the pharyngeal wall. These latter methods are dominating, as they are more complete with less or no residual tissue; but they usually mandate general anesthesia with intubation or laryngeal mask airway (LMA) and carry an increased risk of bleeding. Still, in one study, the tonsils were removed successfully with guillotine in spontaneous sevoflurane breathing patients, without any airway device [13*]. An important aspect for the anesthesiologist of surgical technique was recently studied by Fennessy et al. [14*]. They showed that tightening of the Boyle-Davies gag caused an average displacement of a tracheal tube of 9.5 mm down in the trachea. Whereas this downward displacement may lead to one lung ventilation, especially in small children, there is a wide interindividual variation in down displacement, with a range from minus 10 to 27 mm, implicating that in some few patients the tube may move upwards upon gag-tightening [14*].

The US guideline states the use of routine prophylactic antibiotic is not recommended [1**]. Still, it is a clinical observation in cases with ongoing or chronic infection that preoperative antibiotic treatment may reduce oedema and blood vessel size in the tonsil area. Also, antibiotic treatment may reduce the preoperative bacteremia, especially seen in tonsillectomies with some blood loss [15].

**Preoperative patient health aspects**

Apart from overt malformations or anatomical causes of difficult airway handling, the occurrence of intercurrent or chronic airway disease may be associated with more frequent airway problems, such as episodes of laryngospasm, coughing, breath holding and desaturation in the preoperative phase. In a review of respiratory events in 9207 children due for different types of surgery, there was an association between preoperative coughing, asthmatic episodes and eczema with preoperative airway complications, which, however, very rarely are severe [2**]. Increased rate of complications was also seen in patients with an ongoing upper airway infection or patients with a recent (i.e. within 1–2 weeks) infection. The occurrence of obstructive sleep apnea syndrome (OSAS) is quite frequent in children presenting for adeno-tonsillectomy, with some debate as

**Key points**

- Preoperative evaluation should focus any increased bleeding risk and on potential airway problems, such as ongoing infection and obstructive sleep apnea.
- Safe induction of anesthesia should be with i.v. propofol, although inhalational sevoflurane is a valid alternative.
- Laryngeal mask airway or endotracheal tube may both be recommended; the choice will depend upon the experience of the team.
- Paracetamol and NSAIDs are very useful for postoperative pain treatment and prophylaxis; dexamethasone and local anesthesia infiltration also, although some doubt is being raised.

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to preoperative handling. Preoperative polysomnography will identify patients with a high risk of problems [16*], but also more simple monitoring of oxygen desaturation during normal sleep may contribute with some predictive value [6]. Recent guidelines for OSAS management [5*,17] recommend that high-risk patients should be monitored continuously as inpatients for 1–2 days, especially if they are in need of postoperative opioids.

**Premedication**

Conventional midazolam premedication to ambulatory children may not be without problems, as the dose need when given orally is quite high and may result in postoperative somnolence. In a meta-analyses of 10 studies comparing midazolam with clonidine premedication, the latter was better both in terms of preoperative anxiolyses, less agitation during emergence and less postoperative pain, whereas a small tendency of less postoperative nausea and vomiting (PONV) was inconclusive [18*]. Still, in this analysis no placebo groups were included, and many clinicians will prefer not to use sedative premedication in the routine case [11*].

**Choice of anesthetic technique**

The controversies in this area includes the LMA versus tracheal tube discussion, choice of anesthetic agents, use or nonuse of neuromuscular blockers, ways to optimize drug dosing and measures to prevent postoperative agitation, pain and nausea/vomiting.

The study of tracheal tube versus LMA by Doksrod et al. [19*] showed less postoperative pain, less airway irritation and 5 min shorter total procedure time with the LMA. In another large series of 1126 children for adenotonsillectomies with the LMA, there were no problems with the technique and only six patients needed a change to tracheal tube in order to improve surgical access [20]. This aspect may have to do with the training of the surgeons as well, in a study of 60 LMA patients by Peng et al. [21], as much as 17% (10 patients) needed a transition to tracheal tube due to surgical access problems. Still, there may be arguments in favor of the cuffed tracheal tube. In those very rare cases when you have a severe preoperative bleeding, the inflation of a tracheal tube cuff may be the best insurance for good airway control and insurance against blood aspiration into the airways [11*].

Most authors will argue for the i.v. induction of general anesthesia with propofol to be faster and safer than sevoflurane inhalation [2*], although the latter may be the only viable option in a struggling child with no veins readily available. It is always a good routine to pretreat the child with an effective, skin-penetrating local anesthetic cream (e.g. eutenic mixture of local anesthesia or more rapidly acting Rapydan) before needle puncture [11*]. In order to avoid propofol injection pain, low-concentration propofol (5 mg/ml) in medium chained lipid oil solution is beneficial, eventually mixed with lidocain 1 mg/ml just before use. For anesthetic maintenance there are data indicating less emergence laryngospasm with propofol, but less coughing with sevoflurane when these agents are compared [22], whereas a more recent study showed less pain and PONV after propofol maintenance [23]. In a study of different models for propofol target control infusion (TCI), the adult Scnider model, somewhat surprisingly, proved a better fit with clinical landmarks (i.e., awake → asleep transition) than the dedicated children models of Kataria or adapted Marsh [24*]. Still, the major issues with propofol dosing in children is to remember that children need higher doses than adults, and that numerical target values for TCI always should be adjusted for the specific algorithm or model which is being used.

Depth of sleep monitors, such as bispectral index or other concepts, may be a help in individualized dosing of both propofol and potent inhalational agents. In a study of entropy EEG monitoring during sevoflurane anesthesia there was less sevoflurane consumption and faster awakening compared with standard clinical practice using blood-pressure changes as an indication of dosing [25*].

Whereas desflurane is considered unsuited for inhalational induction due to strong airway irritation, a recent study showed less preoperative bleeding when desflurane was compared with sevoflurane for maintenance [26*]. Also, desflurane maintenance seems to reduce the incidence of postoperative agitation, which is quite frequently seen after sevoflurane [27]. A number of means have been documented to reduce the incidence of postoperative emergence agitation; the simplest is probably to use propofol for maintenance. With inhalational maintenance, especially when sevoflurane is used, the incidence may be reduced either with supplementation of an opioid: alfentanil [28], fentanyl [29*,30*], remifentanil [31*], or ketamine [30*,32] or clonidine [18*] or dexamethomidine [33*].

Dexmedetomidine is an interesting alternative for maintenance due to its nonrespiratory depressant properties, combined with hypnotic and analgesic action [29*,33*,34*]. However, the recovery after dexmedetomidine used as the only and major maintenance agent may be prolonged [29*,34*], thus some authors will rather use this drug in low dose as an adjunct to inhalational anesthesia or propofol [33*].

Whereas many clinicians will do the tracheal tube intubation for adenotonsillectomies, without the use of neuromuscular blockers, there is a recent study by Bartolek et al. [35*] advocating use of low-dose rocuronium, that is
A study looking at restrictions on eating or physical activity postoperatively showed no benefits in terms of less bleedings with such restrictions, rather the patients and parents in the nonrestrictive group was more satisfied overall [37]. In a study of acupuncture preoperatively combined with 24 h use of acupressure band, there was a significant reduction in PONV compared with placebo. Still, as acupressure alone is effective in older studies, we do not know if acupuncture added some value in the present study [38]. Another study looked at intraoperative suggestions in patient’s ear in order to reduce the PONV incidence, without any effect [39].

A meta-analysis of 22 studies on PONV after tonsillectomy in children concluded with significant effects of using dexamethasone, 5-HT-3 blockers or metoclopramide, whereas acupuncture, gastric suction, dimenhydrinate, droperidol or perphenazine were of no effect in the doses studied [40]. Dexamethasone is also included in the evidence-based US recommendations [1**] and found to be of benefit as an opioid-reducing measure in children with OSAS [41]. Still, there has been a concern of more late postoperative bleedings, occurring in eight dexamethasone patients versus 0 after placebo in a prospective study of 215 adenotonsillectomy children [42]. Whereas being just significant, there are problems with statistical power and confounding aspects in this study. Looking more closely at the data, the study involved 11 different surgeons, and most of the severe bleeding episodes occurred with three of the surgeons. As the benefits of analgesia, reduced PONV and reduced opioid need is very extensively documented with dexamethasone [1**], it may seem that more studies are needed in order to confirm the suggestion of increased bleeding coming, so far, from only one study.

The nonopioids are important analgesics after adenotonsillectomies, and NSAIDs seem to be a little better than paracetamol alone, whereas the combination is best [43]. Cox-II-selective inhibitors may have a theoretical advantage due to no bleeding effect on platelets, but so far these drugs are not documented well enough for approval in children. In a meta-analysis of 35 studies on ketamine in mixed types of children surgery, there was less pain postoperatively but no significant effect on opioid dose need [44]. Tramadol may be another option [45] with analgesic effect comparable to paracetamol [46], but some studies have shown increased nausea and vomiting with this partly opioid-acting drug [47]. Two meta-analyses of seven or 13 studies, respectively, both show the effect of bupivacaine infiltration on postoperative pain and opioid consumption [48,49]. The effect of local anesthesia per se was supported by a study by Paloheimo et al. [50] with an elegant design; one tonsil was infiltrated with saline and the other with lidocaine. The preoperative stress response was significantly higher when the saline tonsil was dissected compared with the lidocaine side. The addition of topical clonidine [51], tramadol [45] or epinephrine [52] in other studies did not seem to provide any convincing extra effect. In one study the timing of bupivacaine infiltration was addressed: infiltration by the end of surgery was better for postoperative analgesia than presurgical infiltration [53]. The study by Moss et al. [51] did not show any benefit of 1.5 ml local anesthesia + clonidin infiltration versus placebo infiltration, but may be criticized for using a low dose and not including a true placebo group without any infiltration at all. Very few studies include such ‘true’ placebo group, but one from 1998 found more bleeding and more pain when no infiltration was compared with saline infiltration [54].

**Conclusion**

Adenotonsillectomy in children is a very common surgical procedure, needing dedicated and expert anesthesiologic attention. Whereas a lot of clinical studies on important aspects of anesthetic handling may be identified in recent years, there will still be controversies which may not be fully solved. This may have to do with different types of surgical techniques, skill and speed in different clinics; but also with differences in safety philosophy and priorities as to measures to avoid the very rare and very serious complications. These are very hard to address with sufficient statistical power in randomized prospective studies. Still, there are some quite good evidence on most of the quality issues in these procedures, especially in how to optimize the postoperative period in terms of minimal agitation, pain and nausea/vomiting as well as ensuring a rapid emergence and safely discharge.

**Acknowledgement**

**Conflicts of interest**

There are no conflicts of interest.
Ambulatory anesthesia

References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:
• of special interest
• of outstanding interest
Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 707–708).


4. van der Griend BF, Lister NA, McKenzie IM, et al. Postoperative mortality in children after 101,885 anaesthetics at a tertiary paediatric hospital. Anaesth Analg 2011; 112:1440–1447. A retrospective study on 475 children with reoperation after tonsillectomy. Rapid sequence induction with succinylcholine was used in about 85% of the cases. This study confirms other reports on drug savings when depth of anesthesia is studied and discussed. With a experienced team the laryngeal mask saves time and result in less airway irritation and postoperative pain.

5. Brown KA. Outcome, risk, and error and the child with obstructive sleep apnea. Paediatr Anaesth 2011; 21:771–780. A review including rather complex preoperative risk analyses of obstructive sleep apnea syndrome (OSAS) and adenotonsillectomy. Adenotonsillectomy is efficient treatment in three fourth of the cases; those less successful are the morbid obese children. Simple preoperative sleep oxymetry with repeated values below 80% should be classified as serious OSAS, and with an age below 2–4 years these children should be in-patients and continuously surveilled during the first postoperative night.


10. Collins CE. Anesthesia for pediatric airway surgery; recommendations and review from a pediatric REFERRAL anesthesia. Anesthesiol Clin 2010; 28:505–517. This is a review of the present methods of evaluation and anesthesia for all types of pediatric airway surgery at the Massachusetts Eye and Ear Infirmary in Boston. It covers nicely the overall risks and preoperative concerns, surgical methods as well as postoperative complications occurred, the method clearly demands a highly experienced team.


18. Dahman S, Brasher C, Stany L, et al. Premedication with clonidine is superior to benzodiazepines. A meta analysis of published studies. Acta Anaesthesiol Scand 2010; 54:397–402. This is an analysis of 10 studies in children for a variety of short ambulatory procedures, comparing clonidine 2–5 micro/kg with midazolam 0.4–0.5 mg/kg (5 studies) or diazepam 0.2–0.4 mg/kg (5 studies). Clonidine provided better preoperative sleep, less emergence agitation first 2 h. A tendency in favor of less PONV was present, but concurrent use of antiepileptic prophylaxis may have interfered with this result. The problem with the meta-analysis is that only 2–3 studies were used for each clinical outcome, and that no comparison is done versus placebo or option of no premedication. Benzodiazepines may not be the optimal comparator in these doses as they usually prolong emergence and early recovery, and do not reduce emergence delirium.


30. This study advocates the routine use of ketamine 0.5 mg/kg for postoperative analgesia.
The effect of intraoperative
remifentanil, as other opioids, has some intrinsic properties in protecting against definition would probably have yielded less agitation in both groups.

67%). It may be that a lower dose of sevoflurane resulted in less agitation, or that 2.5% mean), similar time to awakening (about 8 min) and less delirium (23 versus 31

duration of surgery (38–43 min) and anesthesia (70–75 min) was long, and the emergence and the general trend was slow in both groups, not in accordance with daily time

109 patients were randomized into four groups of different single intraoperative doses of morphine or desmethylmorphine. There were no major differences postoperatively

between the drugs, but a dose-dependent effect on analgesia without differences in sedation and time to discharge.

In a nonblinded series with historical controls, the authors showed a reduction in relief of laryngospasm; from 72% of cases to 26% of cases by applying gentle chest compressions at a rate of 20–25 per minute. The incidence of airfilled relief of laryngospasm; from 72% of cases to 26% of cases by applying gentle

In 64 children, there was no difference between i.v. paracetamol 15 mg/kg and tramadol 1 mg/kg in painscores and need of rescue medication during 0–24 h for relief of laryngospasm; from 72% of cases to 26% of cases by applying gentle

embarrassing, in terms of less pain and nausea, than one drug given alone. A retrospective study of 292 children with OSAS, including 92 children with severe OSAS, defined as more than three episodes per night preoperatively with oxygen desaturation below 80%. The introduction of dexamethasone resulted in less respiratory events postoperatively (odds ratio (OR) 0.38), and less use of opioids without any increase in postoperative pain. Nine out of 19 children with an airway event requiring intervention in the severe OSAS group, occurred in the postoperative period after leaving the OR, underlining the need for continuous postoperative surveillance of these high-risk children.

This is an interesting study of two nonpharmacological methods used together. Clearly, this is a technique which needs further evaluation and refinement in more studies.

This is an interesting observation study of 800 children 3–13 years due to adrenal and/or tonsil removal for obstructive symptoms. Parents were instructed to use soft, nonirritating food and restrict physical activity for 2 weeks after discharge form the surgery (at 8–24 h after the procedure), and the success in doing so was recorded. No serious bleedings occurred, but a significant number of small bleeding episodes were registered after strong physical activity. In children being physically active and eating normal food the pain ratings (maximum at days 2 and 3) were lower. The study is rather complicated to interpret as cases of tonsillectomy-only due to recurrent infections were not included, and also of the surgeon'). When removing those cases tonsillectomy in children where volatile anaesthetics are not used: A case report. Anaesth 2010; 20:47–55.

Two doses of rocuronium (0.6 or 0.45 mg/kg) was compared with vecuronium 0.1 mg/kg. The low-dose rocuronium was best in terms of faster recovery, still not being impressive and not compared with the option of no curare. This is a much discussed issue.

Forty children were randomized to have swabs of either tramadol 2 mg/kg or saline versus tramadol for postoperative analgesia after adenotonsillectomy in childhood: study on postoperative pain therapy. Anaesthesist 2011; 60:625–632.

This study confirms some previous data on combination of NSAID and paracetamol being better, in terms of less pain and nausea, than one drug given alone.


A new study, but very much discussed in the literature, is a meta-analysis on postoperative pain therapy in children after tonsillectomy. More studies with sufficient standardization and patient numbers are clearly needed, but increased attention at the bleeding issue is initiated by this study.


The study was stopped for safety reasons because 20 out of 154 patients with dexamethasone were bleeding compared with only two out of 53 placebo patients (P = 0.003, adjusted risk of 6.8). This termination of the study is unfortunate, because the results are not that evident when looked at somewhat closer. A total of 24 bleedings may distribute between groups in clusters when intervening at the ‘worst’ point in a planned sequence of a fixed and higher number of patients. Only four of the eight patients who needed reoperation started to bleed after the day of surgery. Further, looking closely at the data, it seems like 11 different surgeons were involved with the bleeding cases, and their surgical method of tonsillectomy varied (at the ‘discretion of the surgeon’). When removing those three surgeons with most bleeding cases (total of 12 cases), we are left with 10 cases of bleeding in the dexamethasone patients (75% of total patient number) compared with 1 after placebo (25% of patient number), with too low statistical power to allow any conclusions and not even a suspicious tendency in the results. As this study confirms the highly appraised and firmly documented benefits of dexamethasone in terms of less PONV and less need of rescue analgesic medication, it may be too premature to abandon the use of dexamethasone for tonsillectomy. More studies with sufficient standardization and patient numbers are clearly needed, but increased attention at the bleeding issue is initiated by this study.


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In 64 children, there was no difference between i.v. paracetamol 15 mg/kg and tramadol 1 mg/kg in painscores and need of rescue medication during 0–24 h postoperative observation. However, there was a tendency of 40% less nausea (22 versus 38%) and 40% faster recovery with paracetamol which may come out with significance with a higher number of patients studied. The children did not receive any local anesthesia, and duration of surgery was quite long (40–45 min). Rescue analgesia was needed at 10 min (paracetamol) and 18 min (tramadol, ns) after end of anesthesia.


Objective measurement of stress response after lidocaine infiltration.


In this study of 107 valid patients, there was no differences in postoperative pain, rescue medication, feeding or side-effects during days 0–3 after surgery. The authors conclude that peritonsillar injection is of no use. Still, there was significantly less need of analgesic rescue after infiltration with active drugs in the first 0–2 h PACU period. A study limitation is the rather low and fixed (1.5 ml) volume of injection to all patients. The injection technique or the duration of surgery is not reported. The children were allowed to receive maximum 0.5 μg/kg fentanyl during the procedure. The authors do not discuss the potential benefit of a saline injection as their placebo. A true placebo group, that is no injection, was not included. Whereas this study suggests no major effect of peritonsillar injections, the study limitations will still keep the debate going.


The authors recommend postoperative infiltration with bupivacaine alone as equally good and more simple than mixture of bupivacaine, mepivacaine and epinephrine.


The authors recommend post-tonsillectomy infiltration for significant better postoperative analgesia than preoperative infiltration.