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PERI-OPERATIVE PAIN MANAGEMENT FOR PAEDIATRIC ADENOTONSILLECTOMY

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PERI-OPERATIVE PAIN MANAGEMENT FOR PAEDIATRIC ADENOTONSILLECTOMY

BACKGROUND

Adenotonsillectomy is one of the most common paediatric surgeries performed worldwide. Despite being an elective procedure and offering several benefits, the post-operative period following an adenotonsillectomy, is associated with significant morbidity related to pain, nausea and vomiting (PONV), bleeding and dehydration due to impaired oral intake and dysphagia. Post-tonsillectomy pain occurs within the first 3 post-operative days and may postpone return to regular activity [1-4]. Some studies have estimated the mortality to be approximately 1 per 10-20 000 cases. When compared with adults, children have a higher incidence of fatal respiratory events post-operatively [1, 5, 6].

Surgical management is offered mainly to reduce the regularity and severity of recurrent sore throats. A few patients will have a tonsillectomy –often with adenoidectomy – for relief of airway obstruction.

An ideal peri-operative pain control regimen still remains a challenge, but it is essential in order to provide adequate analgesia, reduce side-effects, and expedite recovery[7]. Despite advances in pain management, research shows that children's pain is often undertreated[8].

ADENOTONSILLAR ANATOMY [9]

Tonsils and adenoids are lymphoid tissues that form part of the Waldeyer's ring surrounding the pharynx. They appear at 6months of age and are largest between the ages of 4 and 7 years, after which they regress.

Tonsils

Waldeyer's Ring:

- Circle of lymphoid tissue consisting of palatine/faucial tonsils , pharyngeal tonsils (adenoids), lingual tonsils, and tubal tonsils of Gerlach; lateral bands and the posterior pharyngeal wall complete the ring
- Tonsils increase in size between 6 months–3 years old (after exposure to antigens), peak between 3–7 years old, and may involute after puberty

Arterial Supply (branches of external carotid)

- Lingual artery - dorsal lingual branch (anterior lower pole)
- Facial artery - ascending palatine and tonsillar arteries (main supply, posterior and middle inferior lower pole)
- Ascending pharyngeal artery (posterior upper pole)
- Maxillary artery - greater palatine and descending palatine arteries (anterior upper pole)

Venous Drainage:

- Lingual and pharyngeal veins -internal jugular vein

Lymphatics:

- No afferent lymphatics, drainage into superior deep cervical and jugular digastric lymph nodes

Innervation:

- Anterior pillar: CN X (palatoglossus)
- Posterior pillar:CN X (palatopharyngeus)
- Tonsillar fossa: CN IX, X (superior constrictor)

Adenoids

- similar to palatine tonsils
- present at birth, enlarge in childhood, usually regress during puberty

Arterial Supply:

- Ascending pharyngeal artery from the external carotid artery, minor branches from maxillary artery (ascending pharyngeal branch), facial artery (ascending palatine artery),thyrocervical trunk (ascending cervical), artery of the pterygoid canal

Venous Drainage:

- pharyngeal veins -facial and internal jugular veins

Innervation: CN IX, X

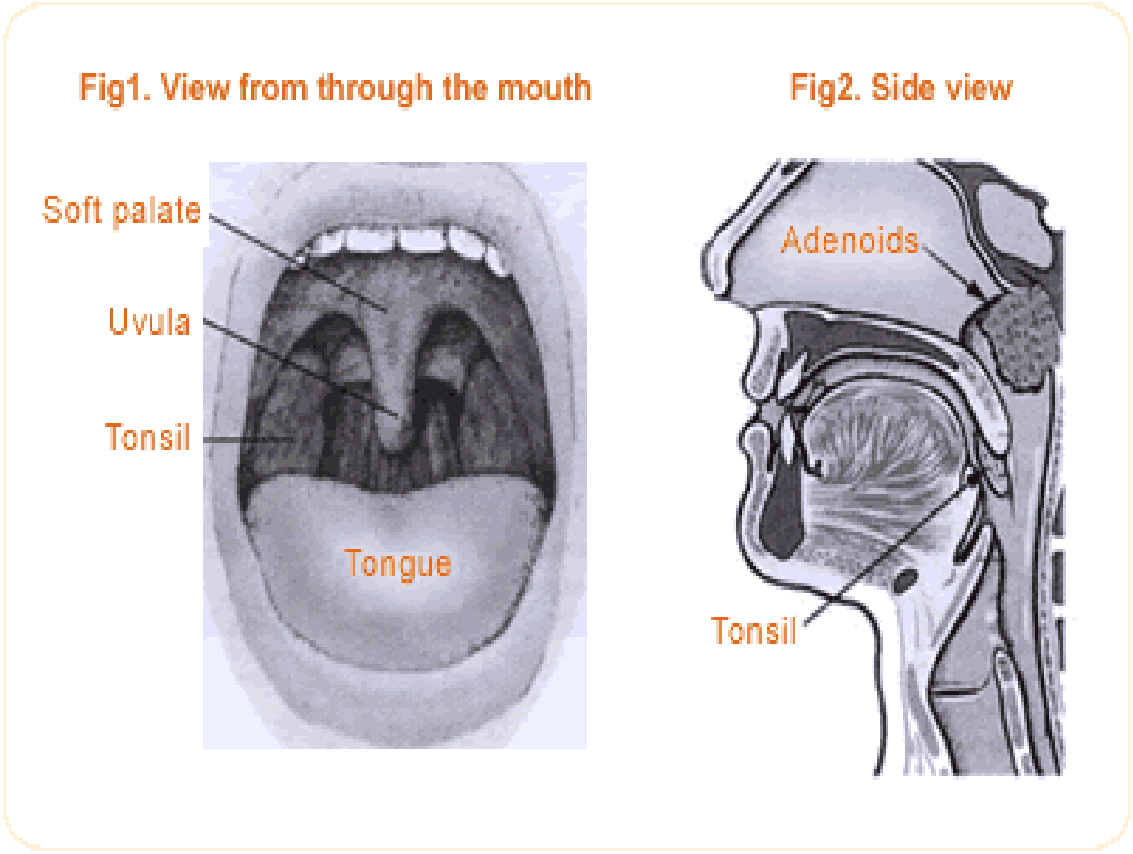


fig 1. Anatomy of tonsils and adenoids (google images)

INDICATIONS FOR ADENOTONSILLECTOMY

Patients with adenotonsillar hypertrophy often present with nasal obstruction, persistent recurrent infections, secretory otitis media and deafness (secondary to Eustachian tube dysfunction), and obstructive sleep apnoea (OSA) which is characterised by restless sleep and snoring with apnoeic pauses. Indications for surgery can be divided into infective and enlargement indications [2, 9].

Tonsillectomy is indicated in children with recurrent tonsillitis with five or more incidences of a painful throat a year as a result of tonsillitis, or if the symptoms have been persistent for a year and have interfered with normal daily functioning. Other indications are chronic tonsillitis, peri-tonsillar abscess and pharyngeal obstruction causing OSA. Adenoidectomy is indicated if there are enlarged adenoids causing obstruction of the nasal passages, OSA, or hearing impairment [2, 10].

Table 1 **[2]**

Common Potential Indications for Adenotonsillectomy
Sleep disordered breathing/ obstructive sleep apnoea (OSA)
Recurrent throat infections
Dysphagia or voice quality changes related to enlarged tonsils
Periodic fever, aphthous stomatitis, pharyngitis and cervical adenitis
Peritonsillar abscess in children with other indications for adenotonsillectomy
Hallitosis
Chronic tonsillitis unresponsive to antimicrobials
Tumour or haemorrhage of tonsils
Paediatric autoimmune neuropsychiatric disorder associated with streptococci
Chronic group A streptococcus carriage

CONTRAINDICATIONS FOR ADENOTONSILLECTOMY [2]

- Haematological disorders
- Active infection
- Uncontrolled systemic disease
- Velopharyngeal insufficiency

Potential complications can be minimised by a thorough pre-operative anaesthetic assessment. The considerations for anaesthetic technique are as follows:

- Pre-operative evaluation and premedication
- Providing adequate surgical access and being mindful of the “shared airway”
- Satisfactory perioperative analgesia
- Preventing post-operative nausea and vomiting
- Managing the airway in recovery
- Being aware of the risk of post-operative bleeding

EFFECTS OF SURGICAL TECHNIQUE ON POST-OPERATIVE PAIN

Positioning the patient

During this type of surgery, the airway is shared between the anaesthetist and the surgeon. The neck will be extended to allow easy access to the operative field. Monitor for post-operative neck spasms and pain. A mouth gag will be used to keep the mouth open- this has been found to cause mild-to-moderate temporomandibular joint pain following an extended period of surgery [2, 10].

Cutting technique [2, 9, 11]

Surgeons can either take tonsils out “cold” or “hot.

1. Cold technique
    a. Sharp dissection using a knife, scissors and snares to remove the tonsils.
    b. Ties/ sutures used to tie off blood vessels
    -this technique is kind to the surrounding tissues with less post-operative pain , but it is not favoured as the surgical field can become bloody and require a lot of suctioning or irrigation

2. Hot technique
    a. Electrocautery device used. This can either be radiofrequency ablation, carbon dioxide laser or harmonic scalpel. It seals the blood vessels as they are cut. It leaves behind collateral thermal damage on the bed of tonsillar tissue. Although this technique is precise and complete, is associated with more post-operative pain and longer healing.

3. Coblation
    a. This is a relatively new surgical technique and is operated in low temperature. It is associated with less post-operative pain and allows faster healing of the tonsillar fossa. This technique significantly reduces operation time and intra-operative bleeding.

PAIN ASSESSMENT TOOLS

The use of different pain measurement tools assists healthcare workers to recognise and classify levels of pain in children, who are less able to express themselves than adults can. These tools help children communicate about their pain. The most common pain assessment tools that are utilised are:

- The Wong-Baker Faces Rating Scale (figure 2) [5, 8]
    - Children from the age of 3 years and older
    - Self report
    - Demonstrates a number of faces ranging from a happy face (0= “no hurt”) to a crying face (10= “hurts worst)
    - The patient chooses a face that best describes how they are feeling

- The Visual Analogue Scale (VAS) (figure 3) [6, 8]
    - Measurement of pain intensity
    - Horizontal line, 100mm in length
    - “no pain”= 0; “worst pain imaginable=100
    - Highly subjective
    - Children 8 years and older

- The FLACC –scale (figure 4)[6]
    - The Faces, Legs, Activity, Cry, Consolability scale (FLACC) is a measurement used to assess pain in children between ages of 2 months and 7 years; recently validated for children up to 16 years
    - Scored in range of 0- 10; 0= no pain
    - 5 criteria which are assigned a score of 0, 1 or 2

- The PPPM (table 2) [6]
    - Parents Post-operative Pain Measurement (PPPM)
    - 15- item behavioural pain assessment tool to assist parents with at-home assessment of children’s pain
    - Well established & validated

Fig.2 Wong- Baker FACES Pain Rating Scale (Google images)

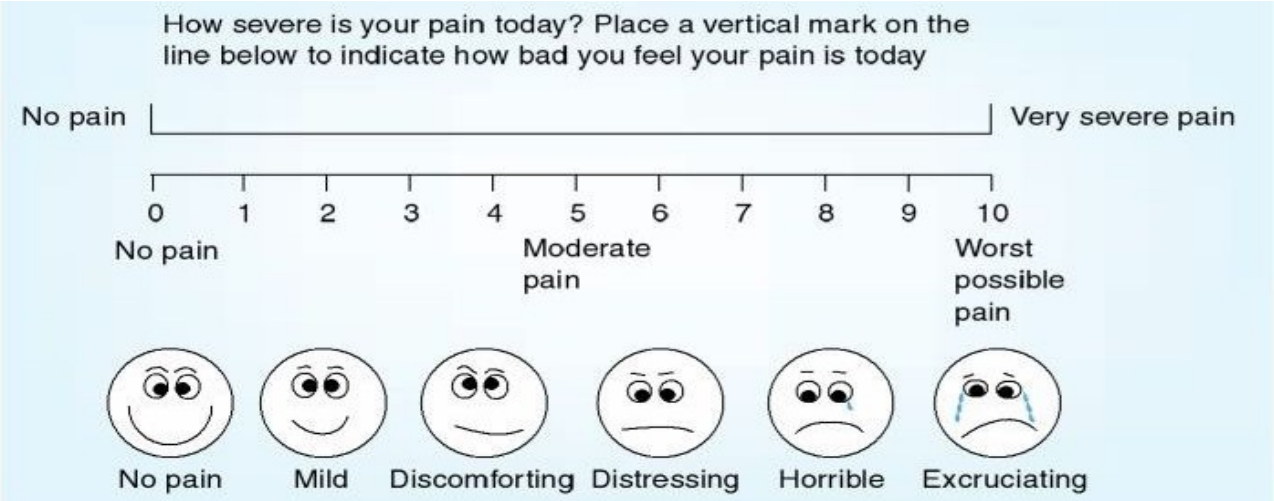


Fig.3 Visual Analogue Scale (VAS) (google images)

	Scoring		
Categories	**0**	**1**	**2**
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant frown, quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid, or jerking
Cry	No cry (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to; distractible	Difficult to console or comfort

Note: Each of the five categories Face (F), Legs (L), Activity (A), Cry (C), and Consolability (C) is scored from 0-2, which results in a total score between 0 and 10.

From Merkel, Voepel-Lewis, Shayevitz, & Malviya (1997). The FLACC: A behavioral scale for scoring postoperative pain in young children. *Pediatric Nursing, 23*(3) 293-297.

Figure 4. FLACC-scale (Medscape; google images)

PARENTS' POSTOPERATIVE PAIN MEASURE (PPPM)

When your child was recovering from surgery between _____ and _____ today, did s/he . . .

1)	Whine or complain more than usual? ...……	Yes No
2)	Cry more easily than usual? ....……	Yes No
3)	Play less than usual? .....…... …. ...…… ….	Yes No
4)	Not do the things s/he normally does? ..……..	Yes No
5)	Act more worried than usual? ....……	Yes No
6)	Act more quiet than usual? ....……..	Yes No
7)	Have less energy than usual? ....……	Yes No
8)	Refuse to eat?..... ....……	Yes No
9)	Eat less than usual? ... .…… ..	Yes No
10)	Hold the sore part of his/her body? .....…….…... .	Yes No
11)	Try not to bump the sore part of his/her body? …….	Yes No
12)	Groan or moan more than usual? .....……....	Yes No
13)	Look more flushed than usual? ...…….……..	Yes No
14)	Want to be close to you more than usual? ……..…..	Yes No
15)	Take medication when s/he normally refuses? ….…...	Yes No

Children sometimes have changes in behavior when recovering from surgery.

The following is a list of behaviors that your child may or may not have exhibited while recovering from surgery between _____ and _____ today.

For each of the behaviors below, circle the appropriate response, yes or no.

Note on Administration and Scoring: Parents are asked to complete the measure between a specific time period (i.e., between breakfast and lunch, between lunch and supper, or supper and bedtime).

The number of items parents have circled "Yes" are summed for a total score out of 15.

A score of at least 6 out of 15 signifies clinically significant pain.

Table 2. PPPM-scale

(*Chambers, C.T., Reid, G.J., McGrath, P.J., & Finley, G.A. (1996).Development and preliminary validation of a postoperative pain measure for parents.Pain, 68, 307-313)*

SEVERITY AND DURATION OF PAIN AFTER ADENOTONSILLECTOMY

In a prospective study by Stewart et al in 2012, in which he investigated the severity and duration of post-operative pain and analgesia requirements in children after tonsillectomy, orchidopexy, or inguinal hernia repair, he revealed that more than 50% (figures 5 a& b) of patients experience moderate-to-severe pain and functional limitation on average for more than 7 days after a tonsillectomy procedure. For some children this persists well into the second post-operative week. Opioid use peaks within the first 48- 72 hours following surgery [(4)].

In a controlled study by Fortier et al (November 2016), which looked at paediatric pain after ambulatory surgery, assessing the intensity, and frequency of analgesic consumption, found that a great number of children were being undertreated at home. Despite 86% of these children being noted as having significant pain, only 24% received 0 or 1 dose of treatment throughout the entire day [(12)].

Fig 5 a: Severity and duration of pain after adenotonsillectomy

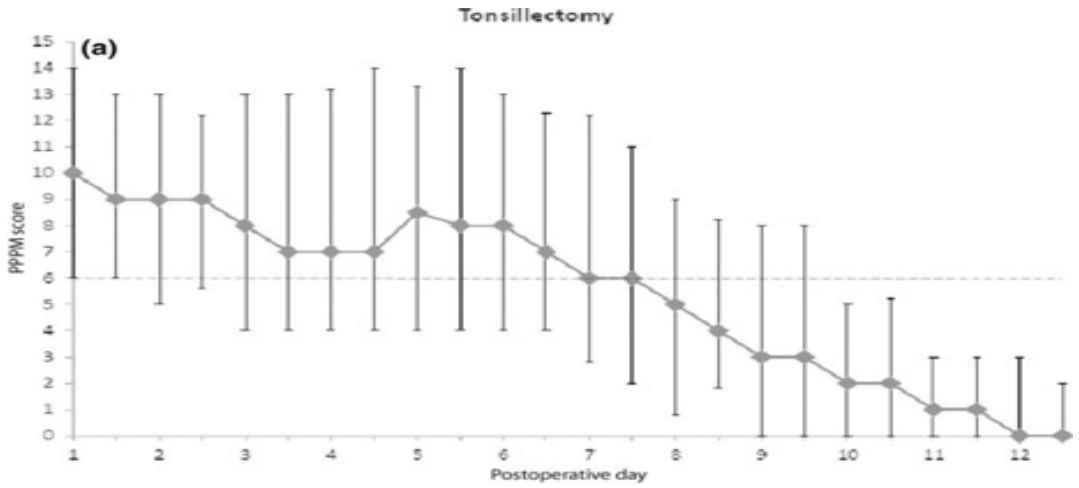
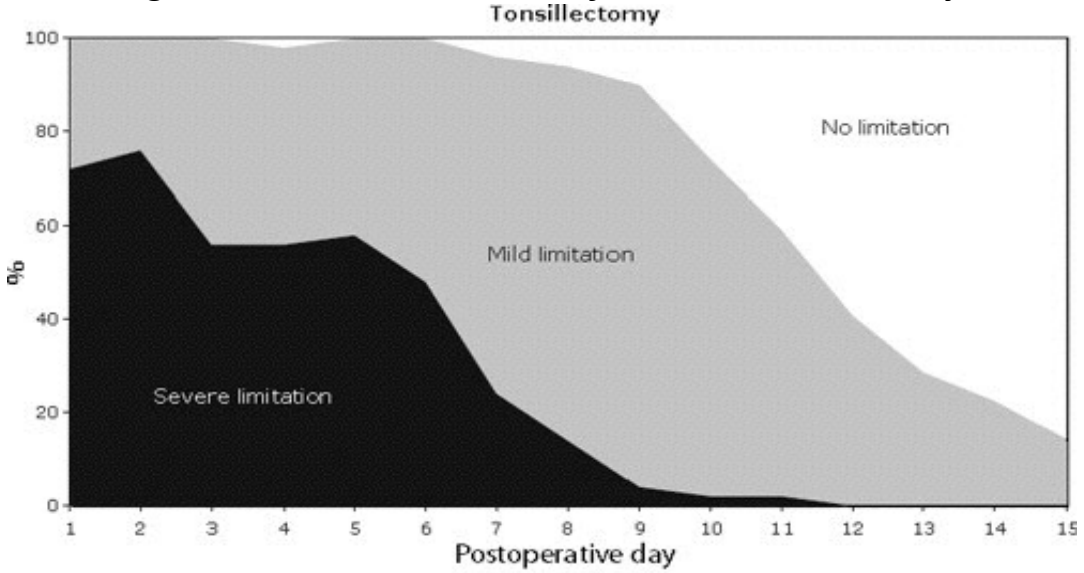


Fig 5 b: Functional limitation after adenotonsillectomy



(Stewart DW, et al. Pediatr Anesth 2012; 22: 136–143)

BARRIERS TO EEFECTIVE POST-OPERATIVE PAIN MANAGEMENT AT HOME

Following an adenotonsillectomy procedure, paediatric patients are plagued by extreme levels of pain for up to a week post-operatively. If left untreated, the incidence of morbidity is increased as there are disturbances in oral intake, sleep and behaviour. Dorkham MC et al (2013) conducted a study on effective post-operative pain management in children after ambulatory surgery, with a focus on tonsillectomy: barriers and possible solutions. They found these barriers to be: parental factors (ability to identify and assess child's pain, and misunderstandings about analgesic medication); child factors (refusing to take medication); medication factors (ineffective medication or insufficient formulation or dose of analgesics); and system factors (poor discharge instructions, difficulty obtaining medication and not enough information provided to families)[8, 13].

These barriers can be dealt with by patient and parental education, ensuring availability of adequate and appropriate treatment and improving discharge instructions and providing adequate information to the family.

Healthcare professionals should also address their knowledge deficits when it comes to children's pain management as they are responsible for communicating with the parents or caregivers.

MANAGEMENT OF ADENOTONSILLECTOMY PAIN

Pharmacological Management

Peri-operative analgesia

Pain control is important in the immediate postoperative phase to allow early return to eating and drinking, decrease the risk of post-operative bleeding and infection, and functional limitation [2, 7, 12].

The SASA South African Acute Pain Guidelines recommendations for tonsillectomy[14]:

1. A combination of individually titrated opioids and regularly administered mild analgesics (**a NSAID and/ a paracetamol**) is needed
2. **Local anaesthetic** injection in the tonsillar fossa may improve pain scores and reduce incidence of referred ear pain.
3. **Tramadol** produces similar analgesia to morphine or pethidine
4. **Ketamine** given intravenously intra-operatively, does not provide significant post-operative advantage, compared with an opioid.

Acceptable pain relief has been achieved with the implementation of standardised protocols which include intra-operative opioids ± an antiemetic, a perioperative NSAID (ibuprofen or diclofenac) and paracetamol. Low rates of nausea and vomiting have also attained.
Aspirin is not an acceptable choice of analgesia in children because of the risk of Reye syndrome.

NSAIDs

Nonsteroidal anti-inflammatory drugs (NSAIDs) inhibit the formation of inflammatory mediators, prostaglandins. By inhibiting the inflammatory cascade, NSAIDs suppress the inflammatory process.

NSAIDs are advantageous in that compared to opioids, they are non-sedating, do not depress respiration, cause nausea and vomiting or constipation. The disadvantage is that NSAIDs inhibit platelet aggregation, prolong bleeding time, causes renal impairment and peptic ulceration. [9, 14].

A *Cochrane* review in 2013,which reviewed 15 trials with +/- 1000 children and included randomized control trials assessing NSAIDs in children up to the age of 16 years old, undergoing elective tonsillectomies or adenoidectomy, showed that, with the exception of ketorolac, there is insufficient evidence that NSAIDs cause increased bleeding. They also found that the incidence of PONV was reduced when using NSAIDs as a pain relief regime, than when they were not used. Ketorolac has shown post tonsillectomy haemorrhage rates ranging from 4.4- 18% [9, 15-17].

In 2013, Riggin et al conducted an updated systemic review& meta-analysis of 36 randomized controlled trials. The objective was to compare bleeding rates and severity between patients receiving NSAIDs to those receiving a placebo or opioids for tonsillectomy surgery. The result showed that there was no increased risk of bleeding in adults or children, when NSAIDs are used in tonsillectomy surgery [18] .

Based on this evidence, the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) Clinical Practice Guideline, states that ibuprofen can be used safely for analgesia after adenotonsillar surgery. In the recovery phase, healthy children with no renal dysfunction, are prescribed oral ibuprofen at a dose of 10mg/kg 6 hourly to, be taken for 3-7 days post- operatively[2]. Diclofenac is administered at a dose of 1-3mg/kg per day in two or three divided doses.

Acetaminophen

Acetaminophen (paracetamol), is an active metabolite of phenacetin. It is an effective non-salicylate antipyretic, non-opioid analgesic with minimal anti-inflammatory properties. Its analgesic effect is mediated by increased descending serotonergic activity.

It can be administered either orally, intravenously or rectally. The advantage of administering paracetamol intravenously gives 100% bioavailability with rapid peak plasma levels, it avoids delays in absorption and has a predictable onset of action and has proven to be of use intra and post-operatively (in cases where oral intake has not yet been established). Oral paracetamol is not well tolerated after surgery due to the immediate inability to swallow adequately[2].

Intravenous acetaminophen was approved by the US Food and Drug Administration (FDA) in 2010, to be used in combination with opioid analgesics to treat pain and fever in patients from the age of 2 years and older [19].

Most reviews recommend the use of acetaminophen with or without ibuprofen as first-line post-operative analgesia. The risk of bleeding has not been seen in recent trials. Acetaminophen alone does not provide adequate analgesia. Previously, acetaminophen was used in combination with codeine, but the addition of codeine provided no added benefit [2, 19].

Rectal acetaminophen may be used in children if in the post-operative period, they are unable to tolerate oral intake.

The FDA reported multiple adverse events that occurred within the first 24 hours of administration of acetaminophen. Proper dosing in the paediatric population is important [19].

The current recommended doses are:

Oral and rectal

Children up to 12 years of age

- 10- 15mg/kg every 4-6 hours (maximum dose not to exceed 5 doses, or 50- 75mg/kg in 24 hours)

Children over the age of 12 years and adults

- 325mg -1000mg 3-4 times daily (maximum dose not to exceed 4g per in 24 hours)

Intravenous

Term neonates to infants up to 1 year old

- 7.5mg/kg (total daily dose is 30mg/kg/day)

Children from 1 year of age to 11 years of age (33 kg)

- 15mg/kg every 4-6 hours (not to exceed 60mg/kg/24 hours)

Children over the age of 12 years and adults

- 15mg/kg (maximum 1g 6 hourly for 24 hours)

Opioids

Satisfactory post –operative analgesia is achieved using opioids such as fentanyl and morphine, but as they carry the risk of excessive sedation, caution should be exercised in patients with obstructive sleep apnoea. Administration of morphine with acetaminophen results in respiratory depression and frequent desaturations [2, 19]. Opioids do provide better analgesia, but adverse effects such as PONV and aforementioned respiratory problems, means caution should be exercised when they are utilized.

Morphine

Morphine is a potent naturally occurring opioid produced from extracts of the poppy plant. It is a μ agonist, which binds to receptors in the brain, spinal cord and other tissues. It is known as the drug of choice for acute pain, but it may be unsafe in certain children.

A prospective randomized clinical trial conducted by Lauren E. Kelly in 2015, comparing morphine and ibuprofen for post-tonsillectomy analgesia, where 91 children aged 1- 10 years were recruited, found there were no differences in analgesic effectiveness, tonsillar bleeding or adverse drug reactions, but the frequency of desaturation events per hour were markedly increased. They suggested that the use of post-operative morphine should be limited in certain children undergoing adenotonsillectomy [16].

Fentanyl

Fentanyl, a medium acting opioid agonist, is often used as an intra-operative analgesic for severe pain at doses of 1- 2µg/kg.

In a randomized, double blinded study of remifentanil versus fentanyl for tonsillectomy and adenoidectomy surgery by Peter J. Davis et al, 9 patients had post-operative hypoxia (3 remifentanil, 6 fentanyl). 3 patients from the fentanyl group needed naloxone for respiratory depression. Patients from the remifentanil group were extubated earlier than those from the fentanyl group, but had significantly higher objective pain discomfort scores than the patients in the fentanyl group. They concluded that continuous infusions of remifentanil were as effective as a bolus of fentanyl, but due to the high incidence of post-operative pain experienced, remifentanil required optimization in order for it to be favoured as analgesic option in children[20].

In 2004, Ilan Keidan et al investigated intraoperative ketorolac as an effective substitute for fentanyl and found that the post –operative pain scores were equal and the use of ketorolac was not advantageous over the use of fentanyl in terms of reducing the incidence of PONV[21].

Pethidine

Pethidine was previously a widely used, affordable opioid, but is no longer used as a first-line analgesic as its analgesic efficacy is not superior to stronger opioids such as morphine. Its disadvantages include a short half-life (3-4 hours), a narrow therapeutic index and is vagolytic. The paediatric dose is 0.5- 2mg/kg 6- 8 hourly.

A study by Amir Hamza et al compared the efficacy of ketorolac and pethidine for post-operative pain relief in the first 24 hours after tonsillectomy showed that ketorolac provided the same analgesic effects as pethidine. Furthermore, the pethidine group had higher incidences of nausea and vomiting and respiratory adverse events such as respiratory depression and desaturation. Due to the potential hypoxia, they suggested caution be exercised when using opioids[22].

Codeine

Codeine, a weak opioid analgesic, was a widely used drug until numerous fatalities related to its use, made it fall out of favour.

It is extensively metabolised to morphine by the hepatic cytochrome p450 enzyme CYP2D6. There are four phenotypes for codeine metabolism: ultra-rapid (1%), extensive, intermediate and poor metabolizers (which make up 10% of the population) do not respond to the analgesic properties of codeine. In the general population, 10% of codeine is metabolized to morphine; in poor metabolizers, almost no morphine is produced. The varying polymorphism leads to inadequate analgesia or overdose [23, 24].

The US Food and Drug Administration added a black box warning to codeine, stating that it is contraindicated in children after adenotonsillectomy surgery. A number of paediatric institutions have removed codeine from their formulary following the vast number of reported fatalities[24].

Table 3: Codeine therapy recommendations based on CYP 2D6 phenotype [23]

Phenotype	**Implications for codeine metabolism**	**Recommendations for codeine therapy**	**Classification of recommendation for codeine therapy**
Ultrarapid metabolizer	Increased formation of morphine following codeine administration, leading to higher risk of toxicity	Avoid codeine use due to potential for toxicity. Consider alternative analgesics such as morphine or a non-opioid. Consider avoiding tramadol	Strong
Extensive metabolizer	Normal morphine Formation	Administer 4 hrly as needed for pain	Strong
Intermediate metabolizer	Reduced morphine Formation	Administer every 4 hrs as needed for pain.If no response, consider alternative analgesics such as morphine or a non-opioid. Monitor tramadol use for response.	Moderate
Poor metabolizer	Greatly reduced morphine formation following codeine administration, leading to insufficient pain relief	Avoid codeine use due to lack of efficacy. Consider alternative analgesics such as morphine or a non-opioid. Consider avoiding tramadol	Strong

Tramadol

Tramadol is a synthetic analogue of codeine and is a weak opioid. Compared to other opioids, it is known to have less abuse potential and less respiratory depression. The non-opioid component is mediated through alpha 2- agonist and serotonergic activity, which it exerts by inhibiting the re-uptake of norepinephrine and 5-hydroxytryptamine in the central nervous system. It undergoes hepatic metabolism into *O*-desmethyltramadol via the cytochrome P450 isoenzymes CYP2B6, CYP2D6 and CYP3A4. In patients with who are poor CYP2D6 metabolizers, as is the case with codeine, there is a reduced analgesic effect, but only a small percentage of tramadol is metabolized by CYP2D6, thus it is safer than codeine with regards to the risk of respiratory depression [24, 25].

Tramadol offers similar analgesic potential to morphine, but it is one tenth less potent. Studies have been conducted to assess its efficacy and safety for use in paediatrics and results have been favourable[3]. It is available as capsules (50mg), oral drops (20 drops= 50mg), ampules (100mg), dispersible (50mg) and sustained- release tablets (50, 100, 150 and 200mg), and suppositories (adult: 100mg up to 4 times daily; paediatric: 15, 30, 50mg).

Oxycodone

This is a semi-synthetic derivative of the opium alkaloid thebaine and is indicated for moderate to severe pain. It is a full opioid agonist and acts on the μ and κ receptors. Oxycodone is used to manage pain in adults, but its use in children has not been well investigated[2]. It would be an ideal choice of analgesia as it offers a favourable efficacy profile, less side effects than other opioids and only a small portion is metabolized via CYP2D6 pathway. The dose for oxycodone is 0.2mg/kg.

Ketamine

Ketamine is a non-competitive antagonist of NMDA receptors. Despite it being found to have opioid-sparing effects in adults, its efficacy in children is still controversial. In 2013, a randomized clinical trial by Eghbal M.H et al, involving 66 children aged 5 to 15years, undergoing adenotonsillectomy, was conducted. The aim of the study was to assess if ketamine improves postoperative pain and emergence after this surgical procedure. The results showed that an intravenous dose of ketamine (0.25mg/kg) given at induction of anaesthesia, reduced the need for rescue analgesia postoperatively and also decreased the incidence of emergence agitation[10].

A study in 2007 by Abu-Shahwan and Chowdary, reported than an intravenous injection of ketamine 0.25mg/kg 10minutes before the end of surgery, reduces the incidence of emergence phenomena in children who had been premedicated with midazolam for dental operations. Bameshki SA et al (2015) investigated the effects of ketamine on post-tonsillectomy sedation and pain relief. They took 50 children between the ages of 5 and 12 years who were due to undergo tonsillectomies, and divided them into two groups. The study groups received ketamine and midazolam, while thecontrol group only received midazolam. Pain scores were assessed using the Wong-Baker Faces Pain Rating scale and sedation was measured using the Riker Sedation-Agitation scale at the time of extubation, then at 5, 10, 15, and 30minutes and 1, 2 and 6 hours after surgery. Pain scores in the Ketamine-midazolam group were lower. They concluded that adding ketamine to midazolam reduces the incidence of agitation and post-operative pain [26, 27]. The conclusion is that ketamine (0.25 – 0.5mg/kg), improves postoperative pain and agitation following tonsillectomy surgery.

Adjuvant Analgesics

Dexamethasone

Several studies advocate administering a dose of dexamethasone to reduce pain. Dexamethasone, a synthetic glucocorticoid with a high potency that is well known for its anti-inflammatory effects, but also has the added advantage of being an effective analgesic with a long duration of action and an anti-emetic. In the paediatric population, PONV and pain are responsible for high hospital readmission rates, hence it is vital that they are managed adequately[9, 14, 28].

No consensus has been reached with regards to the dose, but 0.15- 1.0 mg/kg given intravenously, acts as a powerful analgesic especially if it given at induction of anaesthesia. A Cochrane meta-analysis showed that a single intravenous dose of dexamethasone was effective in reducing morbidity related to paediatric tonsillectomy.
*Perioperative glucocorticoids have fallen out of favour in UK, but are widely used in the United States of America.

Local anaesthetic infiltration

Lately there has been growing interest regarding the use of local anaesthetics infiltrated into the tonsil beds to decrease postoperative pain. Studies looked at the effect of injecting long- and short-acting local anaesthetics pre-, intra- and postoperatively into the tonsil beds. A systemic review of the literature by the Cochrane Institute (2013), suggested that there is no significant benefit from the use of these methods. They recommend that further studies be done[14, 17, 29].

In 2013, a double-blind prospective randomized clinical trial showed a substantial decrease in post-operative pain following peri-tonsillar infiltration of dexamethasone with a local anaesthetic such as levobupivocaine (which is more cardiac stable and more appropriate for use in children) compared to intravenous dexamethasone combined with peritonsillar infiltration of levobupivocaine alone [29].

Alpha 2- adrenoreceptor agonists

Clonidine (imidazole-receptor agonist) and dexmedetomidine have antinociceptive activity. They have synergistic interaction with opioids and have opioid sparing effects [1, 2, 30].Premedication with clonidine, has also shown to be beneficial in reducing the incidence of emergence agitation[30, 31]. Systemic administration of clonidine during tonsillectomy, has been shown to reduce post-operative pain. An editorial review of anaesthesia for tonsillectomy by Martin Johr, suggested using clonidine as a premedication to reduce agitation[31].

Dexmedetomidine is potent and has both sedative and analgesic properties. Its affinity for alpha receptors is 8 times that of clonidine. The primary analgesic effect is mediated via activation of the alpha-2 receptors on the dorsal horn of the spinal cord and by inhibition of substance P [1, 2, 32]. It is short acting and cardiovascularly stable and does not affect the respiratory system adversely. These properties make this a good analgesic adjuvant especially in patients with OSA. A single dose of dexmedetomidine (0.25- 0.5 mcg/kg) intra-operatively, reduces the incidence of emergence delirium, decreases intra- operative opioid requirements and improves pain scores. Although research is ongoing, this could prove invaluable in the anaesthetic management of adenotonsillectomies[2, 10, 32].

Gabapentin
Gabapentin is a structural analogue of GABA, with minimal drug interactions. It is rapidly absorbed orally, is excreted unchanged in urine and has an elimination half- life of 5- 7 hours. It is advantageous in that it is effective as a secondary analgesic, does not increase the incidence of nausea and vomiting, does not cause respiratory compromise and does not increase post-operative bleeding.

A randomised control trial is being conducted at the University of British Columbia. The aim is to prove whether or not a single dose of Gabapentin administered pre-operatively, will decrease post- tonsillectomy pain and subsequent morphine requirements in children. The results have not yet been published. They expect lower pain scores in the Gabapentin group[33].

Ondansetron
The incidence of PONV following paediatric adenotonsillectomy ranges from 23- 73%. It may be considered to be a minor post-operative complication, but it can drastically affect the recovery period. PONV can be distressing for any individual and can result in bleeding, dehydration, electrolyte and acid-base imbalance. If vomiting persists, the results of the adenotonsillectomy can be affected and the risk of aspiration increases. All these factors can ultimately lead to a prolonged stay in hospital [4, 5, 9].

Ondansetron is a selective 5-HT3 receptor antagonist and a potent antiemetic. It is administered at a dose of 0.1mg/ kg (up to 8mg 8 hourly) usually in combination with dexamethasone.The FDA did, however, put a black box warning on this drug as it may cause prolonged QT[5].

Non- pharmacological management

Honey and pain control[34]
In an attempt to manage post tonsillectomy pain with less analgesics, honey was investigated as an alternative. Honey has been utilised for many years for wound healing. Ancient Egyptians even used honey to treat conjunctival and corneal inflammation and burns. Some countries still use it to treat burns, apply to split thickness graft donor site, necrotizing fasciitis, pressure wounds, gangrene, corneal lesions and infected diabetic wounds.

The mechanism of action being that honey hastens the healing process by stimulating the production of inflammatory cytokines from monocytes and keratinocytes. The monocytes then secrete interleukins and tumour necrosis factor-alpha. Stimulation of these mediators aids in tissue repair and healing.

In the Honey Study, a randomized, double blind placebo-controlled clinical trial, oral honey was given to patients post tonsillectomy and was shown to reduce the need for analgesics in children.

Table 4. Pain scores of groups in the 1st, 2nd and 3rd day after tonsillectomy

Group	First day		Second day		Third day	
	Pain score	P value	Pain score	P value	Pain score	P value
Placebo	5.4±0.56	<0.001 *	4.6±0.49	<0.001 *	3.8±0.47	<0.01 *
Honey	3.8±0.69	<0.001 *	3.2±0.43	<0.001 *	2.6±0.42	<0.01 *

*p <0.05

Table 5. Number of painkillers taken after tonsillectomy

	First day		Second day		Third day		Fourth day		Fifth day	
	Painkiller	P value	Painkiller	P value	Painkiller	P value	Painkiller	P value	Painkiller	P value
Placebo	3.52±1.6	<0.01 *	3±1.12	<0.01	2.58±1.09	<0.01	1.81± 1.14	<0.04	1.15± 0.99	<0.01
Honey	1.81± 1.16	<0.01 *	1.5± 1.05	<0.01	1.15± 0.95	<0.01	0,61 ± 0.77	<0.04	0.21± 0.45	<0.01

*p <0.05

Cold treatment

Rinsing the tonsillar fossa with physiological saline at 4 degrees for 10minutes, significantly reduced immediate post-operative pain. Ice packs and ice lollies work by the same mechanism. A prospective, randomised single-blinded study consisting of two groups was conducted by Sylvester DC et al in 2011. The children that were recruited were between the ages of 2-12. Their evidence showed that the pain scores in the group that received ice-lollies post-operatively, were lower. Ice lollies are thus a cheap, effective& safe technique of decreasing post-operative pain for up to 1 hour following adenotonsillectomy.

Parental involvement

Children who were allowed early contact with a parent in the recovery area, were calmer and had better pain scores than those children whose parents were not present post-operatively. Their recovery time was somewhat reduced[8].

Parental involvement also facilitates education and counselling about post-operative management for the children [6, 8]. Alternative methods by parents were holding their child on their lap, spending more time with the child than usual, cuddling the child, limiting their playing to games that would not overexcite them and keeping them in the house and reading to them[35].

OBSTRUCTIVE SLEEP APNOEA [2, 4, 9, 10, 14, 31]

Obstructive sleep apnoea (OSA) is a severe form of sleep-disordered breathing (SDB). It is characterised by an abnormal respiratory pattern during sleep that includes snoring, mouth breathing, and pauses in breathing. The episodic partial or complete obstruction of the upper airway during sleep causes apnoea or cessation of breathing. Intermittent episodes of brief cessation of breathing can be physiological. Apnoea is defined in adults as cessation of breathing for ten seconds or more. Six seconds or more may be pathological in children.

The spectrum of SDB ranges from snoring (10%), upper airway resistance syndrome, obstructive hypoventilation, the extreme being obstructive sleep apnoea (1–3% of the paediatric population). OSA has a prevalence of approximately 2% in the paediatric population and is more common in African children. Sleep disordered breathing can affect children of all ages but its peak incidence is between the ages of three and seven, when the adenoid and tonsillar lymphoid tissue is disproportionately large relative to the pharyngeal airway. There is an equal incidence in boys and girls, but it presents earlier in boys.

Childhood OSA is currently classified into types I (tonsillar hyperplasia without obesity) and II (concurrent obesity, resembling the adult form). About 50% of children with OSA have type II.

Table 6

Risk factors for developing childhood OSA[10]

- ***** Tonsillar and adenoid hypertrophy
- ***** Upper airway obstruction from adenotonsillar hyperplasia
- ***** Ethnicity (more common in Afro-Caribbean/ African Americans)
- ***** Respiratory disease
    - * Asthma
    - * Sinus problems
- ***** Day care exposure and frequent URTIs
- ***** Obesity (25–40% SDB; also more severe and more postoperative complications)
- ***** Former prematurity
- ***** Craniofacial disorders
- ***** Neuromuscular disorders
    - * Cerebral palsy
- ***** Chromosomal abnormalities
    - * Down syndrome
    - * Prader-Willi syndrome
- ***** Family history of OSA

Anaesthetic considerations for children with OSA [2, 10, 31]

Preoperative assessment (to be done in a pre-anaesthetic assessment clinic)

1. Sleep is disrupted by upper airway obstructions. Reduction in pulmonary ventilation and can lead to hypoxaemia and hypercarbia, which lead to arousals.
2. Increased risk of postoperative respiratory complications.
    - Reduced ventilatory response to increased arterial carbon dioxide tensions, which is worsened by general anaesthesia. They are at risk of more frequent episodes of obstruction post operatively.
    - Increased sensitivity to opioids, therefore restrict the dose to half the recommended dosage in patients with OSA.
3. Neurological complications include behavioural problems and learning difficulties. These patients are difficult to manage pre- and postoperatively.
4. Identify OSA on history and examination and assess severity .Evaluate whether or not:
    - the patients can be anaesthetized as a day case procedure and
    - they need further cardio-respiratory assessment preoperatively.
    - avoid sedative premedication

Intraoperative management

- Inhalational induction increase the risk of upper airway obstruction
- There is currently no evidence that advocates the use of an endotracheal tube over a laryngeal airway device
- Aim for an awake extubation using a nasal airway, if possible
- Opioid sensitive and can result in post-operative upper airway obstruction and hypoxia

Postoperative management

- High risk of postoperative respiratory complications

RECOMMENDATIONS FOR ADENOTONSILLECTOMY PAIN CONTROL

Table 7

Normal /mild OSA	**Moderate-severe OSA**
Intra-operatively	*Intra-operatively*
IV Morphine 0.1-0.2mcg/kg	IV Fentanyl 1-2mcg/kg
IV Paracetamol 15mg/kg	IV Ketamine 0.25-0.5mg/kg
	IV Paracetamol 15mg/kg
IV Dexamethasone 0.15mg/kg	IV Dexamethasone 0.15mg/kg
IV Ondansetron 0.1mg/kg	IV Ondansetron 0.1mg
Post operatively	*Post operatively*
**Oral ibuprofen 5-10mg/kg 6hrly for 3- 7/7	**Oral ibuprofen 5-10mg/kg 6hrly for 3-7/7
**Paracetamol 10- 15mg/kg 6hrly	**Paracetamol 10-15mg/kg 8hrly

****** A recent paediatric study by Liu C and Ulualp SO in 2015, that looked at the outcomes of alternating ibuprofen and acetaminophen for pain relief after tonsillectomy in children, suggested using alternating doses of Ibuprofen 5mg/kg 6hourly (not to exceed 2.4g/d) and acetaminophen 10mg/kg (not to exceed 4g/d) for effective pain control with no increase in post-operative bleeding.

As mentioned earlier, non-pharmacological management is also key to expedite post-operative recovery.

CONCLUSION

Adenotonsillectomy is a common surgical procedure performed worldwide, more frequently in the paediatric population. Pain has been found to be one of the most common medical causes of delayed discharge after ambulatory surgery, followed closely by drowsiness, and nausea and vomiting. There are various surgical techniques, including electrocautery which is associated with more post-operative pain.

An aesthetic pre-assessment of a patient due for surgery includes evaluating if a patient is at risk for obstructive sleep apnoea, which will impact on the analgesic management peri-operatively and will alert the physician to take precautionary measures to prevent post-operative respiratory complications.

Multimodal analgesia is an effective strategy which may result in fewer side effects of sedations, nausea, vomiting, pruritis and improved pain relief. It also has an opioid sparing effect.

Numerous deterrents have been identified that contribute to the delay in recovery of children post tonsillectomy. These barriers can be overcome by educational strategies, improved availability of information and improved access to appropriate analgesia.

Multiple studies have been conducted and after evaluating the research, it would seem that for a safe anaesthetic, a multimodal approach would be a combination of acetaminophen administered intravenously with a dose of an NSAID intra- operatively, with the aim to discharge the patient with oral NSAIDs for up to 7 days. Opioids are very effective, but can lead to complications secondary to their sedative effects and should be used sparingly (more especially in the OSA group) in small boluses. Dexamethasone given at the start of surgery has a dual purpose: it reduces post-operative pain and decreases the chances of PONV. Adequate pain control is essential and reduces complications and hospital stay.

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