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# Health and well-being of children and young adults in relation to surgery of the tonsils

Elisabeth Ericsson



**Linköping University**  
FACULTY OF HEALTH SCIENCES

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Department of Neuroscience and Locomotion  
Division of Otorhinolaryngology  
Faculty of Health Sciences, Linköping University  
SE-581 85 Linköping, Sweden

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*To my daughters Sarah and Christina*



# ABSTRACT

Tonsillectomy is one of the most frequently performed surgical procedures in children and youths. The aim of this thesis was to study children and youths in relation to tonsil surgery with the goal of improving the care, and to describe partial tonsillectomy/tonsillotomy (TT) using radiofrequency technique (RF) (Ellman International) in comparison with the more commonly used total tonsillectomy (TE).

The thesis covers studies of two age-groups with obstructive problems, with or without recurrent tonsillitis. Randomization to surgery was done from the existing waiting list; 92 children, 5-15 years old to 49/TT and 43/TE, (I-III) and 76 youths, 16-25 years old to 32/TT and 44/TE (IV-V).

The first purpose (I, IV) was to compare the two surgical techniques with respect to pain and postoperative morbidity. Pain measures were for the children the Face Pain Scale and for the youths and parents and staff a verbal-pain-rating-scale. From the first day, the TT-groups scored significantly less pain than the TE-groups. The doses of pain-killing drugs (paracetamol and diclofenac) taken were significantly less for the children and youths receiving the TT-surgery, they could stop taking pain-killers sooner, and were back to normal activity three (5-15yrs) or four (16-25yrs) days earlier compared with TE-groups.

Paper II focused on the child's behavior (Child Behavior Checklist/CBCL), experience of pain, anxiety (State-Trait-Anxiety Inventory for Children /STAIC), previous experiences of surgery/tonsillitis, and the management of pain. The children scored higher on CBCL than a normative group before surgery, but no connection was observed between CBCL rating and experience of pain reported post surgically. There was no relation between preoperative anxiety and reported pain, but the postoperative anxiety level correlated with pain. The TE-group scored higher anxiety after surgery. Previous experience of surgery or tonsillitis did not influence the postoperative pain. The nurses scored pain lower than the parents/children and under-medicated.

The second purpose was to compare the long-term effects of TT and TE-surgery after one and three years (5-15yrs) and one year (16-25yrs) (III, IV). The effect on snoring was the same for both TT and TE-groups and the rate of recurrence of throat infections was low after both surgical techniques.

After one year, all children (TT/TE) showed improvements on CBCL to the same degree and there was no longer a difference between total behavior and normative values. They also scored improvements in health-related quality of life (HRQL) with Glasgow-Children-Benefit-Inventory.

For both TT and TE, the older group reported lower HRQL preoperatively on all dimensions of Study-Short-Form (SF-36) compared with a normal population. After one year, a large improvement was found in HRQL in both groups and there were no differences compared with a normal population.

**Conclusion:** Preoperative obstructive problems, in combination with recurrent tonsillitis have a negative impact on HRQL. Both after TE and TT there are large improvements in HRQL, infections, obstructive, and behavior problems one to three years after surgery, indicating that both surgical methods are equally effective. With fewer postoperative complications, less pain, shorter recovery time, and lower cost, TT with RF should be considered as method of choice.

## LIST OF ORIGINAL PAPERS

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals I - V.

- I. Hultcrantz E. & Ericsson E. 2004. Pediatric Tonsillotomy with Radiofrequency Technique: Less Morbidity and Pain. *The Laryngoscope*, 114;869-875.
- II. Ericsson E, Wadsby M, Hultcrantz E. 2006. Pre-surgical Child Behavior Ratings and Pain Management after Two Different Techniques of Tonsil Surgery. *International Journal of Pediatric Otorhinolaryngology*. 70;1749-1758.
- III. Ericsson E, Graf J, Hultcrantz E. 2006. Pediatric Tonsillotomy with the Radiofrequency Technique – Long-term Follow-up. *The Laryngoscope*.116;1851-1857.
- IV. Ericsson E, Hultcrantz E. 2007. Tonsil Surgery in Youths – Good Results with Less Invasive Method. *The Laryngoscope*.117; 654-660.
- V. Ericsson E, Ledin T, Hultcrantz E. 2007. Health-Related Quality of Life improvements after Tonsillotomy (RF) and Tonsilleectomy in young people – One-year Follow-up. Accepted for publication in the *Laryngoscope*.

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Paper I-V

## ABBREVIATIONS

BWT	Body Weight
CBCL	Child Behavior Check List
ENT	Ear, Nose and Throat
EQ-VAS	EuroQol -Visual Analog Scale
FPS	Face Pain Scales
GCBi	Glasgow Children's Benefit Inventory
HRQL	Health-Related Quality of Life
IASP	International Association for the Study of Pain
NSAID(s)	Non Steroid Anti Inflammatory Drug(s)
OSA(s)	Obstructive sleep apnea (syndrome)
PONV	Postoperative Nausea and Vomiting
PRN	Pro re nata, the Latin term for "As the situation arises".
Qu	Questionnaire (1,2) in the studies
RF	Radiofrequency surgery
SD	Standard Deviation
SDB	Sleep Disordered Breathing
SF-36	Study 36-Item Short Form Health Survey
STAIC	State-Trait Anxiety Inventory for Children
T&A	Tonsillectomy and Adenoidectomy
TE	Tonsillectomy
TT	Tonsillotomy
UARS	Upper Airway Resistance Syndrome
URI	Upper Respiratory Infection
VPRS	Verbal Pain Rating Scale

## DESCRIPTION OF CONTRIBUTION

### Paper I

Study design	Hultcrantz E, Ericsson E
Data collection	Ericsson E
Data analysis	Ericsson E
Manuscript writing	Ericsson E, Hultcrantz E
Manuscript revision	Hultcrantz E

### Paper II

Study design	Ericsson E
Data collection	Ericsson E
Data analysis	Ericsson E
Manuscript writing	Ericsson E, Wadsby M
Manuscript revision	Wadsby M, Hultcrantz E

### Paper III

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Manuscript writing	Ericsson E, Graf J
Manuscript revision	Hultcrantz E

### Paper IV

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Data collection	Ericsson E
Data analysis	Ericsson E
Manuscript writing	Ericsson E, Hultcrantz E
Manuscript revision	Hultcrantz E

### Paper V

Study design	Ericsson E,
Data collection	Ericsson E
Data analysis	Ericsson E
Manuscript writing	Ericsson E
Manuscript revision	Ledin T, Hultcrantz E

# INTRODUCTION

Tonsillectomy (TE) with or without adenoidectomy is one of the most common surgical procedures performed world wide in children and young adults. The indications are recurrent tonsillar infection or obstruction of the airway. In Sweden, about 6000 individuals were tonsillectomized during 2004, 60% in the age group 5-15 years and 26% in the age group 16-25 years<sup>1</sup>.

During the last 20 years, a significant number of investigations of tonsil surgery have focused on decreasing the duration of surgery, collateral tissue damage, peri- and postoperative pain and recovery time<sup>2</sup>. Total TE, which still is the most commonly used technique, has a high morbidity (pain, bleeding, nausea, vomiting and dehydration), associated with the recovery period (lasting up to 2 weeks)<sup>3-5</sup>. Postoperative pain remains the major side-effect of the operation. Surgeons and anesthesiologists have searched for methods or medication that will reduce peri- and postoperative morbidity<sup>6</sup>.

Several techniques, mostly based on electrosurgery, have been developed as alternatives to traditional blunt dissection. They all seem to work well for the removal of the tonsils and result in less postoperative bleeding, but they do not greatly reduce the postoperative pain<sup>2,7-16</sup>. However, if a partial intracapsular tonsillectomy (tonsillotomy/-TT) is performed, postoperative morbidity is decreased to a remarkably extent<sup>3,17,18</sup>.

Paracetamol is the mainstay of pain treatment for patients undergoing TE even today, despite the fact that paracetamol alone is insufficient<sup>19</sup> and that the commonly used doses of paracetamol are too low<sup>20-22</sup>. Using paracetamol in combination with NSAIDs appears to be helpful in reducing pain, but is still controversial regarding effects on bleeding<sup>22,23</sup>.

Pain in children is underestimated<sup>24,25</sup>, and may be inadequately treated in the hospital and at home after tonsillectomy<sup>26-28</sup>. Although surgery, stress and pain may have negative effects, pain is a risk factor and has a strong correlation with problematic behavior<sup>29,30</sup>. Children develop behavioral stress and anxiety before surgery and this seems to be a factor for later behavioral problems (e.g. sleeping problems, anxiety, nightmares, eating problems)<sup>31-33</sup> which can have an impact on postoperative recovery. In adults, there is a relationship between preoperative anxiety and postoperative outcomes such as experienced pain, use of analgesics and return to normal activities<sup>33-37</sup>.

For children under ten years of age, the most common indication for tonsil surgery is sleep-disordered breathing (SDB), but many children also have several tonsillitis episodes. In young adults, recurrent infections constitute the main indication for surgery and the indication is only rarely based solely on tonsillar hypertrophy with obstructive symptoms. Infections causing repeated absences from school and academic studies may put a young person's future at risk by impeding academic results in high school, college and accomplishment in work and social life.

According to the most recent Cochrane review<sup>38</sup>, the long-term effects on infections after "adult" tonsillectomy have not yet been established. Patients with throat obstructivity and/or recurrent throat infections may have varying symptoms. Those symptoms may have different impacts on patients' lives in terms of health related quality of life (HRQL). Sore throats result in health care visits, the use of oral antibiotics and days off from school or work for many patients. Obstructive problems (long-lasting snoring, difficulty in breathing during sleep, sleep-apnea) have been associated with several health-related consequences. Children and youths can display "daytime behavior changes" such as social withdrawal, hyperactivity, rebellious behavior, aggressiveness, and some research has even linked it to ADHD<sup>39-42</sup>. Daytime sleepiness may impair a person's ability to study, since being tired and fatigued during the day may lead to learning difficulties and to more frequent use of health care services<sup>42,43</sup>.

An improved quality of life has been shown after TE for sleep disorders as well as for those who have had recurrent infections. Recently, much has been written on the benefit of TE and adenoidectomy with respect to improvement of a patient's quality of life as well as an improvement in a child's behavior after TE<sup>44-50</sup>.

Today, the socio-economic aspects of different surgery options are becoming more and more important. Several studies have demonstrated that the technique of TT, compared to TE may decrease the period and level of postoperative pain, the risk for postoperative hemorrhage, and allowing for a quicker return to normal activity and diet<sup>51</sup>. These circumstances minimize the costs for TT and are an important advantage compared to TE. Another way to implement the effectiveness of a surgical method is to evaluate the benefit on the pre-surgical symptoms and the HRQL.

# BACKGROUND

## *Historical Background*

Tonsillectomy procedures are among the oldest operations still existing. Celsus, in Rome (about 40 AD), described the blunt removal of the tonsils by use of the finger. He recommended removing only a portion of the tonsil, recognizing that any attempt to take the entire tonsil might result in uncontrollable hemorrhage.

A device developed in 1828 by Physick, the tonsillotome or tonsil guillotine, gained considerable popularity and was modified many times over the next 100 years. The tonsil "guillotine" allowed tonsillar operations to be performed with increasing speed and frequency, which was important in a time without anesthesia. In 1917, Crowe refined tonsillectomy to sharp dissection by addressing potential risks preoperatively, improving the surgical technique addressing anesthetic concerns and recommending patient discharge from hospital first when all postoperative complications had been resolved. TE quickly evolved into one of the most common surgical procedures performed. In the 1930s and 1940s, the excitement began to wane, as new studies showed a natural decline in the incidence of upper respiratory infection (URI) in children after the first few years in school and also because antimicrobial agents became available. The frequency of TE procedures has been reduced drastically since the advent of antibiotics<sup>52-54</sup>.

The common indication for tonsil surgery in the past was infections. The most common indication for tonsil surgery now is obstructive problems due to hypertrophic lymphoid tissue. In the last 10 years, partial tonsillectomy, or tonsillotomy (TT) for obstructive symptoms, has reappeared in the medical literature in connection with the introduction of new instruments/techniques. Historical experience suggests a lack of consistent precision with older instruments, which may be avoided with the use of new techniques<sup>54,55</sup>.

## *Anatomical Background*

Palatine tonsils are structures derived from the 2nd branchial pouch. The first appearance of the palatine tonsils occurs at about the 14<sup>th</sup>-15<sup>th</sup> of gestation by the development of invaginations of the epithelium in the underlying mesenchymal cells and infiltration of the stroma by lymphoid cells<sup>56</sup>.

The lateral palatine tonsils (in this thesis "the tonsils"), (Fig.1), nasopharyngeal tonsil (adenoids), (Fig.1) and the anterior portion of the lingual tonsils form the ring of lymphoid tissue in the upper part of the pharynx called Waldeyer's Ring<sup>57</sup>.

The lymphatic tissue of Waldeyer's pharyngeal ring is a specific part of the mucosa-associated lymphoid tissue (MALT), consisting of immunocompetent cells (especially rich in antibody-producing B-cells arranged in lymphoid follicles). These lymphoid tissues are thought to be part of the immune system helping to fight infections involved in the defense of the upper airways (by trapping microbial pathogens entering through the mouth and nose)<sup>58-61</sup>. After birth, the tonsils are one of the first organs to react to external antigenic stimuli through respiration and deglutition<sup>56</sup>.

The nerve supply (to the tonsils) is mediated by the tonsillar branches of the glossopharyngeal nerve at the lower pole of the tonsil and through the descending branches of the lesser palatine nerves, which pass through the sphenopalatine ganglion.

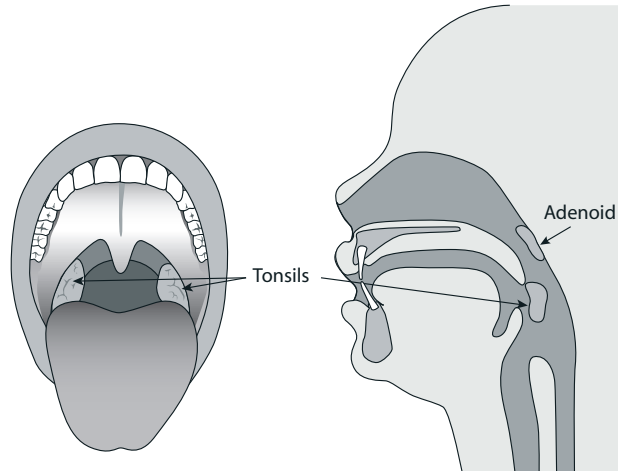
The majority of the blood supply to the tonsils is provided by the tonsillar branch of the facial artery. The ascending pharyngeal, descending palatine and the dorsal lingual branch of the lingual artery also contribute.

The adenoid tissue (i.e., nasopharyngeal tonsils) is situated on the posterior wall of the nasopharynx immediately inferior to the rostrum of the sphenoid<sup>58-61</sup>.

The immunologic importance of the adenoids is greatest during the preschool years, since the adenoid tissue grows during this period and thereafter undergoes an age-related involution resulting in a gradual decrease in size<sup>62</sup>. In adults only small remnants of lymphoid tissue are seen in the nasopharynx.

There is a physiological hypertrophy of adenoids and tonsils during development which also affects systemic immunity, both through initiation of antibody production and activation of T-cells<sup>60,61,63</sup>. The immunological function of the adenoids and tonsils and the possible effects of their removal is still controversial. There are few long-term follow-up studies of the possible alteration in the cellular or humoral immune system after TE<sup>64</sup>.

Parental TE history has been reported to have a significant influence on the decision to tonsil surgery in children, and the children who are operated on have also reported more sore throats and tonsillitis than children of parents who had not undergone TE<sup>65,66</sup>.



*Fig. 1. The tonsils and the adenoid*

## Health before surgery

The indications for TE are recurrent tonsillitis, peritonsillar abscess, chronic tonsillitis or tonsillar hypertrophy resulting in upper airway obstructions. Other indications for surgical removal of the tonsils and/or the adenoids include cor pulmonale (i.e., secondary to adenotonsillar hypertrophy), dysphagia with ingestion of solid food, speech abnormalities, orthodontic aberrations, and suspicion of malignancy<sup>52,55,64,67</sup>.

### *Tonsillitis*

The efficiency of TE for treatment of recurrent infections or chronic tonsillitis was shown by Paradise et al.<sup>68</sup>. They found that if a child undergoes TE, there is a fifty percent chance of not having another “sore throat” in the first postoperative year. If surgery is not performed, there is a ninety percent chance of one or more such episodes. They also observed that a substantial proportion of subjects who did not undergo TE had a relatively low incidence of subsequent throat infection<sup>68</sup>. Thus, the ultimate effects of the procedure are still uncertain<sup>38,69,70</sup>.

### *Obstruction*

Snoring is a common symptom in patients with sleep-disordered-breathing (SDB) that includes primary snoring (PS), upper airway resistance syndrome (UARS), obstructive hypoventilation, and obstructive sleep apnea (OSA). The SDB symptoms include oral breathing, long-lasting snoring, sleep-apnea, difficulty in breathing, restless sleep, frequent awakening, failure to

thrive, enuresis, abnormal bite, and behavior disturbances<sup>65,71-73</sup>.

Primary snoring refers to snoring with no evidence of disturbed alveolar ventilation or the sleep architecture. UARS is characterized by increased respiratory effort and sleep fragmentation without episodes of hyponea or apnea. Obstructive sleep apnea (OSA) is characterized by repeated episodes of upper airway occlusion during sleep<sup>71,74,75</sup>. Primary snoring, UARS, obstructive hypoventilation, and OSA are suggested to represent phenomena of different severity in a continuum, with primary snoring on one end and OSA on the other. There is a great deal of symptom overlap between these four entities. One patient could exhibit all four phenomena<sup>74</sup>.

The present thesis includes children and young adults from existing waiting lists for tonsil surgery, who had not had preoperative sleep registration (i.e., polysomnography/PSG).

### *Consequences*

SDB has been associated with several health-related consequences. Children and youths can display “daytime behavioral changes” such as social withdrawal, inattentiveness, hyperactivity, rebellious behavior, or aggressiveness, some may even be linked to ADHD. Primary and secondary enuresis is common among children with SDB and, in small children, a noticeable “failure to thrive<sup>39-42,76</sup>”. In extreme cases of SDB in children, cor pulmonale and pulmonary hypertension may be presenting problems. Daytime sleepiness may impair a person’s ability to study because of fatigue and sleepiness during the day, leading to learning difficulties and to a more frequent use of health care services<sup>42,43,77-83</sup>. Morning headache is often associated with moderate to severe OSA<sup>74</sup>. Parents of children with OSA are concerned about the sleeping problems with regard to school performance and overall growth and development, even to the point of being fearful for the child’s life.

Sore throats result in health care visits, the use of oral antibiotics, and days off from school or work for many patients. Parents of children with recurrent tonsillitis tend mainly to be worried about performance issues due to missed school days and missed work days when they had to care for the child at home<sup>84</sup>.

Another way to measure the consequences of tonsil problems is to evaluate the effects on general quality of life. Quality of life is a subjective, multidimensional concept that varies with time. It contains various spectra of life such as finance, work, freedom, as well as physical, psychological,

and social health. When evaluating quality of life from a health perspective, the term health-related quality of life HRQL originates from the World Health Organization's (WHO) widely accepted definition of health. It states that "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" and as "the individual's perception on their position in the life, in the context of the culture and value systems in which they live, and in relation to their goal expectations, standards, and concern<sup>85</sup>. The interest in measuring HRQL is growing, and constitutes the end point in clinical trials.

Several studies have determined the impact on HRQL in children and adults with SDB before TE using general quality of life as well as disease-specific instrument measures<sup>44-46,86</sup>. Children with diseased tonsils had significantly poorer HRQL than healthy children; in addition, the general health perception of children with tonsil and adenoid disease, is similar to the perception of children with asthma and juvenile rheumatoid arthritis<sup>87</sup>. Today in Sweden, we have no validated specific measuring instrument translated for assessing HRQL in children with OSA and tonsil disease before and after surgery.

In youths and adults, clinical studies have been focused on the effectiveness of TE, and most authors have examined only changes in objective measures of health status, such as the disease-impact data (the health care visits, treatment used, work-days missed) or the number of episodes of tonsillitis<sup>47,48</sup>. There are no data on the HRQL or health status impact in youths and adults with obstructivity and recurrent tonsillitis that enable comparisons with the general population. Neither are there any longitudinal studies after TE on the impact of HRQL before TT/TE and follow-up with the same instrument.

## **Well-being in the context of surgery**

### ***Preoperative Anxiety***

Preoperative anxiety in connection with surgery is common. Variables such as situational anxiety of the mother, temperament of the child, age of the child, and the quality of previous medical encounters all may predict a child's preoperative anxiety<sup>32,88</sup>.

Preoperative psychological conditions may also influence the prevalence of preoperative anxiety and postoperative pain. It has been observed that forty to sixty percent of children exhibit psychological or physiological manifestations of anxiety in the perioperative period, and preoperative anxiety is associated with postoperative behavioral problems<sup>30,89,90</sup>.

Anxiety seems to be associated with pain<sup>91</sup>. Previous experience is another variable to be considered since negative experiences can influence the next health care visit, which can be associated with more anxiety and with more problematic behavior<sup>30,32,88,92,93</sup>.

### *Preoperative preparation*

Changes in caretaking procedures and policies have created an environment that is increasingly supportive of children and families. Liberal visiting policies, parental rooming-in and structured preparation for the procedures are now almost a routine<sup>94</sup>.

In recent decades, many intervention programs have been described in the literatures that are designed to prevent or reduce children/youth anxiety and distress in the hospital environment. Surgery is stressful for children of all ages and their parents. There are several methods such as photo-albums, hospital tours, play therapy, and filmed modeling that can be utilized to decrease the anxiety associated with these potentially threatening events. The health personnel, mostly the nurses are responsible for working with each family to plan and to implement the type of preparation needed to prevent emotional and behavioral problems, and to help the child and parents to cope with the stress and management of the pain related to the surgery<sup>90,95-99</sup>.

The postoperative instructions are best given in both verbal and written form prior to the day of the child's surgery, to avoid the need to stop on the way home to buy pain medication<sup>100-103</sup>. On the day of surgery, many parents are not in a condition that favors reception and retention of information about postoperative care because of their own anxiety, fatigue and hunger during the day of the child's surgery<sup>102,104,105</sup>.

### *Fasting guidelines in children*

Liberal preoperative fasting guidelines have been implemented in most countries<sup>106,107</sup>. Brady et al.<sup>108</sup> concluded in a Cochrane review that there was no evidence that healthy children who are not permitted oral fluids for more than 6 hrs preoperatively benefit in terms of intraoperative gastric volume and pH compared with children permitted unlimited fluid up to two hours preoperatively. Children who are permitted clear fluids up to 2 hrs prior to anesthesia have more comfortable preoperative experiences in terms of thirst and hunger (light meals 6 hrs prior anesthesia)<sup>106,107</sup>. Long waiting periods on the day of surgery between being admitted to the time of operation are found to be very unpleasant with regard both anxiety and thirst/hunger<sup>109</sup>.

### *Premedication*

A good psychological preparation programme compares favorably with sedative premedication<sup>95</sup>. The most commonly used premedication is midazolam to decrease the child's preoperative anxiety, induce amnesia and to attenuate problematic behavior after hospitalization<sup>110-113</sup>. However, it is not always beneficial in combination with sedation; this disadvantage should be considered. Some children have negative reactions (e.g. violent behavior, physical assault)<sup>114</sup>, and using midazolam can increase later behavioral problems<sup>115</sup>. If the amnesia is not 100%, memories can still be present<sup>116</sup>.

One effective treatment of pain is to start preoperatively with paracetamol<sup>22,117,118</sup>. This practice is based on the assumption that administration of an analgesic drug before nociceptive input can prevent sensitization and thus ameliorate postoperative analgesia<sup>23</sup>. In most cases, paracetamol should be given before surgery and preferably orally.

Several studies have explored the benefits of parental presence during induction of anesthesia to decrease the child's anxiety, and these studies have shown mixed results. Parental anxiety was noted to be a significant predictor of child anxiety. Parents who were highly anxious increased their child's anxiety. Preoperative parental anxiety levels also correlated with the child's fears and behavior one week after surgery<sup>119-123</sup>. With proper preparation, parents should be encouraged to be present during the induction of general anesthesia. In Sweden, the routine is mostly to allow the presence of one of the parents during the induction of anesthesia to make the child less anxious.

### *Anaesthesia*

Today, all tonsillectomies in children is performed under various anesthesia techniques, inhalational or intravenous induction, continued with balanced inhalational anesthesia or total intravenous anesthesia. In tonsil surgery orotracheal intubation is used in a majority of the patients. A tendency to use a laryngeal airway mask is also becoming more common. All patients enrolled in the present studies were anesthetised using orotracheal intubation according to the hospital routines.

The routine for the most pediatric anesthesia wards in Scandinavia is to insert an intravenous needle/IV prior to induction (after 60-90 min application of local anesthesia, EMLA®). If that is not possible, or if the child will not accept IV needle insertion (mostly younger children), inhalation induction with a mask is used with sevoflurane, oxygen and nitrous-oxide. This requires noninvasive blood pressure measurement and monitoring

pulse oximetry, fractional inspired oxygen, and end-tidal carbon dioxide. Inhalational induction with sevoflurane, which is a volatile agent well suited for induction, is well accepted by children, and gives faster induction as well as recovery than halothane<sup>124-126</sup>. Incidence of dysrhythmia is markedly reduced with sevoflurane compared to halothane, and thus, sevoflurane is becoming the first choice agent for ENT surgery in children. Excitement is not uncommon during induction of anesthesia<sup>124</sup>, and addition of nitrous oxide tends to reduce the incidence<sup>127</sup>.

## **Surgical techniques for tonsil surgery**

Over the years, several techniques and instruments have been developed or refined for the surgeon's armamentarium in performing tonsil surgery. The surgical method can be performed either "cold" with blunt dissection or with the aid of a microdebrider or with hot energy tools (cautery, electro-surgical, radiosurgical or laser devices). Table I, illustrates an overview of tonsil-surgical techniques.

### ***Tonsillectomy/TE***

The standard (total) tonsillectomy technique removes the entire tonsil, including its associated capsule. This procedure involves grasping all of the tonsil, pulling it toward the midline, incising the mucous membrane, identifying the tonsillar capsule, dissection along it, snaring the base of the tonsil, and removing the entire tonsil from the fossa. In this thesis, TE was performed with the cold (blunt) dissection technique.

### ***Tonsillotomy/TT***

The tonsillotomy technique is used to perform a subtotal tonsillar resection, also known as a partial tonsillectomy, intracapsular tonsillotomy or intracapsular tonsillar reduction. This procedure involves surgical removal of the majority of the tonsillar tissue without violating the capsule, leaving a protective coating of lymphoid tissue and tonsillar capsule over the pharyngeal structures.

In this thesis, TT was performed by monopolar radiofrequency (RF) with ellman 4.0 Mhz Surgitron Dual Radiowave unit (Ellman International 3333 Royal Ave Oceanside, NY 11572 USA). See the RF-TT-procedures in the "Method" part.

### ***Functionality and advantages of RF-Surgitron Ellman***

Electro-surgical and laser devices operate with low frequency and high temperatures, in contrast to the ellman Surgitron 4MHz dual RF. The radio waves activate the water molecules within the cells that are in close

Table I.

Overview of Techniques for Tonsil Surgery	
<b>Tonsillectomy</b>	
<b>‘Guillotine’</b>	“Historical” method still in use at some clinics outside Sweden. Tonsil is partly or totally removed using guillotine-like instrument <sup>128,129</sup> .
<b>‘Cold knife’ dissection</b>	Removal of tonsils using scalpel and blunt dissection. Ligatures and/or diathermy used for homeostasis <sup>130</sup> . Standard technique for tonsillectomy at most clinics in Sweden.
<b>Electrosurgery</b>	Tonsillar tissue extirpated using electric current (‘hot knife’ dissection). Blood loss reduced by simultaneous electrocautery.
<b>‘hot knife’ dissection</b>	Procedures include <i>monopolar</i> and <i>bipolar</i> diathermy dissection, <i>suction diathermy dissection</i> , and <i>bipolar scissor dissection</i> . Bipolar diathermy: current passed through tissue between tips of a pair forceps, electrical energy concentrated in small area and tissue heats extremely rapidly, resulting in coagulation of blood vessels. Monopolar diathermy: energy passes away from the instrument and dispersed to ground electrode placed on leg of the patient. Heat of electrocautery (400 degrees Celsius) results in thermal injury to surrounding tissue. In USA, electrocautery considered the standard technique <sup>12,131-135</sup> .
<b>Harmonic scalpel</b>	Harmonic scalpel uses blade vibrating at 55,000 cycles per/second. Invisible to the naked eye, vibration transfers energy to tissue, simultaneously cutting and coagulating. Temperature of surrounding tissue reaches 80 degrees Celsius. End result is precise cutting with less thermal damage than electrocautery <sup>136,137</sup> .
<b>‘Coblation’ Bipolar Radiofrequency Cold Ablation</b>	Bipolar probe used that generates low frequency radio-energy through conductive medium (normal saline), forming plasma field of sodium ions around electrode (the “wand”). As energy from ionized particles is transferred to tissue, dissociation occurs in bonds between molecules of tonsil tissues causing break down with less heat generation than with electrosurgical techniques (65°C versus >100°C with standard diathermy). Causes less collateral thermal injury. Can be used to remove all or only part of tonsil. Wands are single use. <sup>138,146</sup> .
<b>Tonsillotomy</b>	
<b>Carbon dioxide laser</b>	Laser tonsil ablation (LTA) performed using hand-held CO <sub>2</sub> laser or potassium-titanyl-phosphate (KTP) laser to vaporize and remove tonsil tissue. Laser acts as hot knife with low lateral heat in vascularized tissue leaving dry wound with excellent homeostasis. Special safety precautions needed to avoid risks such as burns and fire in surrounding tissue and tracheal tube. <sup>17,147,149</sup> .
<b>Microdebrider</b>	Electrically powered rotating shaver with continuous suction. Consists of tubular cutting instrument with suction device connected to handpiece. Used to perform partial tonsillectomy by shaving tonsils, thus removing obstructing tissue without disturbing tonsillar capsule. <sup>150,151</sup> .
<b>Monopolar Radiofrequency surgitron ellman 4Mz</b>	Unipolar probe generates high frequency radio-energy (4MHz) forming plasma field of sodium ions in cells—separating cell bindings and cutting tonsillar tissue with low heat generation (50°C). Low lateral heat gives minimal thermal injury <sup>152,153</sup> . Same equipment can be used for tonsil ablation through probes inserted into tonsil (not cutting) which, by scarring, reduces tonsil size. Procedure can be repeated and performed in office setting. <sup>154</sup>

2,155

contact with the electrode, and cutting is accomplished by a “plasma layer” in front of the electrode. The radio waves are directed by an antenna, which is placed under the shoulder of the patient. The lateral heat reaching the surrounding tissue is minimal and there is no risk for accidental burns on intubation tubes. In contrast to laser surgery, no danger is involved in using oxygen. The result will be minimal scar tissue formation, and faster healing. In contrast to conventional cautery, which causes damage similar to 3rd degree burns, the tissue damage that does occur in high frequency radio surgery is superficial and is comparable to that which occurs with lasers technique.

Compared to laser techniques, the equipment is less expensive, more easily transportable and does not require ad hoc environments. Furthermore, handling, maneuvering and adjustment of the instrument is easier.

## **Health and wellbeing after surgery**

### ***Pain***

Pain after conventional TE is often intense and associated with significant morbidity during the recovery period. Considerable pain may be experienced after TE lasting one week or longer<sup>5,89,156-162</sup>. Following the operation, pain will generally abate over the first few days, then increase for 1-2 days, and finally recede slowly over the following 10 days<sup>163</sup>. In many children, not only drinking and eating, but even speech, may be painful.

As a result of improvement in the appreciation of pediatric pain and pharmacological knowledge, the management of pain in children is changing rapidly. Previously, it was a popular misconception that children do not feel pain as severely as adults do, and that the magnitude and duration of pain was believed to be less than in adults<sup>164,165</sup>. Studies between 1980 and 1990 demonstrated that the prescriptions for children were inadequate. Children were often given less analgesics than prescribed and in comparatively lower doses than adults<sup>25,166,167</sup>. Focus on the management of post-operative pain has demonstrated that under-treatment of postoperative pain still exists<sup>24,168-173</sup>.

TE is a useful model for the study of postoperative pain in children because of the relatively large number of “otherwise healthy” children who undergo this surgery annually. Most of the children will have their first surgical intervention in an otorhinolaryngologic setting.

According to the International Association of the Study of Pain (IASP), pain is defined as “an unpleasant sensory and emotional experience as-

sociated with actual or potential tissue damage or described in terms of damage<sup>174</sup>. This definition emphasizes that pain is not predetermined by the extent of tissue damage; the essential point is that pain is a composite of psychological and physiological variables. The IASP definition further states that pain is subjective and each individual learns the application of the word through earlier experiences.

### *Management of pain*

The goal of postoperative pain management is to minimize or eliminate discomfort, facilitating the recovery process and avoiding complications (IAPS)<sup>174</sup>. Assessment of pain is important; without proper pain assessment, there can be no good quality pain relief<sup>175</sup>.

Nurses play a key role in pain assessment and intervention in children. Some results have shown that professionals overestimate mild pain and under estimate more severe pain<sup>176,177</sup>. The influence of the diagnosis at hand and the child's expression influence the nurses' attribution of pain; they scored more pain for children who vocally expressed their pain<sup>178</sup>. Further, the nurses tended to overestimate the effect of analgesics<sup>172</sup>.

Under-treatment of pain leads to increased morbidity as well as postoperative behavioral changes, such as sleep disturbances, separation anxiety, apathy, and withdrawal<sup>4,30,89,90,169,179,180</sup>. Parents may have several misconceptions about pain. Finely et al.<sup>26</sup> found that parents were hesitant to use pain medication even though children were experiencing pain. Several researchers have found inadequate pain management in children at home after TE<sup>5,26,27,157,179,181</sup>. Poor pain management may also lead to increased utilization of health services.

Children need effective analgesic treatment, both in the hospital and at home, to ensure calm recovery. The immediate postoperative comfort obtained by proactive analgesic needs to be followed by analgesics given on a continuous basis<sup>182-185</sup>. Patients in every age-group and the parents of children are well prepared if they are informed and actively involved in pain assessment and management<sup>186</sup>. Continuing support is necessary to ensure high parental and child satisfaction after discharge.

Several methods of providing the discharge instructions can be used when teaching the parents, children and youth postoperative pain assessment and management. Handouts can be given to both children and parents<sup>187</sup>. Follow-up phone calls should assess the current level of pain, pain management, clarify discharge instructions, and supply (extra) information, and support for decreasing children's pain<sup>187-189 101,102</sup>.

### *Pain-scoring-system*

A variety of factors influence a child's perception of pain, including fear, anxiety, physical states, such as fever, nausea, dyspnea, and the body's individual sensory messages at the time. Response to pain is also affected by past experience, coping strategies, current circumstances, culture, and personal beliefs<sup>167,175,190-192</sup>.

Self-report is the gold standard for pain assessment. However, many studies of post-tonsillectomy pain use parental reports<sup>100,179,181,193-195</sup>. One of the first studies where the children themselves were asked whether they felt pain was published in 1983<sup>28</sup>. All children should be regularly assessed for the presence of pain. Whichever scoring system is used, the assessments should be repeated regularly, appropriate interventions should be prescribed, and their effectiveness in reducing the pain score should be regularly documented. Preoperative teaching is preferable to enable accurate use of this tool.

Visual analogue scales (VAS) can be operated by children from around the age of five, but a detailed facial expression scale is better understood. When using self-report scales in children, they need an understanding of the term "hurt" (Swedish "ont")<sup>191</sup>. They also have to understand the concepts of "less, the same, and more"<sup>190</sup>. As children (7+ yrs) become more comfortable with numbers and the concept of quantification, they can use numbers and verbal description scales (Likert-scale). Few investigators have studied self-report specifically for adolescents. However, this age-group requires instruments that are more restrained and "adult-like"<sup>190</sup>. Face pain scales (FPS)<sup>196</sup> (Fig.5a) provide measures of intensity and effect that appear to be more distinctive than VAS. Facial expression scales would be the most appropriate choice among currently available measures for helping children over a wide age range to estimate the sensory and affective components of their postoperative pain<sup>197</sup>. The FPS used in this thesis has relatively neutral faces, rather than the "smiley" faces chosen by Wong and Banker<sup>198</sup>. For assessment of pain intensity the use of faces without smiles ("no pain") or tears ("worst pain") is to be recommended because children give higher pain ratings when smiling faces indicate "no pain" than when neutral faces are used to signify "no pain"<sup>199</sup>.

### *Medical interventions*

Medical management of postoperative pain following TE is definitely not standard all over the world. There is a wide variety of opinions. Areas of controversy include perioperative injection of local anesthetic agents, postoperative use of antibiotics, perioperative use of intravenous steroids, and analgesics<sup>6</sup>.

#### *Paracetamol*

Paracetamol is justifiably the most popular postoperative analgesic. Paracetamol, as an analgesic used alone, often provides insufficient analgesia after TE<sup>22,27,179,200-202</sup>. The commonly used doses have even less efficacy for postoperative analgesia and therefore high doses are recommended during the first three postoperative days<sup>22,23,203-204</sup>.

An important factor affecting the adequacy of the analgesia of paracetamol is the manner of administration. Rectal paracetamol has lower bioavailability (78%) and a longer interval to peak plasma concentrations compared with oral forms<sup>22,205,206</sup>. Maximum serum concentration after oral administration is reached in 30-60 minutes, while a longer delay is experienced after rectal administration, varying from 1 to 2.5 hours<sup>22</sup>. Orally administered paracetamol is more effective than the same dose rectally<sup>207</sup>.

Codeine, in combination with paracetamol, has an analgesic effect that is slightly higher than that of paracetamol given alone. About 10% of a given dose will be transformed into morphine; however, some individuals are unable to convert codeine to morphine<sup>22</sup>. Several studies have concluded that even paracetamol with codeine was ineffective in managing children's pain the first days after TE<sup>208,209</sup>.

#### *NSAIDs*

The combination of an NSAID with paracetamol performs better than paracetamol alone to provide satisfactory pain relief after TE<sup>22,23,158,183,200,201,208,210-215</sup>. Non-steroidal anti-inflammatory drugs (NSAIDs) are useful for postoperative pain management because surgery causes both pain and inflammation.

NSAIDs are effective analgesics, and lack opioid-related adverse effects<sup>216</sup>. The effectiveness of NSAIDs as pain medications and their anti-inflammatory effects is generally well accepted<sup>217-220</sup> and these medications are opioid sparing in the recovery period<sup>207,212</sup>. NSAIDs do not induce respiratory depression<sup>217</sup>, and they are of considerable advantage for patients who have symptoms of OSA<sup>23</sup>. NSAIDs reduce the incidence of postoperative nausea and vomiting (PONV)<sup>200,201,210,211,221</sup>.

The use of NSAIDs for analgesia after TE is controversial because NSAIDs prevent platelet aggregation, and may increase the risk of perioperative bleeding<sup>216,222</sup>. Several reviews concluded that there is lack of evidence for NSAIDs increasing the incidence of bleeding after TE, and the issue remains ambiguous<sup>216 223,224</sup>. If the first dose of an NSAID medication is given after surgery, it seems that the incidence of postoperative primary bleeding is not increased<sup>211,225</sup>.

#### *Tramadol*

Tramadol is an opioid analgesic that does not inhibit prostaglandin synthesis as do NSAIDs<sup>226</sup>. Tramadol may represent a superior choice over morphine in this group, with the potential to cause less postoperative sedation and respiratory depression<sup>22</sup>.

#### *Steroids*

Corticosteroids have a combined antiemetic and anti-inflammatory effect that may decrease postoperative tissue injury, edema and pain after TE<sup>6</sup>.

#### *Antibiotics*

Antibiotics are used as a therapy in many countries for children undergoing TE in order to decrease possible pharyngeal inflammation from bacterial colonization, and as an approach to improving recovery<sup>6</sup>. In Sweden, postoperative antibiotics are not prescribed because of the side effects of inducing bacterial resistance, and similar considerations have been expressed from clinics in other countries, e.g. UK<sup>227</sup>.

#### *Local anesthesia*

Intraoperative infiltration with local anesthetics may reduce immediate postoperative pain, but it has not been shown to influence long-lasting analgesia<sup>5,228-236</sup>.

#### *Morphine and Ketobemidone*

In the immediate postoperative period after TE, it is not optimal that paracetamol be combined with NSAIDs or codeine for all patients. For postoperative pain when there is need for a rapid onset of analgesia, the intravenous administration of morphine should be the norm<sup>22,207</sup>. Morphine belongs to the strong opioids, and is the most commonly used drug, based on extensive knowledge of its effects<sup>22</sup>. For most children with acute pain, the risk for respiratory depression is very low, but observation is important. The dose of morphine must be titrated against to the level of pain, and the response to a given dose will occur within a few minutes<sup>22,191</sup>. Individualized titration can only be achieved by regular reassessment and re-evaluation of the treatment<sup>190</sup>.

Ketobemidone is very similar to morphine, and is usually used in Scandinavia for acute pain management in patients, but mostly for adults<sup>22,191</sup>.

#### *Nonpharmacologic management*

The postoperative pain can be alleviated by using nonpharmacological methods as adjuvants to analgesics<sup>237</sup>. Pain is processed by the nociceptive system, and the pathway from stimuli to conscious perception of pain is influenced by activities in the central nervous system.

The most commonly used nonpharmacological strategies with young children (TE) are comforting the child and giving emotional support, spending more time than usual with them, distracting them with TV or video watching, or by reading to the child<sup>193,238</sup>. One TE study with school-age children used "guided imagery", a method of distraction with an imagery videotape. The treatment group demonstrated less pain and anxiety<sup>239</sup>.

Physical methods for pain control are drinking and eating iced foods<sup>238</sup>. Proper hydration is also very important during this time, since dehydration can increase throat pain, leading to a vicious cycle of poor fluid intake. Secondary bleeding is thought to be associated with poor intake of food and fluid, and infection.

The best dietary advice that can be given to TE patients is to encourage regular eating so that the child can return to the usual diet soon after surgery. If the child is able to eat foods that the child enjoys, then the child is more likely to comply, making for speedier recovery<sup>240</sup>. No evidence suggests that a special diet is required; however, soft foods are more easily swallowed than solid. Post-tonsillectomy pain on swallowing is thought to be due to the trauma-induced spasm of the constrictor muscles of the tonsil bed. The only physical method to relieve this muscle cramp is achieved by chewing and swallowing solid food. When the muscles are relaxed, pain is less.

Two studies advocated chewing gum for relieving difficulty with swallowing following TE. Also, the referred otalgia can frequently be alleviated by chewing gum, and comfort is improved when this is started the day after surgery. The increased salivary production associated with chewing may reduce the spasm, and saliva decreases the pain (dry sore throats are more painful)<sup>241,242</sup>.

#### *Complications*

Complications of tonsillectomy may occur within the first 24 hours after surgery or weeks to months postoperatively. Most common post-

operative complications include hemorrhage, PONV, dehydration, and referred otalgia<sup>53,243-245</sup>.

Hemorrhage is the most common complication after tonsil surgery. Primary hemorrhage is defined as occurring within the first 24 hours, and secondary hemorrhage occurs after 24 hours<sup>245</sup>. A small degree of bleeding after TE is not uncommon: an estimated 0.1-8.1% of patients have hemorrhage, and mortality because of bleeding is about 0.002%. The overall risk of bleeding is approximately 1-2%, higher in adults, approximately 10% of adult patients develop secondary bleeding<sup>246</sup>.

Small bleeding may stop spontaneously, or via mild intervention (e.g. gargling cold water, sucking on an ice cube). Moderate to severe hemorrhage should be addressed in the operating room. Postoperative tonsillar bleeding can be immediately life-threatening with the involvement of major vessels (internal and external carotid system, facial and lingual arteries). A re-operation and anesthesia is connected with substantial risk, due to the hemorrhage and a dehydrated postoperative patient.

Another complication is the risk for PONV, which may be as high as 50-80% in TE, and antiemetics reduce this risk<sup>247-249</sup>. Morphine increases the incidence of PONV compared with other analgesics<sup>200,250</sup>. Respiratory depression and sedation from morphine may also be risky after pharyngeal surgery<sup>212,217</sup> when a prompt return of airway reflexes is required.

It is also important to note that pain itself can cause nausea<sup>251</sup>. Blood in the stomach causing gastro-intestinal irritation, is another factor of particular interest in ENT operations and is associated with increased incidence of PONV<sup>252</sup>.

Dehydration as a complication to tonsil surgery is secondary to pain and results from nausea/vomiting related to anesthesia, as well as to swallowed blood and decreased oral intake. Younger children are especially prone to develop dehydration, as they are less cooperative and have less volume reserve, and often exhibit postoperative weight loss (common in children who do not eat because of pain).

Otalgia is a common complication associated with a sore throat. The cause of otalgia in tonsillitis and after TE is referred pain through the tympanic branch of the glossopharyngeal nerve. This nerve is located deep in the superior constrictor muscle, which is of importance because it can be injured during dissection.

### *Inpatient versus outpatient recovery*

In recent decades, several authors have reported that outpatient TE is safe for selected patients. There are variable recommendations on the appropriate length of postoperative observation prior to discharge (3-10hrs)<sup>253-262</sup>. All authors conclude that, with good organization, TE can be safely performed as day surgery. In addition to the positive reports of increasing day-case operations, there have also been distressing reports of poor management of postoperative pain, inadequate patient information, and a high degree of contact with health care after discharge. Frequent post TE contacts should be taken into account when financial and personnel resources of day surgery are evaluated. Careful attention must be paid to the quality of counseling prior to discharge from the hospital the day of surgery by providing repeated information and first line telephone-counseling<sup>263</sup>. No studies, except those included in the present thesis, have commented on the outpatient recoveries with regard to tonsillotomy.

### *Quality of well-being after surgery*

Good quality health care is considered the right of every patient, and a responsibility of the medical staff. Tonsillectomies are not performed to save a life, but to improve quality of life. In recent years, attention has been focused on quality of life parameters after TE when treating children and younger adults who suffer from OSA.

Several studies have shown the impact on HRQL pre- and postoperatively after tonsil-surgery in children with SDB. These studies show a large improvement in HRQL, school performance and daily behavior etc. after TE<sup>39,45,46,79,264-266</sup>. A meta-analysis illustrated effective treatment of OSA with TE in the majority of patients, with normalizing polysomnography (PSG) (82.9%)<sup>267</sup>.

In 2002 the only study<sup>44</sup> was done since Paradise et al., 1984<sup>68</sup> that focused on children with recurrent tonsillitis and/or OSA. This study demonstrated an improvement in total behavior and HRQL after TE<sup>44</sup>.

In adults with recurrent and chronic tonsillitis the number of antibiotic prescriptions and clinical visits decreased, and patients enjoyed an improvement in the quality of life after TE<sup>47,48,268</sup>. No studies have evaluated HRQL in youths with obstructive problems and/or recurrent tonsillitis after TT, neither have there been studies evaluating HRQL in children after TT.



## AIMS

**The overall aim of this thesis was**

- to study children and young people in relation to tonsil surgery with the goal of improving the care of these patients.
- to describe a new, more gentle method: tonsillotomy using radiofrequency technique (RF) in comparison with the more commonly used total tonsillectomy (blunt dissection/cold steel).

The specific aims of the studies were as follows:

### **Paper I**

- to compare two techniques for pediatric tonsil surgery (5-15 yrs) with respect to pain and postoperative morbidity. The two methods were partial tonsil resection using radiofrequency technique (RF), tonsillotomy/TT versus tonsillectomy/TE (blunt dissection).

### **Paper II**

- to compare child behavior before surgery with respect to pain and anxiety in relation to two techniques of tonsil surgery.
- to explore whether a connection exists between a child's previous experiences of surgery and/or tonsillitis and their anxiety and experience of pain in connection with surgery.
- to compare the children's, parent's and nurse's rating of postoperative pain, also with regard to age and gender.

### **Paper III**

- to compare effects of partial tonsil resection using radiofrequency technique, TT with total TE after one and three years with respect to prevalence of relapse in snoring or infections, and long-term changes in behavior.

### **Paper IV**

- to describe the RF-method for TT when used on adolescents and young adults (16-25 yrs) who had recurrent infections as the primary indication for surgery.
- to evaluate the technique in comparison to TE both with respect to postoperative morbidity and risk for further infections/obstructivity within the first year.

### **Paper V**

- to evaluate the effects after one year of the surgical techniques TT and TE on adolescents and young adults (16-25 yrs) the obstructive symptoms, the susceptibility for infections and the HRQL (including how HRQL compares with the HRQL for a normal population).



# MATERIAL AND METHODS

## Study designs and subjects

This thesis is based on five publications (I-V), designed as prospective randomized (I,II,IV) and prospective follow-up studies (III,V).

### *Inclusion and exclusion criteria*

The patients eligible for the randomization were those experiencing to a greater or lesser degree, obstructive problems (snoring, experienced restriction in the throat during exercise and/or eating) with or without recurrent tonsillitis.

Criteria for exclusion were previous peritonsillitis or documentation that the subject's tonsils were small. Parents and children/youths were excluded if they could not speak and read Swedish. In study IV-V patients were excluded who had been treated with antibiotics for throat infections during the last three months.

### *Randomization procedure*

The randomization procedure used to allocate the patients to either TE or TT was performed according to a modification of Zelen's method<sup>269-271</sup>. Randomization was implemented using a sequentially numbered list generated by a computer. An independent person drew – even numbers to TT and odd numbers to TE. The modification of Zelen's method was that after randomization for both surgery-groups the patients/parents were asked for their informed consent to participate in the study; if they declined they were excluded.

From October 2002 to March 2003 (study I-III), 150 children (5-15 yrs) and from December 2004 to November 2005 (study IV-V), 114 adolescents and young adults (16-25 yrs) on the ordinary waiting list were randomized on three ENT clinics (Linköping, Norrköping and Jönköping), all within the same region of Sweden.

After randomization, all patients and families received the same information by mail about the purpose of the study, and the surgical techniques used. Written consent to take part was obtained from the parents in study I-III and from the patients themselves in study IV-V if they were 18 or older, otherwise from the parents. After consenting, all parents/patients had a second contact through a telephone call before pre-visit, at which time they could ask further questions.

## *Samples*

Participants and withdrawals are illustrated in Figure 2 (I-III) and Figure 3 (IV-V). The participants' age and gender distribution for are shown in Table II.

**Paper I.** Of the 150 children who were randomized, 92 children were operated on - 49 TT and 43 TE (Fig.2). The ages were similar, but the distribution of genders was slightly different (Table II).

**Paper II.** The same study population participated as in paper I (Fig.2). All the questionnaires were administered and measurements made in connection with surgery. Paper II focused on the child's behavior, experience of pain, anxiety, previous experience with surgery, and the management of pain.

**Paper III.** The same study population participated as in paper I (Fig.2). Ninety-one of 92 children/parents completed the questionnaire (Qu1) after one year. Eighty-nine came for the follow-up visit and three were interviewed by phone. After  $33 \pm 2$  months, all 92 children/parents participated in the follow-up.

**Paper IV.** Of the 114 patients who were randomized, 76 patients were operated on - 32 TT and 44 TE. (Fig.3). One TT was changed to TE during surgery, and this patient was excluded from the analysis. All post-operative logbooks were collected. There was a significant difference in gender ratio ( $p < .05$ ), with more girls in the TE group, but with same age distribution. The study patients were in high school (40/76), at universities (12/76), unemployed (4/76), working (16/76) or in military service (4/76).

**Paper V.** The same study population participated as in paper IV (Fig.3). Seventy-five patients were followed-up one year after surgery. All of them answered the inquiry. One patient (in the TE group), was excluded from analyzes, because the questionnaire was incomplete. This paper focuses on the postoperative obstructive symptoms, tendency for infections and HRQL evaluated after one year.

**Table II**  
**Age, gender distribution and case history of tonsil infection**

Variables	5- 15 years old <i>Study I,II</i>			16-25 years old <i>Study IV</i>		
	TE (n=43)	TT (n=49)	<i>p Value</i> TT/TE	TE (n=44)	TT (n=32)	<i>p Value</i> TT/TE
Age <sup>a)</sup> in years	9.8±3.4	8.7±3.6	ns <sup>c)</sup>	19.7±3.2	19.8±2.6	ns <sup>c)</sup>
Gender <sup>b)</sup> females/males <sup>d)</sup>	17/26	30/19	p<.05 <sup>d)</sup>	32/12	17/15	p<.05 <sup>d)</sup>
Tonsil infection in case history <sup>b)</sup>	29	31	ns <sup>d)</sup>	45	31	ns <sup>d)</sup>

<sup>a)</sup> Mean ± SD, <sup>b)</sup> number <sup>c)</sup> *t*-test <sup>d)</sup>  $\chi^2$ -test

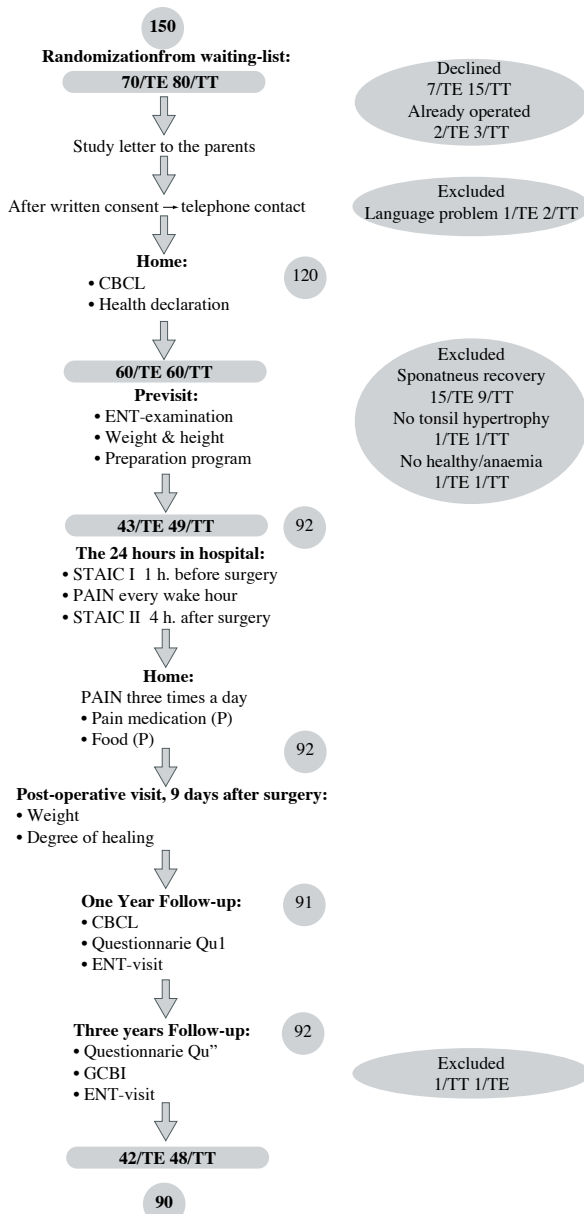


Figure 2 Flow sheet, number of patients, dropouts and data collected. Paper I-III (age-group 5-15 yrs).

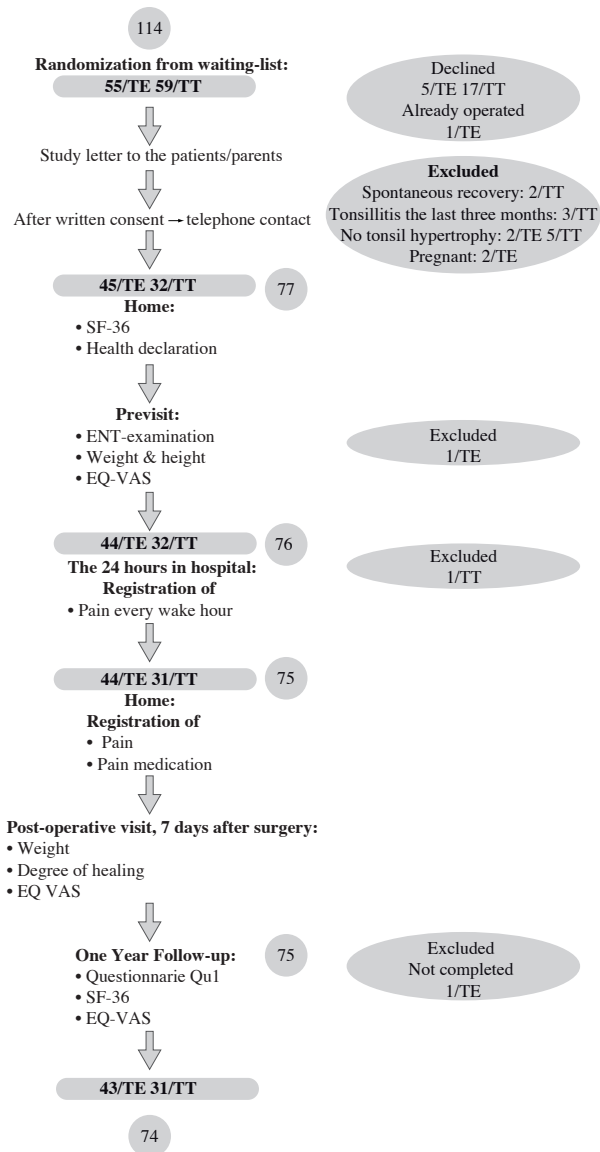


Figure 3 Flow sheet, number of patients, dropouts and data collected.  
Paper IV-V (age-group 16-25 yrs).

## Surgical procedures

### *Tonsillectomy*

Local anesthesia including adrenaline was applied under the mucus membrane of the tonsil, medial to the anterior pillar. The tonsil was pulled medially so that the mucous membrane could be incised at the bottom of fossa supratonsillar and the tonsil be freed outside of its capsule without damage to the anterior pillar. The upper pole of the tonsil was freed and the tonsil bluntly dissected outside the capsule and removed at the tongue base with a sling. Diathermy or ligatures were used for haemostasis during this dissection.

### *Adenoidectomy*

Adenoidectomy was performed if necessary. An ordinary ring knife was used under full vision by placing a mirror in the throat and pulling the soft palate forward using two catheters through the nose to the mouth.

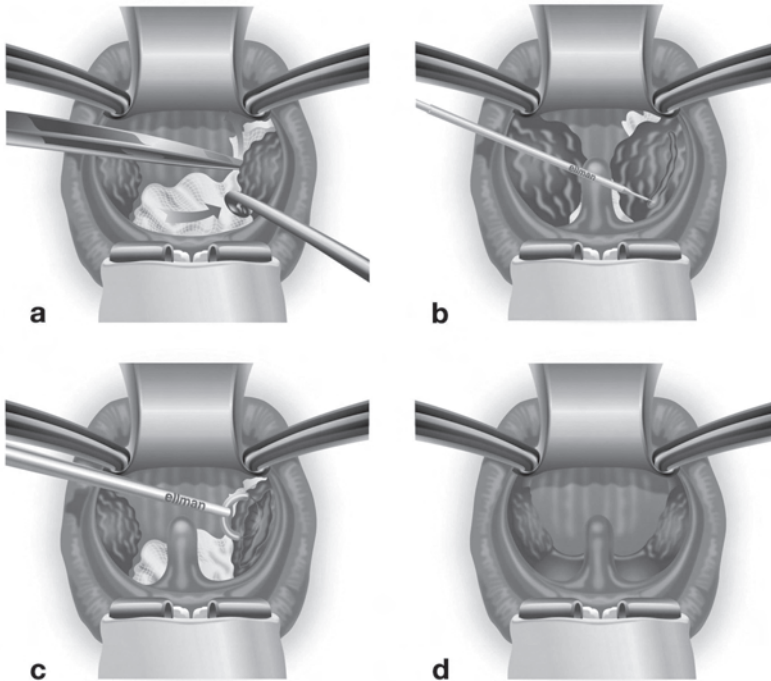
### *Tonsillotomy with RF*

RF-TT-Surgical procedure (The ellman 4.0 Mhz Surgitron Dual Radio-wave unit): A neutral electrode (antenna) was placed under the patient's shoulder and connected to the Surgitron. Local anesthesia including vaso-constrictor (0.25% bupivacaine with epinephrine) was slowly injected into the tonsillar tissue on both sides. A two cm wide gauze strip was pushed through fossa supratonsillar into and along the groove between the tonsil and the posterior pillar in order to protect the posterior pillar (Fig.4a). In adults, this groove can be very shallow.

A needle instrument tip was attached and the Surgitron was activated. Superficial vessels were coagulated with 10% (15Watt). After changing to the cutting mode and increasing to 15% (35Watt) in study IV, an incision was made in the tonsil (not in the anterior pillar up over the upper pole without holding/pulling the tonsil (Fig.4b). After changing to the Htz tonsil sling (tonsillotomy loop) (Fig.4c) and to cut/coagulation mode 40% (47Watt) in study I and 40% (45Watt) in study IV, the tonsil was grabbed with a fine artery forceps so that the incision opened up and the tonsil was cut through with a smooth movement, down to the gauze protecting the pillar. If the groove into which to push the gauze strip was too shallow, the cut was made only halfway through the tonsil, and the final incision done from behind. An ordinary tonsillar swab was pressed against the remaining tonsillar surface for haemostasis. It is important to avoid taking too much tonsillar tissue – hold to the first incision line.

When both sides were finished, the final coagulation of remaining small

vessels was done either with the needle and the ball instrument tip (Fig. 4d). No ligatures were used.



*Figure 4. (a) After injection of local anesthesia into the tonsil a 2 cm wide gauze strip is pushed into the groove between the tonsil and the posterior pillar for protection. (b) An incision is made along the anterior pillar with the needle instrument. (c) The Htz sling is used to cut through the tonsil. (d) Final result-normal sized tonsils.*

## **Anesthesia and pain treatment in the hospital**

The patients arrived at the clinic in the morning on the day of surgery. The body weight was measured if the pre-visit occurred more than two weeks before surgery.

### **Premedication**

The premedication was given orally 1 hr before surgery: paracetamol 40 mg/kg bwt for 5-15 year old patients (I,II) and 2g for 16-25 year olds (IV).

The older age group (IV) was also given diclophenac 50-100 mg on the same occasion, while the younger (I) received diclophenac 1–2.5mg/kg bwt and morphine 0,05 mg/kg bwt before extubation, i.v. If necessary, sedation was given after a decision by the anesthesiologist (I,II,IV).

### *Induction of anaesthesia*

In study I-II, the induction was done with thiopenthone or propofol and fentanyl i.v. The anesthesia was maintained with sevoflurane/air/O<sub>2</sub>. If the child did not accept IV needle insertion, the anesthesia proceeded with mask induction (sevoflurane). Parents were present at the induction of anesthesia. One of the hospitals had an antiemetic drug-routine and gave ondansetron (Zofran®0.05mg/kg bwt) i.v. and betametason (Betapred®0.15mg/kg bwt) i.v. to all children before extubation.

In study IV, the induction for two of the ENT-clinics was propofol and fentanyl i.v. and maintained with sevofluran/air/O<sub>2</sub> and the third total intravenous anesthesia with remifentanil and propofol.

Tracheal intubation was performed in all patients and all had a gauze packing above the larynx (I,II,IV).

### *Postoperative analgesia*

In the postanesthesia care unit (PACU), or the ENT-unit, morphine (I,II) and morphine or ketobemidon i.v. (IV) were given and titrated when the registered pain score “was equal to or more than three” (Fig.5b).

During the first three postoperative days, pain treatment was give as paracetamol 100mg/kg bwt/day, divided into four doses, and then reduced to 75 mg/kg bwt/day for the younger study group (I). Diclophenac, was given in one or two doses, 2-3 mg/kg bwt/day (the first doses after surgery were given after 8 hrs)<sup>203</sup>.

For the older age group (IV), paracetamol 1g was administered orally every 4hrs during the first 24hrs (max 4g/24hrs loading dose not included), and diclophenac 50 mg three times (max 150-200mg/24hrs including loading dose). The parents/patients were instructed to first withdraw diclophenac and thereafter reduce the dosage of paracetamol while keeping the pain level “below 3” e.g. just accepting a minor/slight pain level (Fig.5ab). The instructions for pain medication were given verbally and in writing.

All parents were contacted by phone on the day after discharge, and during the entire postoperative period they had a direct phone number to call.

## Measurements

### *Health declaration (I-V) and Preoperative Questionnaire (IV)*

The questionnaires were answered at home before surgery (Fig.2,3). The questions were: "Does your child / Do you have" any disease at present? Previous diseases? Allergies? Asthma? Prevalent medical treatment? Has the child (Have you) been exposed to surgery earlier? Previous problems with anesthesia? Have relatives had any problems with anesthesia? The preoperative questionnaire that was constructed for study IV, concerned questions about obstructive problems and history of tonsillitis.

### *Child Behavior Checklist (CBCL) (II-III)*

The Child Behavior Checklist (CBCL) was answered by the parents at home before the preoperative visit and one year after tonsil surgery. CBCL was developed by Achenbach and coworkers<sup>272,273</sup> and is widely used to assess behavioral/emotional problems and social competences in children. It has been translated into at least 50 languages and validated in many countries. Sweden is one of those countries for which it has been validated and normed<sup>274</sup>. The CBCL consists of two parts: social competence and behavior/emotional problems. In this study only the items from the behavioral/emotional part was used.

This part is an 113-item survey of specific child behaviors to be answered by the parents. Each item is scored as follows: Not true, 0; Somewhat or Sometimes true, 1; and Very true or Often true, 2. The items are divided into eight narrow-band scales: Withdrawn, Somatic complaints and Anxious-depressed, Social problems, Thought problems, Attention problems, Delinquent problems, and Aggressive problems, and into two broad-band dimensions: Internalizing, which comprises the subscales Withdrawn, Somatic complaints and Anxious-depressed, and Externalizing, which comprises the subscales Delinquent behavior and Aggressive behavior. A total score is also given by the sum of all the items (II,III).

### *STAIC (I-II)*

The State-Trait Anxiety Inventory for Children (STAIC)<sup>275</sup> was completed by the child in the ward one hour before and four hours after surgery. Non-literate children were helped by the parent. The STAIC consists of two separate 20-item self-report rating scales for measuring state (situational) and trait (baseline) anxiety. In the present study, only the state anxiety "How I Feel" scale was used. The STAIC assesses the intensity of a child's feeling of tension, apprehension, nervousness, and worry at a given time. Each STAIC item begins with the stem "I feel" followed by three alternative endings containing a key descriptive term, e.g., "worried." The child responds by

marking the alternative that best describes how he/she feels “right now, at this very moment,” for example (Item 9): “I feel – very worried – worried – not worried.” The STAIC, which can be used from the age of five years, is widely used to measure anxiety in children and adolescents. The scale yields scores ranging from 20 to 60 with higher scores indicating higher anxiety<sup>275</sup>.

**Pain registration (I-IV)**

The Faces Pain Scale (FPS) was used to score the postoperative pain experienced by the children (Fig.5a)<sup>196</sup>. FPS is a widely used self-reported instrument for pain measurement that consist of seven drawings of faces that are rank-ordered in equal intervals for their expression of pain from “no pain” to the “most possible pain” (scored 0–6). Test-retest reliability is very good (.82) and face validity, content validity and construct validity are supported.



*Fig. 5a The Faces Pain Scale (FPS), numbered 0-6 from left to right<sup>196</sup>. Used by permission of the International Association for the Study of Pain®.*

"No pain"	"Slight pain"	"Moderate pain"	"Pain"	"Severe pain"	"Very severe pain"	"Most pain possible"
0	1	2	3	4	5	6

*Fig.5b. Seven-point verbal pain scale (VPRS)*

The parents, the nurses (I-II) and the young adult patients (IV) used a corresponding seven-point verbal pain rating scale (VPRS) from “no pain” to “most pain possible” (Likert type scale) see Figure 5b.

In study I-II the pain was scored independently by the child, the parent and the nurse every hour the child was awake during a period of about 24 hours, and after discharge, the child and parents continued to rate the pain three times per day until the child was pain free. The registration was done before he or she was given/taken medication in both age-groups.

In study IV, pain in the hospital was recorded by the patients each hour they were awake. After discharge, they logged the experienced pain once a day (in the evening), indicating the highest pain level experienced any time during that day. The scoring was always done before medication.

### *Glasgow Children's Benefit Inventory (GCBI) (III)*

Three years after surgery the Glasgow Children's Benefit Inventory (GCBI)<sup>276</sup> was completed by the parents of children younger than 18 years (III). The GCBI is a health-related quality-of-life instrument assessing the child's condition after intervention/surgery. GCBI comprises 24 questions on the consequences of a specified intervention on various aspects of the child's day-to-day life. The GCBI evaluates general symptoms and shows four dimensions related to emotion, physical health, learning and vitality and is suitable for use in pediatric otolaryngology for children of any age. Before use, the original English version of the GCBI was carefully translated into Swedish by two independently qualified users of the English language, and independently back-translated into English to ensure accuracy. The versions from translators were compared and one target version was drafted and discussed with people having knowledge about pediatric otolaryngology.

### *Questionnaires – Qu1 and Qu2 (III,IV)*

A semi-structured questionnaire (Qu1) constructed for the study about general health, snoring, eating difficulties and infection was answered after one and three years (III) and after one year (IV) (Appendix).

Questionnaire Qu2 (III) included 11 questions; eight of them identical to those in Qu1 (Appendix). Three questions were added: (1) number of ENT-infections since the one-year follow-up; (2) whether the child had undergone surgery since the previous control; and (3) whether the family wanted contact with an ENT-specialist.

### *SF-36 and EQ-5D VAS (IV-V)*

The HRQL was measured using the Swedish version of the Medical Outcomes Study 36-Item Short Form Health Survey (SF-36)<sup>277,278</sup>, before and one year after surgery. It is a well known, validated, generic quality of life instrument that measures both physical and mental components of HRQL over a range of eight domains: (1) physical functioning (PF), (2) role limitations because of physical health problems (RP), (3) bodily pain (BP), (4) general health (GH), (5) vitality (energy fatigue) (VT), (6) social functioning (SF) (7) role limitations because of emotional problems (RE), and mental health (psychologic distress and psychologic well-being) (MH).

The response alternative varies from two (“yes” and “no”) to six (Likert type scale). A score of 0 to 100 is calculated for each domain on the basis of patient responses, the higher score indicating a better HRQL. The domain-specific scores are summarized into two summary scores known as the physical component (PCS) and mental component (MCS).

An age and sex-matched reference sample (n=439) was randomly drawn from the Swedish SF-36 national normative database (N=8930)<sup>277</sup>. The scores from the study were compared with those normative data.

The EuroQol-5D (EQ-5D) is a generic, preference-based, utility questionnaire and consists of two parts; EQ VAS and the EQ-5D index<sup>279,280</sup>. In this study, we only used the EuroQol Visual Analogue Scale (EQ VAS), which has been used in a number of therapeutic areas and contains a vertical rating scale (“thermometer” design) from 0 to 100 with 0= ‘Worst imaginable health state’ and 100= ‘Best imaginable health state’. The patients rate how they perceive their health on that particular day.

### *Procedure paper I-III*

The procedure (I-III) and the measures used are illustrated in Figure 2.

At home, the parents completed a questionnaire about the child’s day-to-day behavior (CBCL) and a health declaration including questions about previous experiences of health care.

At a preoperative visit within 2 weeks before the planned operation a physical examination was performed and the child’s body weight was measured.

The design of the study, rating scales for assessment of the child’s experience of pain, and the coming pain medication were explained in a standardized way identical for all families and responsible staff at three participating ENT-clinics by the same nurse/researcher. The parents were given a copy of all the rating scales to take home to practice. Verbal and written information were also given to the parents and child about the general routines at the specific hospital. The child received an instructional booklet explaining the hospital routines through a series of photos of a child starting with the pre-admission visit, continuing with different stages on the day of surgery and finally with the child coming home. Parents were instructed to read the booklets to their children prior to and after surgery. Three different versions of preoperative information for the child were used at the three participating clinic. Hospital 1; preoperative information for the child was given in the operating ward by a nurse anesthetist. Hospital 2; the hospital’s

play therapist informed the child of the procedures in the room for play therapy. Hospital 3; an anesthetics nurse called home the day before surgery and answered questions from the parents and child.

When the children arrived at the hospital all the children had their anxiety level scored by themselves on the STAIC, once before and once after surgery in the ENT-unit.

The children stayed in the hospital for at least 24 hrs after the tonsil surgery, due to the design of the study. All children had a relative that slept overnight with them in the ward.

The postoperative pain was registered independently by the child, the parent and the nurse every hour the child was awake. The children used a Faces Pain Scale (FPS), the parents and the nurses used a seven-point verbal pain rating scale (VPRS), (see Fig.5ab).

Up to the postoperative visit (day 7–10), the child and parents continued to rate the pain three times per day. They also recorded the number of doses of pain-killing drugs used. If the child was not pain-free at the postoperative visit the parents continued to make notes and returned them by mail. No restrictions concerning food intake were given. Each day the parents recorded which kind and how much food the child ate using a three – level scale (liquid, “soft” or “normal”).

At the postoperative visit, the child’s weight was measured and throat condition was checked for the degree of healing. The child and the parent gave their opinion of the entire healthcare encounter.

After one year, the 92 children were investigated with respect to general health, snoring, eating difficulties and infections using two questionnaires Qu1 (Appendix) and Child Behavior Checklist (CBCL). After an ENT-examination, a nurse separately carried out a semi-structured interview with the child and the parent on their opinions of the surgery and perioperative care; weight and length were also recorded. The parents were encouraged to keep a diary of all ENT-infections until the next planned follow-up.

After three years, (mean 33 months) two additional questionnaires (Qu2 and GCBI) were sent to the parents. Qu2 included 11 questions; eight of them identical to those on Qu1 (Table II). Three questions were added: (1) number of ENT-infections since the one-year follow-up; (2) whether the child had undergone surgery since the previous control; and (3) whether the

family wanted contact with an ENT-specialist. Charts from each reported ENT- related doctor visit outside the clinic were collected.

#### *Procedure paper IV-V*

The procedure (IV-V) and the measures used are displayed in Figure 3. Before surgery, the patients completed: 1) a preoperative questionnaire, constructed for the study, about the symptoms of obstructivity and earlier history of sore throats., 2) a measure of HRQL, the Short-Form 36 (SF-36)<sup>277,278</sup>, and 3) a self-rated health visual scale, the EQ VAS<sup>279,280</sup>. At a pre-surgical office visit two weeks before the operation, the indication for surgery was re-evaluated by a physician. The design of the study, the rating scales, and the schedule for taking the analgesics were explained by the nurse/researcher.

The patients used the seven-point verbal rating scale (VPRS) (Fig.5b). In the hospital, pain was recorded every hour the patient was awake. The patients remained in the clinic post-surgery between 6-24 hrs depending on the medical assessment and local tradition (at one clinic all patients stayed overnight). After discharge, he/she logged the experienced pain once a day in the evening, indicating the highest pain level experienced any time during that day. The number and dosage of analgesics was also logged. This procedure continued until pain-free, at which time the logbooks were mailed in.

No restriction was placed on food intake. In the log book, the patients recorded each day how difficult food intake had been using a five-point scale (1 = no problems, 5 = quite severe problems to eat and drink).

On the 7<sup>th</sup> day after surgery, a postoperative check-up office visit was carried out. The patient scored her/his health state on the EQ VAS and their weight was measured once again.

After one year, the patients were investigated with respect to general health, snoring, eating difficulties and infections using two questionnaires: A questionnaire constructed for the study about health, snoring, and infections (Qu1) (Appendix) and SF-36 with EQ VAS. The patients also answered open questions regarding whether they had been through any sort of surgery under the follow-up year, about the operation and the time after surgery, and whether they wanted an ENT-consultation. An ENT appointment was scheduled if the patient requested one, or if their answers otherwise made one appear appropriate. Charts were collected from each reported ENT-related doctor visit outside the surgical clinic.

## STATISTICAL METHODS

Statistical analysis was performed with Statistica 6.0 (Stat Inc,USA) (I) and SPSS® Windows version 11.0. (II-V).

Descriptive statistics were used in all papers to show the characteristics of the subjects. The data was expressed as number of cases and percentage. Parametric data was expressed as mean  $\pm$  standard deviation (SD) and confidence intervals (95%). Nonparametric data was expressed in median and inter-quartile range.

Student's t-test was used for comparing between surgery method with respect to age, duration of surgery and anesthesia, blood-loss, and number of doses of pain-relief given.  $\chi^2$  analysis was used when testing for gender differences and number of preoperative tonsillitis in each group. Fisher's exact test was employed for calculations that include small numbers ( $<5$ ).

Non-parametric methods were employed since the variables are at an ordinal level of measurement and the data is not normally distributed (Kolmogorov-Smirnov test).

Differences on the CBCL between normative data for the Swedish population and the scores from the present study were tested using Student's t-test since only means and standard deviations for the latter group were presented<sup>274</sup>.

SF-36 data was analyzed using tools and normative values provided by the HRQL-group at the University of Gothenburg, Sweden<sup>277</sup>. Differences between the population in this study and the comparative populations were tested using Student's t-test (2-tailed) for normally distributed continuous variables since the calculations could only be done on values for means and standard deviations for the comparative sample.

The Mann-Whitney U test was used to analyze differences between surgical methods in relation to children's behavior, anxiety patient activity, eating problems, EQ VAS, and pain level.

Changes in the child's level of anxiety before and after the operation were assessed using the Wilcoxon signed-rank test and for comparison of preoperative and postoperative data for changes in scores over time (CBCL, SF-36, EQ VAS, Qu1-Qu2).

When assessments of pain by staff, parents and children were compared, the Kruskal-Wallis test was used (II).

Correlation between the different measures of behavior, anxiety, pain and correlation between the questions in Qu1 and Qu2, respectively, was calculated with Spearman rank correlation.

All tests were two-tailed and  $P$  values  $<.05$  were considered statistically significant.  $*=p<.05$ ,  $**=p<.01$ ,  $***=p<.001$

The sample size of the study population was based on data from previous studies of tonsil-surgery in which differences between the results were high enough to allow for about 30 subjects in each group of treatment to be sufficient for inclusion in the planned study<sup>17,148</sup>.

Non-significant findings in a study may be due to Type II error (the problem of study power). A calculation of study power necessitates e.g. estimations of between group differences, data set dispersions, data distribution functions, and choice of inferential statistical method type. Often in a clinical investigation, these parameters are difficult to effectively estimate prior to starting a study, thus making all power calculations uncertain and subject to discussion. Thus we have found it difficult to do precise power calculations.

A simple yet illustrative method is to redo the non significant statistical calculations using the observed dataset “doubled”. Doing this, an estimation can be made of the effects might have been on borderline significances of using a sample that was twice as large.

## ETHICAL CONSIDERATIONS

The Medical Research Ethics Committee of Linköping's University, Sweden (registration no. 02-028 and no.03-449) approved the studies. All participants were given written and oral information about the study. All patients (older than 7 years) and their parents gave their informed consent. Furthermore, they were informed that their participation was voluntary and could be withdrawn by them at any time. The patients who wrote "no" for participation were respected without any explanations requested.

The data were handled confidentially. All questionnaires and protocols were coded. The results are presented in a way that ensures that it is not possible to identify any of the individuals. All patients were given the same information about the study at hand. We do not consider that participation in any of the studies can have had any negative consequences for the subjects included; rather they received more attention, assessment and exercise compared with common clinical handling.



## RESULTS

There were no gender differences of the recorded pain or in the use of analgesics. Comparisons between the data from the three participating clinics showed no clinic related differences in the pain ratings either for youths, children, parents or staff or in the use of analgesics.

There were no differences in how the children scored on anxiety on STAIC I and II related to the three hospitals preparation programs. There were no gender or age differences for CBCL, STAIC, SF-36, EQ VAS or Qu.

### Health before surgery (I-V)

#### *Symptoms (I-V)*

The percentage of antibiotic-treated tonsillitis in each group the year before surgery did not differ significantly.

Paper I-III: 60/92 (65%) of the children (I-III) had had one or more episodes of tonsillitis and obstructive symptoms before surgery and the remainder had solely obstructive symptoms as indication for surgery (Table II).

Paper IV-V: In the older study-group (16-25 yrs), all except one of the 76 patients had had one or more episodes of tonsillitis in addition to obstructivity (Table II).

Paper I and II: Twenty-nine (32%) children had experienced surgery before the tonsil surgery, 23 (25%) in day surgery and 6 (7%) who had been hospitalized, of whom two more than 1 week. There was a significant difference in CBCL scores between the total study group and normative values<sup>274</sup> with respect to "Internalization" ( $p<.001$ ) and "Total behavior" ( $p<.001$ ). There were no differences in CBCL with respect to surgical method. The difference found for CBCL between the total group and the normative values referred to the TT-group (Table III in paper II page 1753).

Paper V: Before surgery, both older TT/TE-groups (among patients with obstructive problems) reported significantly lower HRQL, in almost all dimensions of the SF-36 ( $p<.05$ - $p<.001$ ) when compared with a Swedish normal population (Table II in paper V side 8).

The median self-reported health-status (EQ-VAS) was 70 (inter-quartile range 60-80) in TE-group and 80 (inter-quartile range 70-85) in the TT group, the difference was not significant.

## **Well-being in the context of surgery (I,II,IV)**

### ***Preoperative events (I,II)***

Eighty-one children (88%) did not receive sedation before surgery. Five of the 11 premedicated children scored over the third quartile on CBCL, and STAIC I. Children with previous experience of medical care and surgery did not differ in CBCL and STAIC I and II compared with total selection.

The correlation between preoperative anxiety (STAIC 1) and CBCL was for “Internalization”,  $r_s=.29$ ,  $p<.01$ , “Externalization”,  $r_s=.26$ ,  $p<.05$ , and for “Total behavior”,  $r_s=.30$ ,  $p<.01$ .

### ***Perioperative events (I,II,IV)***

Perioperative data (I,IV) see Table III. The mean duration of anesthesia and surgery was equal for TT and TE in both age groups. There was significantly less bleeding during surgery in the TT groups (I,IV) compared with the TE-groups (I,V). The older TE-group (IV) had a more intra-operative blood loss than the younger group (I).

The difference between the clinics in anesthetic techniques in study IV did not influence the pain scoring or delivery of analgesics.

## **Health and wellbeing after surgery (I,II,IV)**

### ***Postoperative anxiety and pain (II)***

The younger study-group that received TE demonstrated a significantly increased anxiety level (STAIC II) than the TT group. Additionally, all children who experienced pain  $\geq 3$  (FPS) scored increased anxiety.

The TT-children’s anxiety level (STAIC) decreased from the preoperative state to the postoperative state ( $p<.05$ ). There were no similar significant changes in the TE-group.

The postoperative correlation between STAIC II and CBCL was for “Internalization”,  $r_s=.16$ , “Externalization”,  $r_s=.18$ , and for “Total behavior”,  $r_s=.22$ ,  $p<.05$ .

The experience of pain was scored at the same level whether the children had had tonsillitis or previous experience of surgery.

**Table III**  
Perioperative data for the TE group and TT group in study I,II and IV.

Variables	5- 15 years old Study I,II			16-25 years old Study IV			(I,II/IV) 5-15 yr/ 16-25 yr	
	TE (n=43)	TT (n=49)	P-value TT/TE	TE (n=44)	TT (n=31)	P-value TT/TE	P-value TE	P-value TT
Duration of surgery (min) <sup>a)</sup>	26.5±8.0	28.3±11.9	ns <sup>c)</sup>	29.1±25.0	29.8±27	ns <sup>c)</sup>	ns <sup>c)</sup>	ns <sup>c)</sup>
Duration of anaesthesia (min) <sup>a)</sup>	59.2±14.7	63.0±16.9	ns <sup>c)</sup>	58.7±50	56±15.8	ns <sup>c)</sup>	ns <sup>c)</sup>	ns <sup>c)</sup>
Operative blood loss (ml) <sup>a)</sup>	34±42.7	17.2±26.5	p<.05 <sup>c)</sup>	81.4±99.2	18.4±23.8	p<.001 <sup>c)</sup>	p<.01 <sup>c)</sup>	ns <sup>c)</sup>
Number of Adenoidectomies <sup>b)</sup>		5		2	5			
Primary/Secondary <sup>e)</sup> hemorrhage <sup>e)</sup>	1/0	2/0		2/4	0/0			
Mean weight change (kg) day 7 <sup>a)</sup>	-0.66±1.14	-0.13±1	p<.001 <sup>c)</sup>	-1.8±1.5	-0.03±1.1	p<.001 <sup>c)</sup>	p<.001 <sup>c)</sup>	ns <sup>c)</sup>
Days to normal activity <sup>a)</sup>	9.1± 3.2	6± 2.7	p<.001 <sup>c)</sup>	10.6±2.8	6.4±2.3	p<.001 <sup>c)</sup>	p<.05 <sup>e)</sup>	ns <sup>c)</sup>
First pain-free day <sup>a)</sup>	9.1±4.1	5.7±2.7	p<.001 <sup>d)</sup>	12.8±3.1	8.6±2.1	p<.001 <sup>d)</sup>	p<.001 <sup>d)</sup>	p<.001 <sup>d)</sup>
Days for intake of paracetamol <sup>a)</sup>	7.3±2.6	4.2±2.3	p<.001 <sup>c)</sup>	11.8±2.8	7.7±2.3	p<.001 <sup>c)</sup>	p<.001 <sup>c)</sup>	p<.001 <sup>c)</sup>
Days for intake of diclofenac <sup>a)</sup>	4.3±2.6	2.2±2.1	p<.001 <sup>c)</sup>	8.8±2.8	5.4±1.9	p<.001 <sup>c)</sup>	p<.001 <sup>c)</sup>	p<.001 <sup>c)</sup>

<sup>a)</sup> Mean ± SD. <sup>b)</sup> number <sup>c)</sup> t-test <sup>d)</sup> Mann-Whitney U Test

<sup>e)</sup> Primary hemorrhage=within 24 hours and Secondary = within 14 days

### ***Pain (I,II,IV)***

Both of the TT- groups, 5-15 years and 16-25 years old, scored significantly less pain than the TE-groups from the second hour onwards. During the first 24 hours, the TE groups in both age-groups (I,IV) received more doses of morphine or ketobemidon (i.v.) than the TT groups.

The children (II) who were adeniodectomized at the same surgical procedure did not score higher pain levels than the ones who had only tonsil surgery, irrespective of method used.

Figure 6 and 7 shows the daily percentage of patients in each group recording “no pain” and the daily percentage of patients recording pain scores 3-6 (“pain” to “severe pain”). The differences in pain scores between TE and TT was significant from day 1 (I,II,IV).

The amount of painkilling drugs (paracetamol and diclofenac) was significantly less ( $p<.001$ ) for the children and youths treated with the TT-surgery (I,IV), and they stopped taking medication for pain sooner ( $p<.001$ ) compared with those who were treated with TE (Table III).

In the TT-group (I-II), the children  $\geq 10$  years old scored higher pain levels than the younger children day 1–3 ( $p<.01$ ) and day 3–6 ( $p<.001$ ). In the TE-group (I-II), generally a higher level of pain was registered, and there were no age related differences. In the older age group there were no age-dependent differences in pain either for TT or TE (IV).

Comparing the pain-level between the age-groups with the surgical method used shows that patients 16-25 years old (IV), scored significantly higher levels of pain, used more doses of analgetics during more days in pain than the younger age group irrespective of surgical method. There was a significant difference between the older and younger age TE-group (IV) with respect to return to normal activity (school or work). This difference did not exist for the two age groups (I,IV), treated with TT (Table III).

The analgesia with paracetamol and diclophenac was not sufficient during the first six days for a mean of 40% of the younger TE-group (I) or for 75% of the older TE-group (IV) if only pain “below 3” (minor/slight) was regarded as acceptable. Compared with TT, the analgesia given was not sufficient during the first six days for a mean of 20% of the younger TT-group (I) or for 40% of the older TT-group (IV).

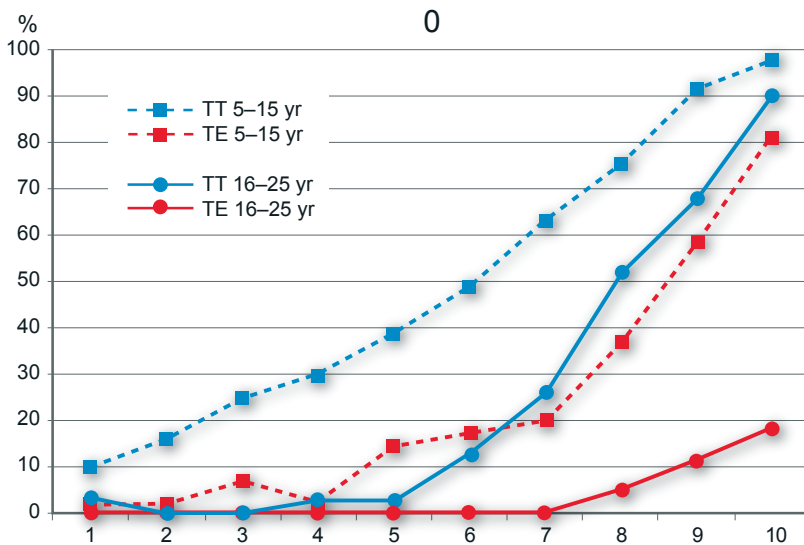


Fig.6. Percentage of patients scoring “no pain”(fig.5ab) in each age and surgery group, from day 1 to day 7 after surgery.

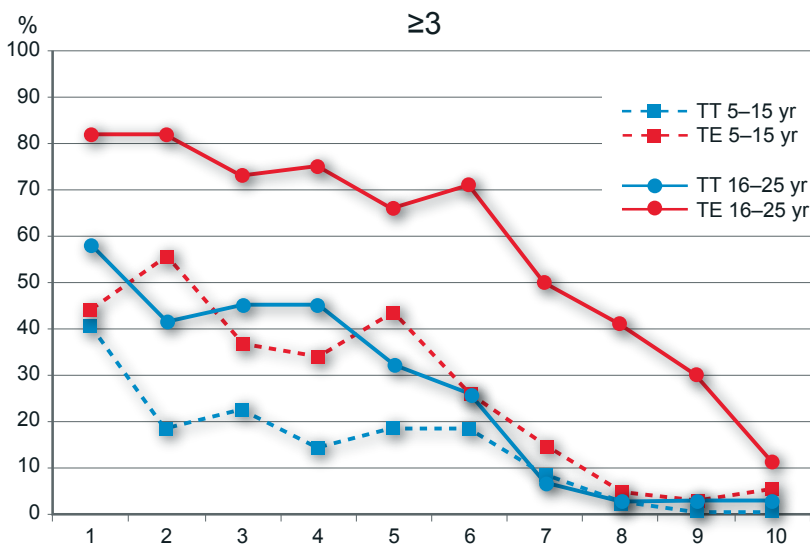


Fig. 7. Percentage in each age and surgery group, recording pain  $\geq 3$  - from “Pain” to “Most pain possible” (fig.5ab) from day 1 to day 7 after surgery (The highest pain level experienced at any time during the particular day).

Paper IV: 21/44 of the TE group made one or more telephone calls to consult about pain or bleeding. In the TT group 1/31 called once regarding pain. Nine TE and two TT patients came for extra visits to the physician due to pain or bleeding.

#### *Pain assessment and treatment (II,IV)*

Paper II: The level of postoperative pain was registered independently by the child, the parent and the nurse every hour the child was awake. The nurses generally scored pain lower than the parents (VPRS) and the children (FPS) ( $p < .05$ ). There was no significant difference between parents' scoring of pain (VPRS) and children's (FPS) either in the hospital or at home. Few children received the maximum dosage of paracetamol (100 mg/bwt) and diclophenac (2–3 mg/bwt) as was prescribed for the first 24 hrs. Twenty-five/92 received a mean of <50% of paracetamol prescribed and 42/92 received a mean of <50% of diclophenac prescribed (Table V in paper III page 1755). The parents did not under medicate their children's pain but many did not fully follow the instructions for reducing the dosages of the medication. Some kept the diclofenac longer and reduced the paracetamol instead. One TE-child (age 5) had visited the ENT-clinic on the third day after surgery due to pain and nausea, and had medication changed to paracetamol with codeine and antibiotics (penicillin V).

Paper IV: Both older groups followed the instructions for reduction of the analgesia and the number of days to the end of medication and the total dosage of paracetamol and diclophenac differed significantly between TT and TE. Five TE and one TT with poor pain control received extra tramadol. Three TE, two of whom had had primary bleeding and one with gastritis, were prescribed paracetamol + codeine instead of diclophenac. One TE patient with severe secondary hemorrhage on the 9<sup>th</sup> day was changed over from diclophenac to tramadol.

#### *Discharge from hospital, postoperative follow-ups (I-V)*

##### *Discharge from hospital after surgery (I,II,IV)*

Paper I-II: All children were discharged the day after surgery.

Paper IV: 18/31 of the older TT group was discharged on the day on surgery. None of the TE patients were discharged on the same day. Three patients stayed two nights in the hospital: one TE due to acute infection with pneumonia, one of the TE with primary bleeding for extra observation, and one TT stayed two nights due to nausea and vomiting caused by virosis in his family.

#### *Follow-up after 10 days (I,II)*

All 92 children were examined 10 ( $9,8 \pm 1,2$ ) days after surgery. Eighteen (42%) in the TE-group and four (8%) in the TT group still had pain at the follow-up visit. The day of follow-up was independent of which kind of surgery had been received, but the degree of healing was significantly better in the TT group ( $p < .001$ ).

Ninety percent of the parents experienced positive changes in the child's behavior as reflected in the fact that their child had stopped snoring and was sleeping better. Ten percent displayed negative changes: three children seemed to have regressed in age, six were more anxious, sensitive, afraid of darkness, having nightmares, and were more dependent on the parents (6TE, 3TT).

#### *Follow-up after 7 days (IV-V)*

At the 7 days follow-up the self-reported health-status (EQ-VAS) was lower for the TE group as compared with the TT group ( $p < .001$ ).

#### **Complications (I,IV)**

##### *Postoperative eating difficulties and weight loss (I,IV)*

Paper I: The mean postoperative weight loss in the younger age group was significant for the TE group but not for the TT-group ( $p < .001$ ). The type of food and amount of food the children could eat also showed significant differences from the first to the 8<sup>th</sup> day after surgery ( $p < .05$ ) (Table III).

Paper IV: The TT group in the older age group had all returned to normal eating habits by day 7 compared to day 12 for the TE-group ( $p < .001$ ). The TE-group lost a mean of 1.8 kilos during the first postoperative week, compared to no significant weight loss for the TT group ( $p < .001$ ) (Table III).

##### *Primary and secondary hemorrhage (I,IV)*

Paper I: Of the 49 children, who were tonsillotomized, two had postoperative bleeding on the day of surgery (2–3 hrs after surgery); one was stopped with diathermy after new anesthesia, and the other stopped spontaneously after suction on ice. One postoperative bleeding occurred among the 43 TE children, which was stopped by injection of desmopressine. No child had secondary hemorrhage (Table III).

Paper IV: There was no primary or secondary hemorrhage in the older TT-group. Two primary postoperative bleedings occurred in the TE group. One was stopped by "suction on ice", the other by injection of desmopres-

sine, both patients received tranexamic acid (1g x 3) for four days. Four TE-patients had secondary hemorrhage. Of these one was severe, occurring on the 9<sup>th</sup> day, and had to be treated in the operating room (Table III).

#### *Otalgia (I,IV)*

Paper I: 8/43 children in the TE group and none in the TT group reported that ear-ache had bothered them more than the sore throat.

Paper IV: 12/44 in the older TE group reported postoperative otalgia and 1/31 in the TT group.

#### *PONV (I)*

Children with postoperative nausea and vomiting (PONV) rated an increase in pain ( $p<.05$ ) (FPS) from the fourth hour after surgery. The children who received only one dose of morphine (0,05mg/kg) had more PONV than the children who received more than one dose ( $p<.01$ ). There was no significant difference of PONV among the children who received antiemetic drugs or not.

### **Long-term Health and Quality of well-being after surgery (III,V).**

Paper III: 91/92 children/parents completed the questionnaire (Qu1) after one year. Eighty-nine came for the follow-up visit and the rest were interviewed by phone (Fig.2).

After  $33\pm 2$  months, all 92 children/parents participated in the follow-up (Fig.2). Two children had moved to foster homes, and the foster parents did not know about the surgery or the infections before surgery. Eight families asked for a telephone contact with a doctor and six of them later came for a visit. Five children had had other surgery after the one year out of whom follow-up – 3 TT and 2 TE had received an adenoidectomy.

Paper IV: All 75 enrolled young adults (Fig.3) answered the one-year follow-up (35% needed two mailings of the questionnaires before responding). All answers were completed by the patient except one (TE)—this one was excluded because it was incomplete. Three TT and two TE patients also came for an ENT-visit; two TT for control after tonsillitis, one TT for sleep registration, one TE due to common colds, sore throat and snoring and one TE due to increased snoring compared with before surgery.

Six patients had had surgery during the follow-up period: 2 TT-boys had

adenoidectomy after a CT-scan was done due to the suspicion of juvenile angiofibroma, one for a haemangioma on the neck, one for a benign breast tumor and one due to an extrauterine pregnancy.

*Self reported postoperative snoring (III,V)*

Paper III: There was no significant difference between the younger TT- and TE-group concerning either frequency (Fig.8) or loudness of snoring either at the one or the three year follow-ups. Snoring was still present for some children in both groups, but there were no children where the parents reported apneas.

After three years, 80% of the parents in both groups rated the child’s sleep at night much better/better and 20% experienced no changes (GCBI).

Paper V: There were no significant differences between the TT and TE-groups either in frequency (Fig.8) or loudness of snoring. Most of the patients, who according to their records had had apneas before surgery, did not have apneas after one year.

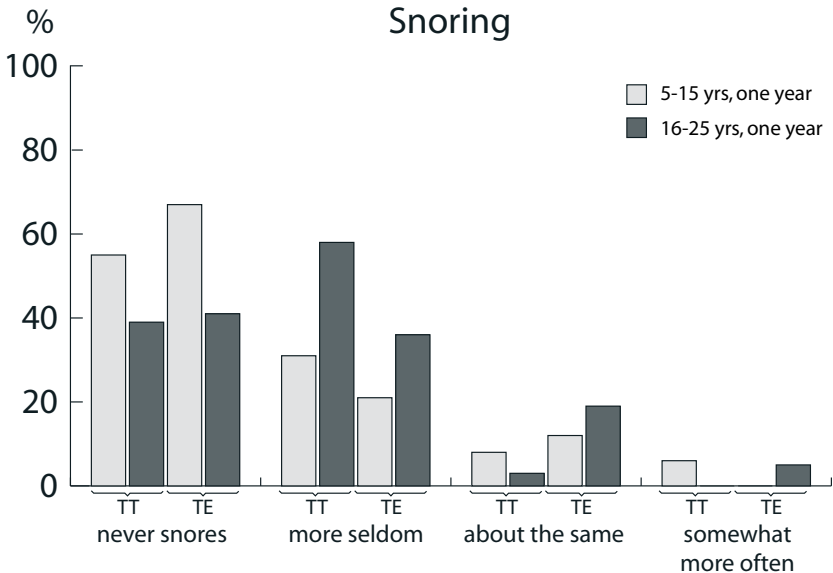


Figure 8. The frequency of snoring one year after surgery in comparison with snoring before operation (Qu) rated by parents' (5-15yrs) and youths' (16-25yrs).

### *ENT infections and use of antibiotics (III,V)*

Paper III: There was no significant difference between the younger TT- and TE-groups regarding all ENT infections (otitis and URI including sore throats) (Fig.9) or the use of antibiotics twelve and 33 months after surgery. Among the children who had had tonsillitis before surgery (65%), the TE-children rated slightly better than the TT regarding all ENT-infections ( $p<.05$ ) after 33 months. Among the children who had had no tonsillitis before surgery there was no difference between the groups after 33 months.

There was no significant difference concerning sore throats/tonsillitis treated with antibiotics between the groups after one year. In the immediate postoperative period, one child in each group was treated with antibiotics due to infection of the surgical field. One child in the TT-group had three episodes tonsillitis during the first year, but none thereafter. During the first year, one TT-child and one TE-child had tonsillitis at the same time as their families suffered from “strep throats”.

At the three year control, there was still no significant difference between the groups in number of sore throat infections treated with antibiotics. In the TE-group, one child, also treated with antibiotics during the first year, had been treated with antibiotics for “strep throat” and three children were treated for “URI including sore throat”. In the TT-group, one child had had tonsillitis after 30 months, another child had had tonsillitis after 13 months and one peritonsillitis after 20 months (17 year-old girl); both were tonsillectomized two months after the follow-up. Three other (TT) were treated for “URI with sore throat”.

On the GCBI-question about whether the child’s operation had made her/him more prone to catch colds or infections, 77% in both groups answered “much better” and “better” (health).

Paper V: There was no difference between the older TT and TE-groups regarding ENT infections (upper respiratory infection including sore throats) (Fig. 9) or the use of antibiotics.

There were five treatment periods with antibiotics for upper respiratory infections (URI) for the TE-group and four for the TT-group. One boy in the TT-group had had two tonsillitis episodes after surgery; he was the only one who had not had tonsillitis before surgery. He was “very satisfied” with the surgery as he had been cured from his obstructivity and slept well with no snoring and had a much better appetite. One TT girl had had mononucleosis two months after surgery; after one year she scored “fewer infections” and “more seldom” with respect to snoring compared to the time

before tonsil surgery.

Infections and health were significantly correlated ( $r_s=-0.47$ ,  $p<.001$ ) as well as infection and satisfaction ( $r_s=-0.37$ ,  $p<.01$ ) (Qu).

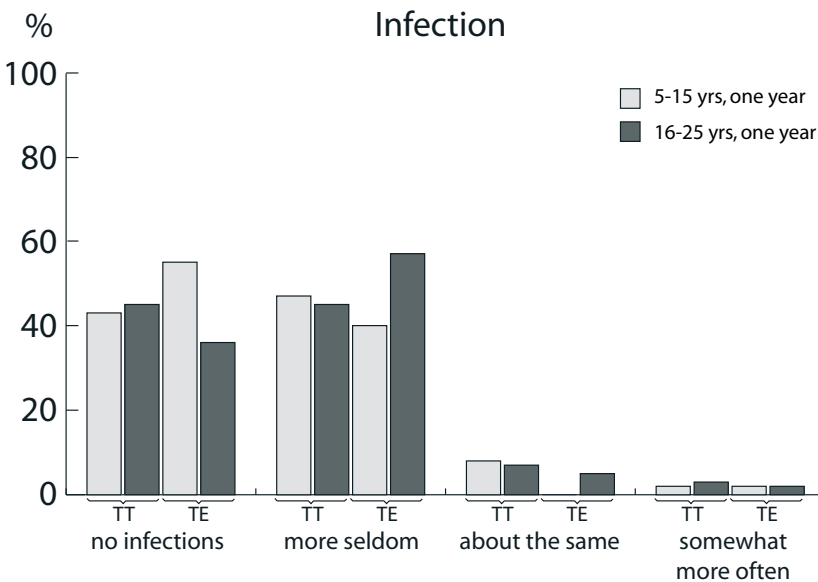


Figure 9 Assessment of how prone to ENT infections (Qu) children and youths were during the first year after surgery.

### General Health, HRQL, Behavior (III,V)

Paper III: Both groups in the younger age group reported improvement in general health after one (Fig. 10) and three years post-surgery with no significant difference between groups. After three years, 97% of the TE- and 96% of the TT-parents rated their child’s overall life “much better” and “better”, no one rated “worse” (GCBI).

There was a correlation between the questions (Qu2) concerning general health and snoring ( $r_s=.47$   $p<.001$ ) as well as between general health and infection ( $r_s=.24$   $p<.05$ ).

There were no significant changes between the one and three year results in the responses of Qu1-Qu2 concerning general health, snoring and infections in either study group.

Compared to normative values on the CBCL there was a difference

before surgery between the whole study group's score and normative values<sup>274</sup> on "Internalization" ( $p<.001$ ) and "total behavior" ( $p<.001$ ). After one year, there was no difference between total behavior and normative values, even though the study group still showed more "Internalization" but in a lower degree than before surgery. After one year, both groups showed the same degree of improvement of scores of the CBCL ( $p<.01$ ).

The results after 33 months regarding emotion, learning and vitality on the GCBI, largely demonstrated "no changes". On the question about absence from school, 64%/TE and 55%/TT rated "better" and "much better".

In both groups, about 50% of the children had better appetite and about 50% rated no changes and normal growth and weight after one year. After 33 months (GCBI), about 50% of the parents rated that the operation had affected the child's enjoyment of food for the better, 50% rated no change. One child in the TT-group rated "worse" on enjoyment of food.

Before surgery, 10 children (7/TE 3/TT), age  $7.4\pm 2.2$  years suffered from primary enuresis. Nine of the ten were dry at night within two weeks after surgery.

Paper V: Both older TT/TE-groups evaluated their health (Qu) to be improved compared with the time before surgery (Fig.10). The results concerning temper, stamina, and concentration after one year showed improvement for approximately 50% of the patients in both groups. On the rest of the variables, each group had about the same score as before surgery.

The younger adults (16-25 yrs) with obstructive problems and tonsillitis showed great significant improvements, 12 months after surgery; in almost all of the dimensions of the SF-36 including some of the dimensions in mental health. There were no differences between the groups. The scores after one year were improved and now normalized and not significantly different from the values among the normal population (Table II in paper V page 8 ).

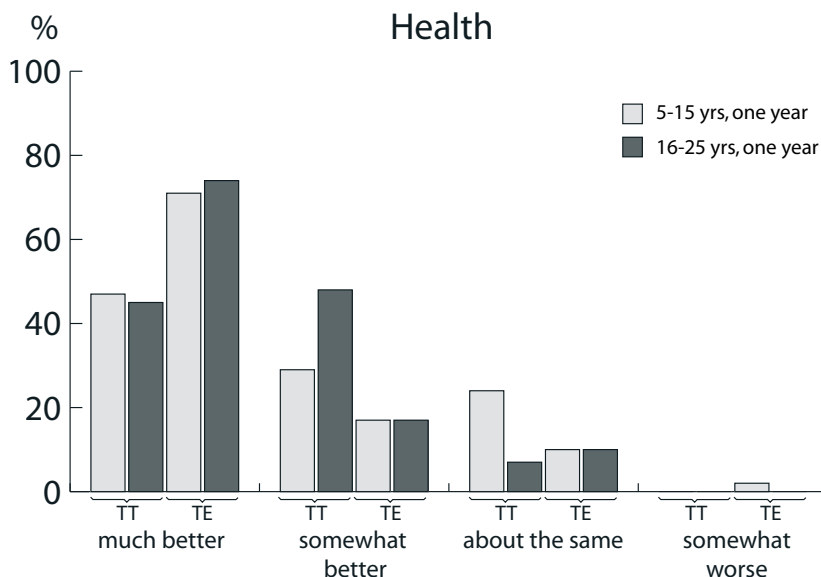


Figure 10. The current health (*Qu*) one year after surgery compared with preoperative condition rated by parents (5-15yrs) and youths (16-25 yrs).

The self-rated overall health on EQ VAS improved in both groups when responses before surgery were compared with those one year after surgery ( $p<.001$ ); there were no differences between the groups (TE/TT). The correlation between EQ VAS and “general health” (SF-36) before surgery was  $r_s=.49$  ( $p<.001$ ) and one year after surgery was  $r_s=.42$  ( $p<.001$ ).

#### *Satisfaction with the surgery (III,V)*

Paper III: After one year more parents in TE group were satisfied with the surgery method. This was due to the three children in the TT group who had suffered tonsillitis after surgery and consequently were not satisfied. After 33 months there were no differences between the level of satisfaction with the different methods. There was a positive correlation between general health and satisfaction after one year ( $r_s=.62$   $p<.001$ ) and after three years ( $r_s=.52$   $p<.001$ ).

Paper V: Both older groups expressed overall satisfaction with the surgery regardless of the method used. No one in the TT-group rated themselves to be “less satisfied”. There was a positive correlation between health and “satisfaction” after one year ( $r_s=.71$   $p<.001$ ).



## DISCUSSION

Every year, a very large number of tonsil operations are performed over the world. The operations are performed on children, teenagers, and young adults who are bothered by enlarged palatine tonsils and recurrent throat infections. Enlarged tonsils can cause a variety of symptoms, mostly in the form of problems with swallowing and breathing. Usually, difficult breathing is more pronounced during the night and leads to sleep disturbance.

A tonsil operation can be performed in two distinctly different ways: The surgeon can totally remove the tonsils, or instead reduce the volume of the tonsils by removing only the enlarged parts. In my work as an anesthetist nurse I have been present in the operation room during a large number of tonsil operations of each kind. I also met many patients in the ward after surgery. I noticed that the postoperative course could be quite different: children and young people who had been subjected to traditional total removal of the palatine tonsils seemed to experience more postoperative pain than those who had received a more conservative, volume reducing operation. In addition to the two surgical methods, different technical instruments are used for tonsillar surgery. Is the surgical method of main importance for the postoperative pain experienced by patients? Can the choice of technical instrumentation used for removal of tonsillar tissue also be of importance? These questions comprised the primary motivation to start the present work.

The present thesis demonstrates that TT with RF performed on selected patients (Fig.2,3), is less painful and associated with considerable reduction of morbidity compared to conventional TE.

### *HRQL and behavior*

Preoperatively the participating children and youths with obstructive problems combined with recurrent tonsillitis had a much lower HRQL with negative impact on their behavior. In several studies upper airway obstruction and OSA have shown serious effects with disruption of school performance, and aggressive behavior<sup>76,79,281</sup>. The disease itself is known to adversely affect HRQL.

One year after surgery both the TT and TE-groups showed the same degree of improvement of scores on the CBCL, and the “total behavior” score approached normal values. Some children still showed more “internalization” problems, but to a lesser extent. This is consistent with other studies after TE<sup>44</sup>. However, this is the first study showing similar improve-

ment after TT. After one year, the youths demonstrated great improvement in HRQL, with transition toward normal values in all dimensions of the SF-36, ranging from physical function to mental health.

The reduction of symptoms and the resulting improvement in HRQL are important outcomes. The findings reported in this thesis confirm for the first time that young adults with obstructivity and recurrent sore throats do have an impaired health status as compared with the general population. Absence from school due to infection, sleep problems, and other health problems promote a vicious circle with impairment of the working memory, attention, and mental flexibility resulting in learning problems<sup>43</sup>. Poor scholastic performance affects many aspects of the patients' life, including their physical, emotional, social and psychological well-being. This not only causes problems for the student, but also places a greater burden on parents and the school system.

The pronounced and rapid improvement after surgery observed in the present work suggests that the operation was the most important factor in bringing about these improvements. It is important that primary care physicians appreciate how patients experience the personal, domestic and social impact of symptoms when judging the usual clinical aspects, and when making a decision regarding referral for surgery. Even though a recurrent sore throat is no life-threatening problem, it is associated with considerable and prolonged morbidity that can be reduced by TE<sup>44,49,282</sup>. Our data clearly demonstrate the same improvement after TT.

#### *Economic benefits*

The economic benefits of TE for adult patients with chronic tonsillitis have been studied previously. TE improves the HRQL and reduces the use of antibiotics, the number of workdays missed, and the number of visits to physicians. Owing to savings in health care, the overall costs for TE in an adult is regained in approximately 2 years<sup>47,48,283,284</sup>.

Data from our TT-studies show a cost/benefit advantage for TT compared to TE, although we have not conducted a strict economical analysis thus far: TT patients recover significantly more rapidly than TE patients, and the need for pain medication is reduced. Almost all TT-operations can be performed as outpatient procedures. The incidence of complications is lower for TT compared to TE. TE-patients require extra support, both in the form of telephone contacts, extra visits due to pain and/or secondary postoperative bleeding. TT-patients return to school/work earlier, and the parents take less time off work compared to TE. These factors are important when

examining the cost-efficacy of TT for recurrent throat infections in adults with tonsillar hypertrophy in comparison to TE.

#### *Advantage with RF-surgery*

Why is RF-tonsillotomy less painful? Why does it cause less bleeding than conventional tonsillectomy? After TE, trauma to surrounding pharyngeal musculature with exposure of underlying nerve endings of the glossopharyngeal and vagus nerves leads to significantly more postoperative pain. The tissue damage is related to the mechanical trauma and the high temperature caused by cautery. The muscles become inflamed, which can lead to spasm. That is the source of intense pain, because every act of swallowing involves movement of the muscles<sup>142</sup>. With the TT(intracapsular procedure), the tonsil capsule and the bottom of the crypts are not damaged, the capsule with the remaining tonsillar lymphoid tissue serves as a “biological dressing”, which prevents the development of an intense inflammatory reaction<sup>17,148,285-287</sup>.

Reducing damage to the surrounding tissue and thereby avoiding damage to the autonomic nerve fibers will also cause less otalgia. This was confirmed in the present work, where less postoperative otalgia was experienced in the TT-group. In a study comparing microdebrider technique in TT and TE, there was a 100% correlation between otalgia and TE<sup>287</sup>.

It is important to avoid unnecessary pain after TT by the choice of surgical instrument, since some instruments (such as the “hot knife”, or laser resection) produce “lateral heat”, which also results in tissue damage<sup>17,148,285,286</sup>. When using the “guillotine method” with no lateral heat at all, it is easy to remove too much tissue due to retraction and “tenting” of the tonsil. This can lead to damage of the tonsillar capsule, which involves a risk for increased bleeding and pain.

#### *Complications*

Pain and hemorrhage are the most important potential complications after TE. In the included studies, there were no secondary bleedings in the younger group, but secondary bleeding occurred in four patients in the older TE-group (9%) and none after TT.

The surgeon may often be more concerned about perioperative bleeding and “knife time”, but for the patient, pain is likely to be the most important issue together with concerns regarding time off from school or work and the time for return to normal activities. Therefore, choosing the best technique involves a complex decision process.

The volume of blood lost during surgery is usually small and the difference between TT and TE is only likely to be relevant when operating on younger children in whom small volume losses may be significant. When the techniques for tonsil surgery are compared, the technique most preferred is often one where perioperative data show the least intraoperative blood loss and the shortest “knife time”. However, blood loss measured in milliliters is mostly small for both methods described here and this loss has scarcely any influence on the patient’s blood circulation. Most of the time in the operating theatre is devoted to induction and ending the anesthesia, so the actual gain from a shorter surgical procedure is seldom of major importance. Seemingly, these aspects are generally not taken into account when surgical techniques are compared. The surgical equipment can be expensive (laser, or RF equipment) and the learning curve can be long (coblation), which also must be considered in an analysis of the cost effectiveness of a certain method.

After TT, a re-growth of the tonsils might be expected, but the risk seems to be low<sup>54</sup>. The rate of tonsillar re-growth for microdebrider tonsillotomy (intracapsular) is estimated to be 0.5-3%<sup>151,288</sup>. In the present thesis, no re-growth of tonsillar tissue was observed in the TT groups, neither at the one-year, nor after the three-year follow-up. However re-growth of adenoid tissue was noticed in a few cases. For our older study group where the natural involution of the tonsils is to be expected, the risk for tonsil re-growth might be still lower than for the younger children.

The risk for development of a peritonsillar abscess might prevail following a partial procedure. In our TT-study group with 5 to 15 years old children<sup>289</sup>, one peritonsillar abscess occurred after one year. However, the same complication can occur following total TE as previously described<sup>54</sup>. In the older TT-group, no episodes of peritonsillitis were seen after one year, but further follow-up is needed in order to confirm that the finding will hold true in a long-term perspective.

#### *Upper respiratory infections*

To suggest the use of TT for patients with a history of tonsillitis, may seem provocative and up to this point, partial surgery has been performed only for illness associated with tonsillar hypertrophy. The results from histological analyses of tonsils after TE suggest a possible relation between recurrent infections and palatine tonsil hypertrophy<sup>290</sup>. Reichel et al.<sup>291</sup> performed a prospective evaluation of the differences in histological and immunological findings in children with recurrent tonsillitis and tonsillar hyperplasia. They found signs of acute and chronic inflammation, even in

specimens from children with no history of recurrent tonsillitis. However, they did not find any higher risk for development of peritonsillar abscesses, or relapsing infections, after TT<sup>291</sup>. In fact, both TT and TE, as described in the present work, demonstrated a large improvement with less infection problems at the one- and three-years follow-up after surgery.

#### *Breathing and sleep disorder*

TT had similar beneficial effects on snoring and disturbed breathing during sleep as TE, as evaluated by questionnaires and clinical examinations. No sleep studies were performed in these patients; this is accordance with praxis in Sweden for “regular cases”. No sleep analysis is done when the clinical findings are consistent with the case history of obstructive problems during sleep.

The reason why TT was as effective as TE in reducing snoring may be due to the Bernoulli effect. The airway is normalized by reducing the volume of the tonsils, with a consequent reduction of the negative pressure caused by the Bernoulli effect. This will lead to less vibration of the soft tissues, or to no vibrations at all, which means reduced or no snoring. A small amount of tissue left in the tonsillar pouches as is the result in TT, may even help to make the pharynx more stable.

#### *Pain, anxiety, treatment and management*

One important aim of this thesis was to study children and young people in relation to tonsil surgery in order to improve the care of these patients. The goal was to give the patients enrolled in the study the best possible “evidence based” treatment through information and pain management before and after surgery. Was that treatment good enough?

Anxiety seems to reflect pain intensity: If children are in significant pain they also report negative emotions. The children in this study were instructed to score the pain (FPS) by answering the question “How much does it hurt you now”, and to answer the STAIC questions “How do you feel right now?” All the children from both TT and TE-group who experienced pain  $\geq 3$  also scored an increased level of anxiety. Postoperatively, the children who underwent TE scored higher anxiety levels than children in the TT-group. The results of this study were similar to other studies in that moderate to severe pain was associated with emotional distress and anxiety<sup>292</sup>. Other studies have shown a correlation between high levels of preoperative anxiety and postoperative pain<sup>293,294</sup>. However, this was not demonstrated in the present work.

We found no correlation between preoperative anxiety and pain, nor did

we see any relation between CBCL and experience of pain. One explanation may be that the children (and parents) had received good preoperative preparation, which reduced the preoperative anxiety. Only a fraction of the children were given any pharmacologic sedation. The TT-children rated less anxiety postoperatively, probably because they did not experience pain or discomfort to the same degree as the children in the TE-group. The hypothesis that children compared their earlier experience of pain in connection with tonsillitis or previous surgery (“more than” or “less than”) with the postoperative pain was not supported. The operation seemed to be a specific event with its own specific subjective experience.

Most patients and parents (98%) were generally satisfied with the written and verbal information regarding the importance of using adequate pain relief medication given at regular intervals and the negative effects of under-medication (poor oral fluid intake, sleep disturbance, behavioral changes, nausea and emesis). The impression was that the patients were not under-medicated. The telephone contact the day after discharge from hospital was also of benefit in reinforcing and clarifying the importance of good pain management.

Many of the children in the TT-group, had “no pain” or “mild pain”, as indicated by pain scores of 0, 1 and 2. Children under age 10 generally scored less pain than those who were older. In the TE-group, no age-related experience of pain could be shown, but this group generally scored higher on pain than did the TT-group. In another study the amount of pain reported was shown to be age related after TE-surgery<sup>159</sup>, which is consistent with the present findings. It is possible that younger children might be easier to distract from pain than are older children, and the effect of “non-pharmacologic” pain management can be considered for children, both younger and older.

Symptoms of postoperative nausea and vomiting (PONV) are common after tonsil surgery. One reason may be the use of opioid medication. In the present work, the children who were given only one dose of morphine had more PONV than children who were given more than one dose. PONV was also significantly related to the pain level, which is in agreement with other studies<sup>89,201</sup>. Effective prevention from pain seems to be more important in reducing PONV than avoidance of opioids. However, the low prevalence of PONV is also related to the use of diclofenac, a drug that provides sufficient pain relief for many patients.

The combination of paracetamol and diclofenac for analgesia proved to be sufficient for most children in the younger age group. However, in the younger TE-group, 40% reached the score  $\geq 3$  some times during the first six days. Therefore, the analgesia could not be regarded as optimal in this group.

The older age group experienced more pain in both surgery groups than did the younger children. Pediatric TE is said to be easier to perform than is TE in adult patients because of less frequent preexisting inflammatory scar formation along the tonsillar capsule. When present, the scarring can make the blunt dissection more difficult, causing more tissue damage. Most of the TE-youths had considerable pain the first week and the pain treatment was not sufficient. Probably, they should have received opiates e.g. tramadol from the very beginning.

Most parents did not under-medicate their child. Rather, they did not exactly follow the instructions for reducing the dosages of the medication: Some kept the diclofenac for a longer time than prescribed and instead began to reduce the paracetamol. One explanation given by parents was that the child preferred to take the diclofenac pills because they were smaller, and parents also found that the onset effect of diclofenac was quicker than for paracetamol.

Pain is the main reason for poor oral intake after tonsil surgery. Therefore, the parents and youths were instructed to administrate medication one hour before meals. However, despite medication, the TE-group had lost significantly more weight after ten days than the TT-group. As a consequence one can infer that the TE-group suffered more of pain at home than the TT-group.

A regime with intake of analgesic at regular intervals<sup>118,295</sup> was followed but only a few children in the younger group received the maximum doses of both paracetamol and diclophenac during the initial 24 hours in hospital. This is in accordance with other studies, showing that children were not given as much medication as was prescribed<sup>292,295</sup>. The nurses scored pain lower than the parents and children in the present study. Even when scoring high pain, the nurses did not always follow the PRN-ordination of morphine. The reason may be misconceptions about opioid tolerance and inappropriate anxiety regarding opioid side effects, such as respiratory depression.

Nurses have a unique role in pain management<sup>292</sup>. Results from other studies indicate that nurses administer pain-relieving medication to children according to how the child expresses the pain: If a child verbalizes his/her pain as becoming more intense, the nurses give analgesics sooner than in cases where a child silently withdraws in bed<sup>178,296</sup>. An increased “internalization” behavior can be one explanation for insufficient pain relief in children in the present work. That acute pain in children still is a problem, was shown in a Swedish nationwide survey performed in 1996. The reason for under-medication was regarded as organizational: There was a lack of clear, written prescriptions, pain assessment routines, and knowledge<sup>297</sup>.

The golden standard for pain measurement is self-report: The patient’s own description of his or her own sensations, and the personal interpretation of these feelings. The national study findings indicated that nurses were generally under-treating the patients’ pain. The findings were similar in the present work, as well as in other studies focusing on pain management after tonsil surgery<sup>172</sup>. Contrary to what they are accustomed to, in the present work the nurses were instructed not to ask the child about the pain, but to make their own judgement, which might have been more difficult and a reason for under-medication. However, there is no obvious explanation as to why they did not follow the standardized prescription.

In a recent Swedish study<sup>29</sup> of which factors are associated with problem behavior, TE was found specifically to have a negative impact on behavior after surgery. A strong correlation was found between pain and problem behavior. Pain experienced at home was the greatest risk factor. Similar to many other studies<sup>100-105</sup>, the author suggests several different interventions to overcome this problem. The first remedy would be to give the parents the possibility of treating the pain pharmacologically by giving them detailed prescriptions and verbal and written information about effects and side effects.

The timing of instruction is also important; it must be given prior to the hospitalization. Parents need to be informed about pain signals and receive instructions on the use of pain measurement using pain scales. This is the procedure that was followed in the work included in the present thesis. Still, some children displayed negative behavior changes during the week following surgery – twice as many TE-patients (n=6) compared with TT patients (n=3). It is not possible to evaluate whether the outcome depended on the surgery or on the hospitalization per se, due to the small sample size.

## Methodological considerations

168 of the original 264 randomized study-patients were operated on (64%). That only 64% were operated is due to two interacting factors: 1) The randomization was done in accordance with the Zelen's method<sup>269,270</sup>, which means that patients were randomized before being contacted and asked if they were willing to participate in the study. 2) The younger patient group had been on the waiting list for surgery more than a year, during which time some of them had become free of infections/snoring resulting in the exclusion of 24 patients. All subjects in the older patient group had been waiting less than six months.

The number of patients who declined to participate without explanation was quite high, 12 TE and 32 TT patients – the latter figure being 50% of all dropouts. The fact that more patients “declined” the TT rather than the TE alternative represents an inclusion bias. Since no analysis was done of those who declined, we cannot exclude the possibility that subjects who had been more severely affected by tonsillitis might have more likely to hesitate when offered the option of a TT-operation. In the introductory letter, all subjects were informed that TT usually causes less pain. The aim of the study – to find out whether patients operated on with TT would be more prone to tonsillitis after the operation than if they had had TE surgery – was also explained in the letter.

After surgery, a “placebo effect” might have been present in the TT group due to an expectation of “painless” tonsil surgery. Such a bias might be present both for patient and parental ratings, as well as for the nurses involved who, when making their evaluations, were aware of which surgical procedure each patient had received. However, when patients were still in the hospital, children, parents, and nurses scored the pain independently. In order to avoid comparison, most of the TT and TE patients (80%) were operated on different days and, when two patients happened to be operated on with different methods on the same day, they were never placed in the same room.

## Clinical implications

The results reported in this thesis demonstrate clear advantages for choosing TT over TE when performed to relieve recurrent tonsillitis in combination with obstructive symptoms. From the viewpoint of health economics, the cost is lower since TT-operations can be performed as out-patient procedures. There is less need and cost for analgesics, and fewer complications with a resulting need for additional postoperative health care.

Thus, the most important point is that the use of the TT-procedure is associated with considerably less postoperative morbidity for both children and young adults, with a considerable socio-economic gain. On the average, parents need to stay home with the child about three days less with TT as compared with tonsillectomy, and the time off from school or work will average four days less for young adults.

## **Suggestions for further research**

The present plan for further research includes long-term follow-ups for all patients enrolled in the studies included in the present thesis, with the aim to monitor the recurrence of obstructive symptoms or/and throat infections after TE and TT.

Children with OSA and sleep disorder breathing have significantly poorer quality of life than healthy children. In Sweden, there is no translated and validated instrument specifically designed to assess SDB for children. Our plan is to validate the OSA-18 in a Swedish translation for SDB/OSA in Swedish children before and after surgery. The OSA-18 (18-item) is divided into five sections: assessing sleep disturbance, physical symptoms, emotional distress, daytime function, and caregivers' concern. Results from OSA-18 have already shown positive correlations to tonsil-size, the adenoid size and also respiratory disturbance<sup>46,298</sup>. The OSA-18 is suitable for use in a wide variety of situations for which patient-based measures of outcome are desirable. Hopefully, clinicians and researchers can use the OSA-18 to categorize the baseline impact of SDB on quality of life as "small", "moderate" or "large", and to quantify changes in HRQL. The OSA-18 is the only survey instrument that has been validated as both a discriminative measure of SDB severity among individuals, and as an evaluative measure of longitudinal change in SDB status. The survey is self-administered and easily completed in about 5 minutes by most caregivers.

Another plan for future research is to validate the Glasgow Children's Benefit Inventory (GCBI)<sup>276</sup> in the Swedish translation. which was used for the first time in the present thesis and needs to be validated in a larger group. The GCBI is a post-intervention health-related benefit measure and it is eminently suitable for use in pediatric otolaryngology (see method section in this thesis).

## CONCLUSIONS

- Children and young people with preoperative obstructive problems, in combination with recurrent tonsillitis display a remarkably low HRQL compared to normal values. The preoperative problems also have a negative impact on behavior compared to normal values.
- Postoperative pain is not correlated with previous behavior of the child (CBCL), with previous surgical experience or with tonsillitis. Only the method of tonsil surgery is associated with the amount of postoperative pain. TE yields a significantly higher pain level and a higher level of anxiety postoperatively than TT.
- Patients and parents reported high satisfaction with verbal and written information about pain management and analgesic treatment given before surgery as well as with the follow-up phone calls after surgery.
- The nurses judged pain to be of lower intensity than the parents/children, and administered less than the prescribed levels of analgesics. For effective application of up-to-date pain treatment and management there is a need for improved education of all health personnel, including physicians, nurses, assistant nurses etc, with regard to pain after tonsil surgery, prevention of pain, and effect of analgesics.
- The combination of paracetamol and NSAID used for analgesia after tonsil surgery is sufficient for most of the younger children. For an older age group the combination is only sufficient in cases involving low intensity pain. For the more severe pain that is experienced by most patients after TE, more effective postoperative analgesia is required, such as tramadol or other opiates.
- Both TT and TE yielded large improvements in HRQL, infections, and obstructive and behavioral problems at the one-year follow-up. This held true for both age groups and for the young age group at the three-year follow-up. This indicates that both surgical methods are equally effective.
- With its lower frequency of postoperative complications, less pain, shorter recovery time and cost reduction, TT with radio frequency technique is considered as the best surgical method. Further follow-up is needed to confirm that these findings will hold over a longer time span.



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# SVENSK SAMMANFATTNING

## *Barns & ungdomars hälsa och välbefinnande i samband med tonsilloperation*

*Elisabeth Ericsson,*

*Institutionen för nervsystem och rörelseorgan,*

*Avd för Otorhinolaryngologi, Hälsouniversitetet, Linköpings universitet*

Halsmandlarna (tonsillerna) sitter på var sin sida i svalget i höjd med tungans rot. Tonsillerna är en del av svalgets lymfvävnad som medverkar i kroppens försvar mot infektioner. Ett mycket stort antal tonsilloperationer utförs varje år över hela världen. Det gäller barn, tonåringar och vuxna som har besvär av förstörade tonsiller och upprepade halsinfektioner. När tonsillerna blir för stora kan de sitta i vägen och ge besvär, främst med sväljning och andning. Andningsproblemen är mest påtagliga under natten och stör sömnen. En tonsilloperation kan genomföras på två principiellt olika sätt: Man kan avlägsna hela tonsillerna (tonsillektomi/TE), eller enbart minska tonsillernas storlek (tonsillotomi/TT), genom att ta bort det som blockerar och därigenom lämna kvar en del immunologiskt aktiv vävnad.

Under mitt arbete som narkosköterska har jag medverkat vid många operationer av båda slagen. Jag har blivit medveten om att förloppet efter operationerna kan vara mycket olika. Barn och ungdomar tycks uppleva mer smärta efter en TE, än efter en volymreducerande TT operation. Det finns också olika tekniska utrustningar som används vid tonsilloperationer. Kan det främst vara valet av kirurgisk metod som har betydelse för smärtan som upplevs efter operation? Ger vi tillräcklig information och smärtlindring efter dessa operationer? Det var för att få svar på sådana frågor, som det här arbetet startades.

### *Beteende och livskvalitet*

Störd nattsömn leder till dagtrötthet med svårigheter att "hänga med" i skolarbete eller problem med att sköta arbete och ger negativ påverkan på andra sociala aktiviteter. Barn kan på grund av sömnbrist och trötthet under en längre tid utveckla psykosociala och beteendemässiga problem från att vara inåtvända, och hämmade till att vara hyperaktiva och "stökiga". Upprepande halsinfektioner leder också till ett försämrat allmäntillstånd med minskad ork och energi. Föräldrar störs också av barnens snarkningar med oro för andningsuppehåll och oro för sina barns och ungdomars skolfrånvaro och därvid skolresultaten. Föräldrar påverkas också genom den förlorade arbetsinkomst de får vid vård av sjukt barn.

Flera studier har tidigare visat att TE förbättrar livskvalitet och beteende. Det finns inte några tidigare studier om huruvida TT påverkar den hälso-relaterade livskvaliteten och beteendet i samma grad eftersom TT innan detta arbete startade enbart hade gjorts på barn med förstorade halsmandlar utan några halsinfektioner i sjukhistorien.

### *TE och TT*

TE medför en lång postoperativ konvalescensperiod på upp till 14 dagar med smärtor och blödningsrisk. TT ger mindre besvär efter operationen än TE, eftersom tonsillkapseln med många infiltrerade nervtrådar och blodkärl sparas. Metoden för TT kan variera men det är viktigt att använda en teknik som samtidigt blodstillar. I denna avhandling har vi använt oss av högfrekventa radiovågor som ger en lägre värmeverkan i operationsområdet vilket minskar graden av vävnadsskador.

### *Smärta och oro*

Smärta är en sensorisk och emotionell upplevelse. Smärta ökar kroppens stressnivå vilket i sig försenar läkningsprocessen. Psykologiskt omhändertagande, inkluderande förberedelse och information är en mycket viktig del för att minska obehaget av operationstillfället. Barnets personlighet, ålder, utvecklingsstadium, tidigare erfarenheter och föräldrars oro är andra faktorer som antas påverka hur barn och ungdomar reagerar både före och efter operation.

### *Smärtlindring*

Paracetamol (ex Panodil, Alvedon) är stöttepelaren i medicineringen av alla patienter som genomgår tonsilloperation, men ger inte tillräcklig smärtlindring som enda medicin. I kombination med ett icke-steroid-antiinflammatoriskt läkemedel (NSAID) ger det bättre smärtlindring. Användandet av NSAID-preparat vid tonsillkirurgi är omdiskuterat med motiveringen att preparaten kan öka blödningsbenägenheten. Flera litteraturstudier har emellertid visat att så inte är fallet.

## **Syfte**

Det övergripande syftet i denna avhandling var att studera barn och ungdomar i samband med tonsilloperation. Syftet var att komma fram till optimala förhållanden när det gäller omhändertagande samt att beskriva och utvärdera den nya mer skonsamma TT metoden, i jämförelse med sedvanlig TE.

## Deltagare

Avhandlingen består av fem delstudier. I dessa delstudier deltog två åldersgrupper med 92 barn 5-15 år gamla och 76 ungdomar i åldern 16-25 år. De som inkluderades i studien var redan uppsatta på väntelista för tonsillektomi på grund av tonsillförstoring som medfört obstruktiva besvär, med eller utan halsinfektioner i sin sjukhistoria. Deltagarna lottades slumpmässigt till 49 TT-operationer och 43 TE-operationer (barn) respektive 32 TT-operationer och 44 TE-operationer (ungdomar). Alla deltagare fick samma information (åldersanpassad) och vid inskrivningen inför operationen, både skriftligt och muntligt om vad som skulle hända vid operations-tillfället, hur smärtskattning skulle ske och hur smärtan skulle behandlas. Smärtstillande mediciner som användes var paracetamol kombinerat med NSAID (Diclofenac).

## Resultat

### *Hälsa före operation*

Innan operationen hade 65% av barnen haft antibiotikabehandlade halsinfektioner och 30% hade tidigare erfarenheter av olika operationer. Föräldrarna besvarade ett formulär om barnets "grundbeteende", Child Behavior Checklist (CBCL). Barnen med obstruktionsbesvär hade mer beteende- och emotionella problem totalt sett jämfört med en svensk normalpopulation, företrädesvis problem avseende ångslan, oro, rädsla och tillbakadragenhet. Barnen som visade sådana beteenden skattade också en högre grad av oro/ångslan före operation på State-Trait Anxiety Inventory for Children (STAIC).

Samtliga ungdomar utom en hade haft behandlade halsinfektioner före operationen. Ungdomarna skattade hälsorelaterad livskvalitet (SF-36) mycket lågt i både fysiska och psykiska dimensioner och betydligt lägre hälsa jämfört med data från en svensk åldersanpassad befolkning.

### *Operationstillfället*

Det var ingen skillnad mellan operationsmetoderna TT och TE när det gällde anestesi och operationstid, men TT medförde mindre blödningsvolymer under operationen än TE.

### *Hälsa och välbefinnande första tiden efter operation*

Barnen skattade sin smärta på en skala med sju olika ritade ansiktsuttryck från "ingen smärta" till "svår smärta" (Face-Pain-scale, Biere). Föräldrar, ungdomar och sjuksköterskor fick också skatta smärta men då på en 7-gradig verbal skala. Barnen bedömde även sin oro/ångslan enligt

STAIC efter operation. TE-barnen skattade högre oro efter operation än TT-barnen. Alla barn som skattade smärta  $\geq 3$ , dvs. medelsvår till värsta tänkbara smärta, skattade också högre grad av oro än de som skattade lite smärta. Det fanns ingen relation mellan barnets grundbeteende och smärta efter TT/TE, inte heller något samband mellan tidigare halsinfektioner och hur man upplevde smärtan efter operationen. Det var ingen skillnad mellan föräldrarnas och barnens smärtskattningar. Personalen skattade lägre smärta än barnen och föräldrarna på sjukhuset, vilket kan ha medfört underbehandling med smärtstillande det första dygnet trots en stående ordination.

Den äldre åldersgruppens operationer gjordes både som dagkirurgi och inläggande (ett dygn), beroende på respektive sjukhus rutiner och patienternas resväg. Fler patienter i TT-gruppen skrevs ut inom 8 timmar efter operation än i TE-gruppen. Dagen efter hemkomsten från sjukhuset kontaktades alla per telefon för att stämma av hur smärtlindringen fungerade och för att ge möjlighet att ställa frågor. Alla hade fått ett telefonnummer där de kunde få kontakt när som helst på dygnet vid behov. Denna möjlighet brukades av över 50% av patienterna i TE-gruppen p.g.a. smärta, svårighet att äta och blödning jämfört med 3% i TT-gruppen.

TT i båda åldersgrupperna gav betydligt mindre smärta, nedgång av allmäntillståndet, lägre intag av smärtstillande medicin och tre dagar (5-15 år) respektive fyra dagars (16-25 år) kortare postoperativ konvalescensperiod i hemmet, än efter traditionell TE. Kombinationen av paracetamol och NSAID visade sig vara tillräcklig för de flesta TT/TE barnen och TT-ungdomarna, medan de äldre i TE-gruppen behövde komplettering med opioid (tramadol).

Det gavs inga restriktioner vad gällde mat och dryck. Instruktionerna var att ta smärtstillande medicin en timme före måltid och att försöka komma igång med normal kost så fort som möjligt för att befrämja läkningsprocessen. Alla fick dagligen notera hur besvärligt det hade varit att äta. TT-gruppen kunde oftast äta normalkost dagen efter operation medan TE-gruppen åt flytande och mjuk kost på grund av smärta i flera dagar. Patienterna i TE-gruppen fick därför en betydande viktne-  
dgång. De var också mycket mer allmänt nedgångna än TT-gruppen vid återbesöket efter sju till nio dagar. I den yngre åldersgruppen, varken för TT eller TE eller i den äldre TT-gruppen, var det inte någon som fick en blödning veckan efter operationen. I den äldre TE-gruppen däremot var det fyra ungdomar som fick uppsöka sjukhuset p.g.a. blödning sex-åtta dagar efter operationen. En av dessa blödningar stoppades under narkos, de andra medicinbehandlades.

I TE-gruppen klagade fler på smärta upp mot öronen än i TT-gruppen. Läkningsprocessen var betydligt kortare för TT-gruppen och vid återbesöket vid dag 9, var 73% i TT-gruppen helt läkta medan endast 31% av TE-gruppen.

#### *Långtidsuppföljning av hälsa och livskvalitet efter operation*

Ett år efter operationen kom barn och föräldrar på uppföljningsbesök hos öronläkare och sköterska. CBCL och ett frågeformulär (Qu) om hälsa, infektion, obstruktivitet och beteende besvarades. Tre år efter operationen besvarades per post frågeformuläret (Qu) igen, samt ett livskvalitetformulär (Glasgow Children's Benefit Inventory). Ett år efter operation besvarade samtliga ungdomar per post frågeformuläret (Qu) samt SF-36. Tre TT och två TE kom också på ett mottagningsbesök.

Resultaten visade att effekten på snarkning var densamma för TT och TE och antalet infektioner var lågt för båda operationsmetoderna. Det förelåg inga skillnader i dessa resultat mellan åldersgrupperna.

Efter ett år var barnens grundbeteende förbättrat i samma grad hos båda operationsgrupperna och det var inte längre någon skillnad mellan gruppernas skattning på CBCL jämfört med genomsnittsvärden från en svensk population. Både TT och TE gruppen hade förbättrats i aptit, ork/energi, koncentrationsförmåga och hade förbättrad hälsa både efter ett och efter tre år.

En betydande förbättring hade skett av livskvaliteten hos ungdomarna inom samtliga dimensioner vid mätning ett år efter operationen. Det var ingen skillnad mellan TT/TE eller mellan grupperna och normaldata.

## **Slutsatser**

Barn och ungdomar med obstruktiva halsproblem i kombination med varierande antal halsinfektioner uppvisar oftare ett mer negativt grundbeteende och skattar sin hälsa lägre än jämnåriga i normalpopulation. Grundbeteende, tidigare erfarenheter av operationer och halsinfektioner påverkar inte den postoperativa smärtupplevelsen utan det är enbart operationsmetoden som är det avgörande. TE är förknippat med mer oro och betydande mer självskattad smärta än TT. Smärtbehandling med en kombination av paracetamol och NSAID är tillräckligt för de flesta yngre barn men hos ungdomar som TE-opereras behövs en komplettering med ett opiatpreparat.

Resultaten visar att TT med RF-teknik är en säker och skonsam metod för tonsillkirurgi med mindre smärta och mindre nedgång av allmän tillståndet. TE och TT har lika god effekt på snarkning, infektioner, beteende och livskvalitet. Genom att övergå till det mer skonsamma ingreppet TT skulle det gå att åstadkomma en avgörande minskning vad gäller patienternas lidande, och en kortare frånvaro från skola och arbete, vilket skulle leda till en samhällsekonomisk vinst. Eftersom TT kan utföras i dagkirurgi får man också en sjukvårdsekonomisk vinst.

## APPENDIX

### Questionnaire after tonsil surgery, Qu 1-2 (III,V)

*All information that you submit will be handled confidentially, i.e. no names or personal data will be presented in the study. No single person's answers will be able to be identified at presentations of the study*

1. \* **How do you think your child's health is now (How do you perceive your health now) compared to the time before the operation on the tonsils?**  
Much better ☐ Some what better ☐ About the same ☐ Somewhat worse ☐ Much worse ☐
2. **How do you think your child's temper is now (How do you perceive your temper now)" compared to before surgery?**  
Much better ☐ Some what better ☐ About the same ☐ Somewhat worse ☐ Much worse ☐
3. **How do you think your child's stamina/energy is (How do you perceive your stamina/energy)compared to before surgery?**  
Much better ☐ Some what better ☐ About the same ☐ Somewhat worse ☐ Much worse ☐
4. **How do you think your child's (How do you perceive your) concentration is now compared to before surgery?**  
Much better ☐ Some what better ☐ About the same ☐ Somewhat worse ☐ Much worse ☐
5. **How do you think your child's appetite is (How do you perceive your appetite) compared to before surgery?**  
Much better ☐ Some what better ☐ About the same ☐ Somewhat worse ☐ Much worse ☐
6. \* **How often does your child (How often do you) snore now, compared with before operation?**  
Never snores ☐ More seldom ☐ About the same ☐ Somewhat more often ☐ Much more often ☐
7. \* **How loudly does your child (How loudly do you) snore now, compared with before operation?**  
Does not snores ☐ Less loudly ☐ About the same ☐ Somewhat more loudly ☐ Much more loudly ☐
8. \* **How often has your child (How often have you) been affected by infections within ear, nose and throat area, compared with before the operation?**  
No infections ☐ More seldom ☐ About the same ☐ Somewhat more often ☐ Much more often ☐
9. \* **How many of these infections have been treated with antibiotics?**  
Fill in a number:
10. \* **Which types of infections have been treated with antibiotics? (For example, otitis, throat infection)\_\_\_\_\_**
11. \* **How satisfied are you and your child (How satisfied are you) with the results of the operation on the tonsils?**  
Very satisfied ☐ Satisfied ☐ Somewhat satisfied ☐ Less than satisfied ☐ Not satisfied at all ☐
12. \* **If you have any comments to our questions, about the operation or the time after the throat operation, you are welcome to write them here and use the reverse side of the paper if you need to:**

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\* Eight questions included in questionnaire, Qu2 (three years follow-up study III).



## REFERENCES

1. Socialstyrelsens statistikdatabaser. 2005. [www.socialstyrelsen.se/Statistik/statistik-databas/](http://www.socialstyrelsen.se/Statistik/statistik-databas/) Assess date: January 29 2007
2. Carroll T, Ladner K, Meyers AD. Alternative surgical dissection techniques. *Otolaryngol Clin North Am* 2005;38:397-411.
3. Hultcrantz E, Linder A, Markstrom A. Tonsillectomy or tonsillotomy?--A randomized study comparing postoperative pain and long-term effects. *Int J Pediatr Otorhinolaryngol* 1999;51:171-176.
4. Husband AD, Davis A. Pain after tonsillectomy. *Clin Otolaryngol Allied Sci* 1996;21:99-101.
5. Warnock FF, Lander J. Pain progression, intensity and outcomes following tonsillectomy. *Pain* 1998;75:37-45.
6. Thomsen J, Gower V. Adjuvant therapies in children undergoing adenotonsillectomy. *Laryngoscope* 2002;112:32-34.
7. Oko MO, Ganly I, Loughran S, Clement WA, Young D, Geddes NK. A prospective randomized single-blind trial comparing ultrasonic scalpel tonsillectomy with tonsillectomy by blunt dissection in a pediatric age group. *Otolaryngol Head Neck Surg* 2005;133:579-584.
8. Ishlah LW, Fahmi AM, Srinovianti N. Laser versus dissection technique of tonsillectomy. *Med J Malaysia* 2005;60:76-80.
9. Kirazli T, Bilgen C, Midilli R, Ogut F, Uyar M, Kedek A. Bipolar electrodissection tonsillectomy in children. *Eur Arch Otorhinolaryngol* 2005;262:716-718.
10. Parsons SP, Cordes SR, Comer B. Comparison of posttonsillectomy pain using the ultrasonic scalpel, coblator, and electrocautery. *Otolaryngol Head Neck Surg* 2006;134:106-113.
11. Potts KL, Augenstein A, Goldman JL. A parallel group analysis of tonsillectomy using the harmonic scalpel vs electrocautery. *Arch Otolaryngol Head Neck Surg* 2005;131:49-51.
12. Pinder D, Hilton M. Dissection versus diathermy for tonsillectomy. *Cochrane Database Syst Rev* 2001;CD002211.
13. Bergler W, Huber K, Hammerschmitt N, Hormann K. Tonsillectomy with argon plasma coagulation (APC): evaluation of pain and hemorrhage. *Laryngoscope* 2001;111:1423-1429.
14. Moriyama I, Nobori T, Nishizano H, Ohgama M. A new instrument for use with Nd:YAG in tonsillectomy. *J Clin Laser Med Surg* 1992;10:47-50.
15. Raut V, Bhat N, Kinsella J, Toner JG, Sinnathuray AR, Stevenson M. Bipolar scissors versus cold dissection tonsillectomy: a prospective, randomized, multi-unit study. *Laryngoscope* 2001;111:2178-2182.
16. Sugiura N, Ochi K, Komatsuzaki Y, Nishino H, Ohashi T. Postoperative pain in tonsillectomy: comparison of ultrasonic tonsillectomy versus blunt dissection tonsillectomy. *ORL J Otorhinolaryngol Relat Spec* 2002;64:339-342.
17. Densert O, Desai H, Eliasson Aet al. Tonsillotomy in children with tonsillar hypertrophy. *Acta Otolaryngol* 2001;121:854-858.
18. Koltai PJ, Solares CA, Mascha EJ, Xu M. Intracapsular partial tonsillectomy for tonsillar hypertrophy in children. *Laryngoscope* 2002;112:17-19.
19. Anderson B. Acetaminophen analgesia in infants. *Anesth Analg* 2001;93:1626-1627.
20. Anderson BJ. What we don't know about paracetamol in children. *Paediatr Anaesth* 1998;8:451-460.

21. Romsing J. Assessment of nurses' judgement for analgesic requirements of postoperative children. *J Clin Pharm Ther* 1996;21:159-163.
22. Kokinsky E, Thornberg E. Postoperative pain control in children: a guide to drug choice. *Paediatr Drugs* 2003;5:751-762.
23. Kokki H. Nonsteroidal anti-inflammatory drugs for postoperative pain: a focus on children. *Paediatr Drugs* 2003;5:103-123.
24. Johnston CC, Abbott FV, Gray-Donald K, Jeans ME. A survey of pain in hospitalized patients aged 4-14 years. *Clin J Pain* 1992;8:154-163.
25. Schechter NL. The undertreatment of pain in children: an overview. *Pediatr Clin North Am* 1989;36:781-794.
26. Finley GA, McGrath PJ, Forward SP, McNeill G, Fitzgerald P. Parents' management of children's pain following 'minor' surgery. *Pain* 1996;64:83-87.
27. Romsing J, Hertel S, Harder A, Rasmussen M. Examination of acetaminophen for outpatient management of postoperative pain in children. *Paediatr Anaesth* 1998;8:235-239.
28. Mather L, Mackie J. The incidence of postoperative pain in children. *Pain* 1983;15:271-282.
29. Karling M. *Child behavior and pain after hospitalization, surgery and anaesthesia*. Doctoral thesis, Umeå University, Umeå, Sweden 2006.
30. Kotiniemi LH, Ryhanen PT, Moilanen IK. Behavioural changes in children following day-case surgery: a 4-week follow-up of 551 children. *Anaesthesia* 1997;52:970-976.
31. Kain ZN. Postoperative maladaptive behavioral changes in children: incidence, risks factors and interventions. *Acta Anaesthesiol Belg* 2000;51:217-226.
32. Kain ZN, Mayes LC, O'Connor TZ, Cicchetti DV. Preoperative anxiety in children. Predictors and outcomes. *Arch Pediatr Adolesc Med* 1996;150:1238-1245.
33. Kain ZN, Sevarino F, Pincus S et al. Attenuation of the preoperative stress response with midazolam: effects on postoperative outcomes. *Anesthesiology* 2000;93:141-147.
34. Johnston M. Pre-operative emotional states and post-operative recovery. *Adv Psychosom Med* 1986;15:1-22.
35. Johnston M, Carpenter L. Relationship between pre-operative anxiety and post-operative state. *Psychol Med* 1980;10:361-367.
36. Kain ZN, Sevarino F, Alexander GM, Pincus S, Mayes LC. Preoperative anxiety and postoperative pain in women undergoing hysterectomy. A repeated-measures design. *J Psychosom Res* 2000;49:417-422.
37. Sime AM. Relationship of preoperative fear, type of coping, and information received about surgery to recovery from surgery. *J Pers Soc Psychol* 1976;34:716-724.
38. Burton MJ, Towler B, Glasziou P. Tonsillectomy versus non-surgical treatment for chronic / recurrent acute tonsillitis. *Cochrane Database Syst Rev* 2000;CD001802.
39. Avior G, Fishman G, Leor A, Sivan Y, Kaysar N, Derowe A. The effect of tonsillectomy and adenoidectomy on inattention and impulsivity as measured by the Test of Variables of Attention (TOVA) in children with obstructive sleep apnea syndrome. *Otolaryngol Head Neck Surg* 2004;131:367-371.
40. Ray RM, Bower CM. Pediatric obstructive sleep apnea: the year in review. *Curr Opin Otolaryngol Head Neck Surg* 2005;13:360-365.
41. O'Brien LM, Gozal D. Neurocognitive dysfunction and sleep in children: from human to rodent. *Pediatr Clin North Am* 2004;51:187-202.
42. Guilleminault C, Tilkian A, Dement WC. The sleep apnea syndromes. *Annu Rev Med* 1976;27:465-484.

43. Leiberman A, Stiller-Timor L, Tarasiuk A, Tal A. The effect of adenotonsillectomy on children suffering from obstructive sleep apnea syndrome (OSAS): the Negev perspective. *Int J Pediatr Otorhinolaryngol* 2006;70:1675-1682.
44. Goldstein NA, Fatima M, Campbell TF, Rosenfeld RM. Child behavior and quality of life before and after tonsillectomy and adenoidectomy. *Arch Otolaryngol Head Neck Surg* 2002;128:770-775.
45. De Serres LM, Derkay C, Sie Ket al. Impact of adenotonsillectomy on quality of life in children with obstructive sleep disorders. *Arch Otolaryngol Head Neck Surg* 2002;128:489-496.
46. Franco RA, Jr., Rosenfeld RM, Rao M. First place--resident clinical science award 1999. Quality of life for children with obstructive sleep apnea. *Otolaryngol Head Neck Surg* 2000;123:9-16.
47. Bhattacharyya N, Kepnes LJ, Shapiro J. Efficacy and quality-of-life impact of adult tonsillectomy. *Arch Otolaryngol Head Neck Surg* 2001;127:1347-1350.
48. Mui S, Rasgon BM, Hilsinger RL, Jr. Efficacy of tonsillectomy for recurrent throat infection in adults. *Laryngoscope* 1998;108:1325-1328.
49. Oluwasanmi AF, Thornton MR, Khalil HS, Tierney PA. Effect of tonsillectomy on recurrent sore throats in adults: patients' perspectives. *J Laryngol Otol* 2006;120:e7.
50. Stewart MG, Glaze DG, Friedman EM, Smith EO, Bautista M. Quality of life and sleep study findings after adenotonsillectomy in children with obstructive sleep apnea. *Arch Otolaryngol Head Neck Surg* 2005;131:308-314.
51. Anand A, Vilela RJ, Guarisco JL. Intracapsular versus standard tonsillectomy: review of literature. *J La State Med Soc* 2005;157:259-261.
52. Derkay CS, Darrow DH, LeFebvre SM. Pediatric tonsillectomy and adenoidectomy procedures. *Aorn J* 1995;62:887-904; quiz 906-810.
53. Younis RT, Lazar RH. History and current practice of tonsillectomy. *Laryngoscope* 2002;112:3-5.
54. Koempel JA, Solares CA, Koltai PJ. The evolution of tonsil surgery and rethinking the surgical approach to obstructive sleep-disordered breathing in children. *J Laryngol Otol* 2006;120:993-1000.
55. Darrow DH, Siemens C. Indications for tonsillectomy and adenoidectomy. *Laryngoscope* 2002;112:6-10.
56. Nossios G, Xanthopoulos J, Zaraboukas T, Vital V, Konstantinidis I. Morphological study of development and functional activity of palatine tonsils in embryonic age. *Acta Otorhinolaryngol Ital* 2003;23:98-101.
57. Winkelmann A. Wilhelm von Waldeyer-Hartz (1836-1921): An anatomist who left his mark. *Clin Anat* 2006.
58. Bernstein JM, Gofrien J, & Brandtzaeg, P. Mucosal Immunology. Ogra, P.L., Mestecky, J, Strober, W., Bienenstock, J., and McGhee, J.E.: *Academic Press*, 1998:1339-1362.
59. van Kempen MJ, Rijkers GT, Van Cauwenberge PB. The immune response in adenoids and tonsils. *Int Arch Allergy Immunol* 2000;122:8-19.
60. Brandtzaeg P. Immunology of tonsils and adenoids: everything the ENT surgeon needs to know. *Int J Pediatr Otorhinolaryngol* 2003;67 Suppl 1:S69-76.
61. Lopez-Gonzalez MA, Sanchez B, Mata F, Delgado F. Tonsillar lymphocyte subsets in recurrent acute tonsillitis and tonsillar hypertrophy. *Int J Pediatr Otorhinolaryngol* 1998;43:33-39.
62. Fujiyoshi T, Watanabe T, Ichimiya I, Mogi G. Functional architecture of the nasopharyngeal tonsil. *Am J Otolaryngol* 1989;10:124-131.

63. Zielnik-Jurkiewicz B, Jurkiewicz D. Implication of immunological abnormalities after adenotonsillotomy. *Int J Pediatr Otorhinolaryngol* 2002;64:127-132.
64. Paulussen C, Claes J, Claes G, Jorissen M. Adenoids and tonsils, indications for surgery and immunological consequences of surgery. *Acta Otorhinolaryngol Belg* 2000;54:403-408.
65. Lofstrand-Tidestrom B, Thilander B, Ahlqvist-Rastad J, Jakobsson O, Hultcrantz E. Breathing obstruction in relation to craniofacial and dental arch morphology in 4-year-old children. *Eur J Orthod* 1999;21:323-332.
66. Capper R, Canter RJ. Is the incidence of tonsillectomy influenced by the family medical or social history? *Clin Otolaryngol Allied Sci* 2001;26:484-487.
67. Blum DJ, Neel HB, 3rd. Current thinking on tonsillectomy and adenoidectomy. *Compr Ther* 1983;9:48-56.
68. Paradise JL, Bluestone CD, Bachman RZ et al. Efficacy of tonsillectomy for recurrent throat infection in severely affected children. Results of parallel randomized and nonrandomized clinical trials. *N Engl J Med* 1984;310:674-683.
69. Marshall T. A review of tonsillectomy for recurrent throat infection. *Br J Gen Pract* 1998;48:1331-1335.
70. van Staaij BK, van den Akker EH, van der Heijden GJ, Schilder AG, Hoes AW. Adenotonsillectomy for upper respiratory infections: evidence based? *Arch Dis Child* 2005;90:19-25.
71. Marcus CL. Sleep-disordered breathing in children. *Am J Respir Crit Care Med* 2001;164:16-30.
72. Guilleminault C, Stoohs R. Chronic snoring and obstructive sleep apnea syndrome in children. *Lung* 1990;168 Suppl:912-919.
73. Hultcrantz E, Larson M, Hellquist R, Ahlqvist-Rastad J, Svanholm H, Jakobsson OP. The influence of tonsillar obstruction and tonsillectomy on facial growth and dental arch morphology. *Int J Pediatr Otorhinolaryngol* 1991;22:125-134.
74. Ng DK, Chow PY, Chan CH, Kwok KL, Cheung JM, Kong FY. An update on snoring. *Acta Paediatr* 2006;95:1029-1035.
75. Guilleminault C, Pelayo R. Sleep-disordered breathing in children. *Ann Med* 1998;30:350-356.
76. Chervin RD, Archbold KH, Dillon JE et al. Inattention, hyperactivity, and symptoms of sleep-disordered breathing. *Pediatrics* 2002;109:449-456.
77. Amin RS, Carroll JL, Jeffries J et al. Twenty-four-hour ambulatory blood pressure in children with sleep-disordered breathing. *Am J Respir Crit Care Med* 2004;169:950-956.
78. Brouillette RT, Fernbach SK, Hunt CE. Obstructive sleep apnea in infants and children. *J Pediatr* 1982;100:31-40.
79. Gozal D. Sleep-disordered breathing and school performance in children. *Pediatrics* 1998;102:616-620.
80. Ali NJ, Pitson DJ, Stradling JR. Snoring, sleep disturbance, and behaviour in 4-5 year olds. *Arch Dis Child* 1993;68:360-366.
81. Guilleminault C, Winkle R, Korobkin R, Simmons B. Children and nocturnal snoring: evaluation of the effects of sleep related respiratory resistive load and daytime functioning. *Eur J Pediatr* 1982;139:165-171.
82. Gozal D, O'Brien LM. Snoring and obstructive sleep apnoea in children: why should we treat? *Paediatr Respir Rev* 2004;5 Suppl A:S371-376.
83. Chervin RD, Clarke DF, Huffman J et al. School performance, race, and other correlates of sleep-disordered breathing in children. *Sleep Med* 2003;4:21-27.
84. Howel D, Webster S, Hayes J, Barton A, Donaldson L. The impact of recurrent throat infection on children and their families. *Fam Pract* 2002;19:242-246.

85. WHO. Constitution of the World Health Organization, Geneva, 1946. <http://w3.who.sea.org/> Access date: January 30.2007.
86. Flanary VA. Long-term effect of adenotonsillectomy on quality of life in pediatric patients. *Laryngoscope* 2003;113:1639-1644.
87. Stewart MG, Friedman EM, Sulek Met al. Quality of life and health status in pediatric tonsil and adenoid disease. *Arch Otolaryngol Head Neck Surg* 2000;126:45-48.
88. Caumo W, Broenstrub JC, Fialho Let al. Risk factors for postoperative anxiety in children. *Acta Anaesthesiol Scand* 2000;44:782-789.
89. Kotiniemi LH, Ryhanen PT, Valanne J, Jokela R, Mustonen A, Poukkula E. Postoperative symptoms at home following day-case surgery in children: a multicentre survey of 551 children. *Anaesthesia* 1997;52:963-969.
90. McCann ME, Kain ZN. The management of preoperative anxiety in children: an update. *Anesth Analg* 2001;93:98-105.
91. Tripi PA, Palermo TM, Thomas S, Goldfinger MM, Florentino-Pineda I. Assessment of risk factors for emergence distress and postoperative behavioural changes in children following general anaesthesia. *Paediatr Anaesth* 2004;14:235-240.
92. Lumley MA, Melamed BG, Abeles LA. Predicting children's presurgical anxiety and subsequent behavior changes. *J Pediatr Psychol* 1993;18:481-497.
93. Proczkowska-Bjorklund M, Svedin CG. Child related background factors affecting compliance with induction of anaesthesia. *Paediatr Anaesth* 2004;14:225-234.
94. Mansson ME, Dykes AK. Practices for preparing children for clinical examinations and procedures in Swedish pediatric wards. *Pediatr Nurs* 2004;30:182-187, 229.
95. Edwinson-Månsson M. *The value of informing children prior to investigations and procedures*. Doctoral thesis, Lund University, Lund, Sweden, 1992.
96. Margolis JO, Ginsberg B, Dear GL, Ross AK, Goral JE, Bailey AG. Paediatric preoperative teaching: effects at induction and postoperatively. *Paediatr Anaesth* 1998;8:17-23.
97. Schmidt CK. Pre-operative preparation: effects on immediate pre-operative behavior, post-operative behavior and recovery in children having same-day surgery. *Matern Child Nurs J* 1990;19:321-330.
98. Meursing AE. Anaesthesia for day care surgery, patient selection, evaluation, preoperative preparation and selection of drugs. *Acta Anaesthesiol Belg* 1999;50:29-34.
99. LaMontagne LL, Hepworth JT, Cohen F. Effects of surgery type and attention focus on children's coping. *Nurs Res* 2000;49:245-252.
100. Kankkunen P, Vehvilainen-Julkunen K, Pietila AM, Halonen P. Is the sufficiency of discharge instructions related to children's postoperative pain at home after day surgery? *Scand J Caring Sci* 2003;17:365-372.
101. Hicklin L, Tostevin PM, Wyatt ME. Parental satisfaction with paediatric day-case ENT surgery. *J Laryngol Otol* 1999;113:1072-1075.
102. Lander J, Warnock F. Supporting the parents of children in day surgery. *Can Nurse* 1999;95:29-33.
103. Huth MM. Pediatric day surgery outcomes management: the role of preoperative anxiety and a home pain management protocol. *J Child Fam Nurs* 1999;2:273-275.
104. Kankkunen PM, Vehvilainen-Julkunen KM, Pietila AM. Children's postoperative pain at home: family interview study. *Int J Nurs Pract* 2002;8:32-41.
105. Snowdon AW, Kane DJ. Parental needs following the discharge of a hospitalized child. *Pediatr Nurs* 1995;21:425-428.
106. Cook-Sather SD, Litman RS. Modern fasting guidelines in children. *Best Pract Res Clin Anaesthesiol* 2006;20:471-481.

107. Soreide E, Eriksson LI, Hirlekar Get al. Pre-operative fasting guidelines: an update. *Acta Anaesthesiol Scand* 2005;49:1041-1047.
108. Brady M, Kinn S, O'Rourke K, Randhawa N, Stuart P. Preoperative fasting for preventing perioperative complications in children. *Cochrane Database Syst Rev* 2005; CD005285.
109. Astfalk W, Warth H, Leriche C. Day case surgery in childhood from the parents' point of view. *Eur J Pediatr Surg* 1991;1:323-327.
110. Kain ZN, Mayes LC, Wang SM, Hofstadter MB. Postoperative behavioral outcomes in children: effects of sedative premedication. *Anesthesiology* 1999;90:758-765.
111. Payne KA, de Roubaix JA. Post-hospitalisation behavioural changes in children: effects of day-stay surgery. *Afr J Med Med Sci* 1994;23:327-332.
112. Watson AT, Visram A. Children's preoperative anxiety and postoperative behaviour. *Paediatr Anaesth* 2003;13:188-204.
113. Parnis SJ, Foate JA, van der Walt JH, Short T, Crowe CE. Oral midazolam is an effective premedication for children having day-stay anaesthesia. *Anaesth Intensive Care* 1992;20:9-14.
114. Golparvar M, Saghaei M, Sajedi P, Razavi SS. Paradoxical reaction following intravenous midazolam premedication in pediatric patients - a randomized placebo controlled trial of ketamine for rapid tranquilization. *Paediatr Anaesth* 2004;14:924-930.
115. McGraw T, Kendrick A. Oral midazolam premedication and postoperative behaviour in children. *Paediatr Anaesth* 1998;8:117-121.
116. Pringle B, Dahlquist LM, Eskenazi A. Memory in pediatric patients undergoing conscious sedation for aversive medical procedures. *Health Psychol* 2003;22:263-269.
117. Wall PD. The prevention of postoperative pain. *Pain* 1988;33:289-290.
118. Thornevan G, Akervall J. Pain treatment after tonsillectomy: advantages of analgesics regularly given compared with analgesics on demand. *Acta Otolaryngol* 2000;120:986-989.
119. Kain ZN, Mayes LC, Caramico LA et al. Parental presence during induction of anaesthesia. A randomized controlled trial. *Anesthesiology* 1996;84:1060-1067.
120. Stargatt R, Davidson AJ, Huang GH et al. A cohort study of the incidence and risk factors for negative behavior changes in children after general anaesthesia. *Paediatr Anaesth* 2006;16:846-859.
121. Cameron JA, Bond MJ, Pointer SC. Reducing the anxiety of children undergoing surgery: parental presence during anaesthetic induction. *J Paediatr Child Health* 1996;32:51-56.
122. Kam PC, Voss TJ, Gold PD, Pitkin J. Behaviour of children associated with parental participation during induction of general anaesthesia. *J Paediatr Child Health* 1998;34:29-31.
123. Bevan JC, Johnston C, Haig MJ et al. Preoperative parental anxiety predicts behavioural and emotional responses to induction of anaesthesia in children. *Can J Anaesth* 1990;37:177-182.
124. Meretoja OA, Taivainen T, Raiha L, Korpela R, Wirtavuori K. Sevoflurane-nitrous oxide or halothane-nitrous oxide for paediatric bronchoscopy and gastroscopy. *Br J Anaesth* 1996;76:767-771.
125. Taivainen T, Tiainen P, Meretoja OA, Raiha L, Rosenberg PH. Comparison of the effects of sevoflurane and halothane on the quality of anaesthesia and serum glutathione transferase alpha and fluoride in paediatric patients. *Br J Anaesth* 1994;73:590-595.

126. Greenspun JC, Hannallah RS, Welborn LG, Norden JM. Comparison of sevoflurane and halothane anesthesia in children undergoing outpatient ear, nose, and throat surgery. *J Clin Anesth* 1995;7:398-402.
127. Dubois MC, Piat V, Constant I, Lamblin O, Murat I. Comparison of three techniques for induction of anaesthesia with sevoflurane in children. *Paediatr Anaesth* 1999;9:19-23.
128. Wake M, Glossop P. Guillotine and dissection tonsillectomy compared. *J Laryngol Otol* 1989;103:588-591.
129. Mathews J, Lancaster J, Sherman I, Sullivan GO. Guillotine tonsillectomy: a glimpse into its history and current status in the United Kingdom. *J Laryngol Otol* 2002;116:988-991.
130. Gendy S, O'Leary M, Colreavy M, Rowley H, O'Dwyer T, Blayney A. Tonsillectomy--cold dissection vs. hot dissection: a prospective study. *Ir Med J* 2005;98:243-244.
131. Andrea M. Microsurgical bipolar cautery tonsillectomy. *Laryngoscope* 1993;103:1177-1178.
132. Goycoolea MV, Cubillos PM, Martinez GC. Tonsillectomy with a suction coagulator. *Laryngoscope* 1982;92:818-819.
133. Pizzuto MP, Brodsky L, Duffy L, Gendler J, Nauenberg E. A comparison of microbipolar cautery dissection to hot knife and cold knife cautery tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2000;52:239-246.
134. Nunez DA, Provan J, Crawford M. Postoperative tonsillectomy pain in pediatric patients: electrocautery (hot) vs cold dissection and snare tonsillectomy--a randomized trial. *Arch Otolaryngol Head Neck Surg* 2000;126:837-841.
135. Maddern BR. Electrosurgery for tonsillectomy. *Laryngoscope* 2002;112:11-13.
136. Wiatrak BJ, Willging JP. Harmonic scalpel for tonsillectomy. *Laryngoscope* 2002;112:14-16.
137. Willging JP, Wiatrak BJ. Harmonic scalpel tonsillectomy in children: a randomized prospective study. *Otolaryngol Head Neck Surg* 2003;128:318-325.
138. Temple RH, Timms MS. Paediatric coblation tonsillectomy. *Int J Pediatr Otorhinolaryngol* 2001;61:195-198.
139. Timms MS, Temple RH. Coblation tonsillectomy: a double blind randomized controlled study. *J Laryngol Otol* 2002;116:450-452.
140. Polites N, Joniau S, Wabnitz Det al. Postoperative pain following coblation tonsillectomy: randomized clinical trial. *ANZ J Surg* 2006;76:226-229.
141. Belloso A, Chidambaram A, Morar P, Timms MS. Coblation tonsillectomy versus dissection tonsillectomy: postoperative hemorrhage. *Laryngoscope* 2003;113:2010-2013.
142. Friedman M, LoSavio P, Ibrahim H, Ramakrishnan V. Radiofrequency tonsil reduction: safety, morbidity, and efficacy. *Laryngoscope* 2003;113:882-887.
143. Glade RS, Pearson SE, Zalzal GH, Choi SS. Coblation adenotonsillectomy: an improvement over electrocautery technique? *Otolaryngol Head Neck Surg* 2006;134:852-855.
144. Ragab SM. Bipolar radiofrequency dissection tonsillectomy: a prospective randomized trial. *Otolaryngol Head Neck Surg* 2005;133:961-965.
145. Tan AK, Hsu PP, Eng SP et al. Coblation vs electrocautery tonsillectomy: postoperative recovery in adults. *Otolaryngol Head Neck Surg* 2006;135:699-703.
146. Divi V, Benninger M. Postoperative tonsillectomy bleed: coblation versus noncoblation. *Laryngoscope* 2005;115:31-33.

147. Unkel C, Lehnerdt G, Schmitz KJ, Jahnke K. Laser-tonsillotomy for treatment of obstructive tonsillar hyperplasia in early childhood: a retrospective review. *Int J Pediatr Otorhinolaryngol* 2005;69:1615-1620.
148. Linder A, Markstrom A, Hultcrantz E. Using the carbon dioxide laser for tonsillectomy in children. *Int J Pediatr Otorhinolaryngol* 1999;50:31-36.
149. Remacle M, Kechian J, Lawson G, Jamart J. Carbon-dioxide laser-assisted tonsil ablation for adults with chronic tonsillitis: a 6-month follow-up study. *Eur Arch Otorhinolaryngol* 2003;260:456-459.
150. Koltai PJ, Solares CA, Koempel JA et al. Intracapsular tonsillar reduction (partial tonsillectomy): reviving a historical procedure for obstructive sleep disordered breathing in children. *Otolaryngol Head Neck Surg* 2003;129:532-538.
151. Sorin A, Bent JP, April MM, Ward RF. Complications of microdebrider-assisted powered intracapsular tonsillectomy and adenoidectomy. *Laryngoscope* 2004;114:297-300.
152. Ericsson E, Hultcrantz E. Tonsil Surgery in Youths-Good Results with Less Invasive Method. *Laryngoscope* 2007;117:654-661.
153. Hultcrantz E, Ericsson E. Pediatric tonsillectomy with the radiofrequency technique: less morbidity and pain. *Laryngoscope* 2004;114:871-877.
154. Nelson LM. Radiofrequency treatment for obstructive tonsillar hypertrophy. *Arch Otolaryngol Head Neck Surg* 2000;126:736-740.
155. Kelley PE. Painless tonsillectomy. *Curr Opin Otolaryngol Head Neck Surg* 2006;14:369-374.
156. Bartley JR, Connew AM. Parental attitudes and postoperative problems related to paediatric day stay tonsillectomy. *N Z Med J* 1994;107:451-452.
157. Gedaly-Duff V, Ziebarth D. Mothers' management of adenoid-tonsillectomy pain in 4- to 8-year-olds: a preliminary study. *Pain* 1994;57:293-299.
158. Homer JJ, Swallow J, Semple P. Audit of pain management at home following tonsillectomy in children. *J Laryngol Otol* 2001;115:205-208.
159. Lavy JA. Post-tonsillectomy pain: the difference between younger and older patients. *Int J Pediatr Otorhinolaryngol* 1997;42:11-15.
160. Salonen A, Kokki H, Nuutinen J. Recovery after tonsillectomy in adults: a three-week follow-up study. *Laryngoscope* 2002;112:94-98.
161. Stoker KE, Don DM, Kang DR, Hauptert MS, Magit A, Madgy DN. Pediatric total tonsillectomy using coblation compared to conventional electrosurgery: a prospective, controlled single-blind study. *Otolaryngol Head Neck Surg* 2004;130:666-675.
162. Rivas Lacarte M. [Tonsillectomy as a major outpatient procedure. Prospective 8-year study: indications and complications. Comparison with inpatients]. *Acta Otorrinolaringol Esp* 2000;51:221-227.
163. Toma AG, Blanshard J, Eynon-Lewis N, Bridger MW. Post-tonsillectomy pain: the first ten days. *J Laryngol Otol* 1995;109:963-964.
164. Anand KJ. Consensus statement for the prevention and management of pain in the newborn. *Arch Pediatr Adolesc Med* 2001;155:173-180.
165. Taddio A. Pain management for neonatal circumcision. *Paediatr Drugs* 2001;3:101-111.
166. Beyer JE, Bournaki MC. Assessment and management of postoperative pain in children. *Pediatrician* 1989;16:30-38.
167. Schechter NL. Pain and pain control in children. *Curr Probl Pediatr* 1985;15:1-67.
168. Banos JE, Barajas C, Martin M et al. A survey of postoperative pain treatment in children of 3-14 years. *Eur J Pain* 1999;3:275-282.
169. Hamers JP, Abu-Saad HH. Children's pain at home following (adeno) tonsillectomy. *Eur J Pain* 2002;6:213-219.

170. Helgadottir HL. Pain management practices in children after surgery. *J Pediatr Nurs* 2000;15:334-340.
171. Kokinsky E, Thornberg E, Nilsson K, Larsson LE. Postoperative nausea and vomiting in children using patient-controlled analgesia: the effect of prophylactic intravenous dixyrazine. *Acta Anaesthesiol Scand* 1999;43:191-195.
172. Romsing J, Moller-Sonnergaard J, Hertel S, Rasmussen M. Postoperative pain in children: comparison between ratings of children and nurses. *J Pain Symptom Manage* 1996;11:42-46.
173. Tesler MD, Wilkie DJ, Holzemer WL, Savedra MC. Postoperative analgesics for children and adolescents: prescription and administration. *J Pain Symptom Manage* 1994;9:85-95.
174. Merskey HBN. *Classification of Chronic pain: Description of chronic pain syndromes and definitions of pain terms*. In Merskey H, Bogduk N (eds). Seattle IASP press, 1994.
175. Schester N, Berde C, Yaster M, editors. *Pain in infants, children and adolescents*. Baltimore (MD):Williams & Wilkins, 1993.
176. Sjoström B, Haljamae H, Dahlgren LO, Lindström B. Assessment of postoperative pain: impact of clinical experience and professional role. *Acta Anaesthesiol Scand* 1997;41:339-344.
177. Zalon ML. Nurses' assessment of postoperative patients' pain. *Pain* 1993;54:329-334.
178. Hamers JP, Abu-Saad HH, van den Hout MA, Halfens RJ, Kester AD. The influence of children's vocal expressions, age, medical diagnosis and information obtained from parents on nurses' pain assessments and decisions regarding interventions. *Pain* 1996;65:53-61.
179. Sutters KA, Miskowski C. Inadequate pain management and associated morbidity in children at home after tonsillectomy. *J Pediatr Nurs* 1997;12:178-185.
180. Breivik H. Postoperative pain management: why is it difficult to show that it improves outcome? *Eur J Anaesthesiol* 1998;15:748-751.
181. Kankkunen P, Vehvilainen-Julkunen K, Pietila AM, Kokki H, Halonen P. Parents' perceptions and use of analgesics at home after children's day surgery. *Paediatr Anaesth* 2003;13:132-140.
182. Kokinsky E, Thornberg E, Ostlund AL, Larsson LE. Postoperative comfort in paediatric outpatient surgery. *Paediatr Anaesth* 1999;9:243-251.
183. Salonen A, Kokki H, Nuutinen J. The effect of ketoprofen on recovery after tonsillectomy in children: a 3-week follow-up study. *Int J Pediatr Otorhinolaryngol* 2002;62:143-150.
184. Wolf AR. Tears at bedtime: a pitfall of extending paediatric day-case surgery without extending analgesia. *Br J Anaesth* 1999;82:319-320.
185. Dhiwakar M, Brown PM. Are adjuvant therapies for tonsillectomy evidence based? *J Laryngol Otol* 2005;119:614-619.
186. Hallström I, Runeson I, Elander G. An observational study of the level at which parents participate in decisions during their child's hospitalization. *Nurs Ethics* 2002;9:202-214.
187. Huth MM, Moore SM. Prescriptive theory of acute pain management in infants and children. *J Soc Pediatr Nurs* 1998;3:23-32.
188. Kleinpell RM. Improving telephone follow-up after ambulatory surgery. *J Perianesth Nurs* 1997;12:336-340.
189. Rosbe KW, Jones D, Jalisi S, Bray MA. Efficacy of postoperative follow-up telephone calls for patients who underwent adenotonsillectomy. *Arch Otolaryngol Head Neck Surg* 2000;126:718-721; discussion 722.

190. Beyer JE, Wells N. The assessment of pain in children. *Pediatr Clin North Am* 1989;36:837-854.
191. Jylli Leena. *Acute Pain In Pediatrics Patients. Aspects of pain management and pain assessment*. Doctoral thesis, Karolinska Institute University, Stockholm, Sweden, 2004.
192. Schechter NL. Management of pain in children. *Aust Paediatr J* 1989;25:1-2.
193. Kankkunen P, Vehvilainen-Julkunen K, Pietila AM, Halonen P. Parents' use of non-pharmacological methods to alleviate children's postoperative pain at home. *J Adv Nurs* 2003;41:367-375.
194. Kankkunen PM, Vehvilainen-Julkunen KM, Pietila AM, Halonen PM. Parents' perceptions of their 1-6-year-old children's pain. *Eur J Pain* 2003;7:203-211.
195. Kokki A, Kankkunen P, Pietila AM, Vehvilainen-Julkunen K. Validation of the Parents' Postoperative Pain Measure in Finnish children aged 1-6 years. *Scand J Caring Sci* 2003;17:12-18.
196. Bieri D, Reeve RA, Champion GD, Addicoat L, Ziegler JB. The Faces Pain Scale for the self-assessment of the severity of pain experienced by children: development, initial validation, and preliminary investigation for ratio scale properties. *Pain* 1990;41:139-150.
197. Perrott DA, Goodenough B, Champion GD. Children's ratings of the intensity and unpleasantness of post-operative pain using facial expression scales. *Eur J Pain* 2004;8:119-127.
198. Wong DL, Baker CM. Pain in children: comparison of assessment scales. *Okla Nurse* 1988;33:8.
199. Chambers CT, Craig KD. An intrusive impact of anchors in children's faces pain scales. *Pain* 1998;78:27-37.
200. Mather SJ, Peutrell JM. Postoperative morphine requirements, nausea and vomiting following anaesthesia for tonsillectomy. Comparison of intravenous morphine and non-opioid analgesic techniques. *Paediatr Anaesth* 1995;5:185-188.
201. Romsing J, Ostergaard D, Drozdiewicz D, Schultz P, Ravn G. Diclofenac or acetaminophen for analgesia in paediatric tonsillectomy outpatients. *Acta Anaesthesiol Scand* 2000;44:291-295.
202. Hamers JP, Huijter Abu-Saad H, Geisler FE et al. The effect of paracetamol, fentanyl, and systematic assessments on children's pain after tonsillectomy and adenoidectomy. *J Perianesth Nurs* 1999;14:357-366.
203. Lundeberg S, Lonnqvist PA. Update on systemic postoperative analgesia in children. *Paediatr Anaesth* 2004;14:394-397.
204. Korpela R, Korvenoja P, Meretoja OA. Morphine-sparing effect of acetaminophen in pediatric day-case surgery. *Anesthesiology* 1999;91:442-447.
205. Anderson B, Kanagasundaram S, Woollard G. Analgesic efficacy of paracetamol in children using tonsillectomy as a pain model. *Anaesth Intensive Care* 1996;24:669-673.
206. Coulthard KP, Nielson HW, Schroder Met al. Relative bioavailability and plasma paracetamol profiles of Panadol suppositories in children. *J Paediatr Child Health* 1998;34:425-431.
207. Hamunen K, Kontinen V. Systematic review on analgesics given for pain following tonsillectomy in children. *Pain* 2005;117:40-50.
208. Sutters KA, Miaskowski C, Holdridge-Zeuner Det al. A randomized clinical trial of the effectiveness of a scheduled oral analgesic dosing regimen for the management of postoperative pain in children following tonsillectomy. *Pain* 2004;110:49-55.
209. Moir MS, Bair E, Shinnick P, Messner A. Acetaminophen versus acetaminophen with codeine after pediatric tonsillectomy. *Laryngoscope* 2000;110:1824-1827.

210. Pickering AE, Bridge HS, Nolan J, Stoddart PA. Double-blind, placebo-controlled analgesic study of ibuprofen or rofecoxib in combination with paracetamol for tonsillectomy in children. *Br J Anaesth* 2002;88:72-77.
211. Romsing J, Ostergaard D, Walther-Larsen S, Valentin N. Analgesic efficacy and safety of preoperative versus postoperative ketorolac in paediatric tonsillectomy. *Acta Anaesthesiol Scand* 1998;42:770-775.
212. Watters CH, Patterson CC, Mathews HM, Campbell W. Diclofenac sodium for post-tonsillectomy pain in children. *Anaesthesia* 1988;43:641-643.
213. White MC, Nolan JA. An evaluation of pain and postoperative nausea and vomiting following the introduction of guidelines for tonsillectomy. *Paediatr Anaesth* 2005;15:683-688.
214. Swanepoel A, Semple P. Oral versus rectal diclofenac for postoperative tonsillectomy pain in children. *Anaesthesia* 1999;54:298-299.
215. Walmsley AJ. Peri-operative use of nonsteroidal anti-inflammatory drugs in children. *Anaesthesia* 1997;52:1120.
216. Moïniche S, Romsing J, Dahl JB, Tramer MR. Nonsteroidal antiinflammatory drugs and the risk of operative site bleeding after tonsillectomy: a quantitative systematic review. *Anesth Analg* 2003;96:68-77, table of contents.
217. Bone ME, Fell D. A comparison of rectal diclofenac with intramuscular papaveretum or placebo for pain relief following tonsillectomy. *Anaesthesia* 1988;43:277-280.
218. Dommerby H, Rasmussen OR. Diclofenac (Voltaren). Pain-relieving effect after tonsillectomy. *Acta Otolaryngol* 1984;98:185-192.
219. Kotecha B, O'Leary G, Bradburn J, Darowski M, Gwinnutt CL. Pain relief after tonsillectomy in adults: intramuscular diclofenac and papaveretum compared. *Clin Otolaryngol Allied Sci* 1991;16:345-349.
220. Nordblad I, Ohlander B, Bjorkman R. Analgesia in tonsillectomy: a double-blind study on pre and post-operative treatment with diclofenac. *Clin Otolaryngol Allied Sci* 1991;16:554-558.
221. Pendeville PE, Von Montigny S, Dort JP, Veyckemans F. Double-blind randomized study of tramadol vs. paracetamol in analgesia after day-case tonsillectomy in children. *Eur J Anaesthesiol* 2000;17:576-582.
222. Marret E, Flahault A, Samama CM, Bonnet F. Effects of postoperative, nonsteroidal, antiinflammatory drugs on bleeding risk after tonsillectomy: meta-analysis of randomized, controlled trials. *Anesthesiology* 2003;98:1497-1502.
223. Krishna S, Hughes LF, Lin SY. Postoperative hemorrhage with nonsteroidal anti-inflammatory drug use after tonsillectomy: a meta-analysis. *Arch Otolaryngol Head Neck Surg* 2003;129:1086-1089.
224. Cardwell M, Siviter G, Smith A. Non-steroidal anti-inflammatory drugs and perioperative bleeding in paediatric tonsillectomy. *Cochrane Database Syst Rev* 2005; CD003591.
225. Norris A, Un V, Chung F, Thanamayooran S, Sandler A, Katz J. When should diclofenac be given in ambulatory surgery: preoperatively or postoperatively? *J Clin Anesth* 2001;13:11-15.
226. Bozkurt P. Use of tramadol in children. *Paediatr Anaesth* 2005;15:1041-1047.
227. Dhiwakar M, Eng CY, Selvaraj S, McKerrow WS. Antibiotics to improve recovery following tonsillectomy: a systematic review. *Otolaryngol Head Neck Surg* 2006;134:357-364.
228. Hollis LJ, Burton MJ, Millar JM. Perioperative local anaesthesia for reducing pain following tonsillectomy. *Cochrane Database Syst Rev* 2000;CD001874.
229. Ohlms LA. Injection of local anesthetic in tonsillectomy. *Arch Otolaryngol Head Neck Surg* 2001;127:1276-1278.

230. Jebeles JA, Reilly JS, Gutierrez JF, Bradley EL, Jr., Kissin I. Tonsillectomy and adenoidectomy pain reduction by local bupivacaine infiltration in children. *Int J Pediatr Otorhinolaryngol* 1993;25:149-154.
231. Jebeles JA, Reilly JS, Gutierrez JF, Bradley EL, Jr., Kissin I. The effect of pre-incisional infiltration of tonsils with bupivacaine on the pain following tonsillectomy under general anesthesia. *Pain* 1991;47:305-308.
232. Broadman LM, Patel RI, Feldman BA, Sellman GL, Milmo G, Camilon F. The effects of peritonsillar infiltration on the reduction of intraoperative blood loss and post-tonsillectomy pain in children. *Laryngoscope* 1989;99:578-581.
233. Goldsher M, Podoshin L, Fradis Met al. Effects of peritonsillar infiltration on post-tonsillectomy pain. A double-blind study. *Ann Otol Rhinol Laryngol* 1996;105:868-870.
234. Schoem SR, Watkins GL, Kuhn JJ, Alburger JF, Kim KZ, Thompson DH. Control of early postoperative pain with bupivacaine in adult local tonsillectomy. *Arch Otolaryngol Head Neck Surg* 1993;119:292-293.
235. Schoem SR, Watkins GL, Kuhn JJ, Thompson DH. Control of early postoperative pain with bupivacaine in pediatric tonsillectomy. *Ear Nose Throat J* 1993;72:560-563.
236. Nordahl SH, Albrektsen G, Guttormsen AB, Pedersen IL, Breidablikk HJ. Effect of bupivacaine on pain after tonsillectomy: a randomized clinical trial. *Acta Otolaryngol* 1999;119:369-376.
237. Vessey JA, Carlson KL. Nonpharmacological interventions to use with children in pain. *Issues Compr Pediatr Nurs* 1996;19:169-182.
238. Idvall E, Holm C, Runeson I. Pain experiences and non-pharmacological strategies for pain management after tonsillectomy: a qualitative interview study of children and parents. *J Child Health Care* 2005;9:196-207.
239. Huth MM, Broome ME, Good M. Imagery reduces children's post-operative pain. *Pain* 2004;110:439-448.
240. Bhaskar K. Diet following tonsillectomy. *Paediatr Nurs* 1998;10:25-27.
241. Schiff M. Chewing gum and tonsillectomy. *Laryngoscope* 1982;92:820.
242. Jones TM, Temple RH, Morar P, Roland NJ, Rogers JH. General practitioner consultations after a paediatric tonsillectomy. *Int J Pediatr Otorhinolaryngol* 1997;39:97-102.
243. Johnson LB, Elluru RG, Myer CM, 3rd. Complications of adenotonsillectomy. *Laryngoscope* 2002;112:35-36.
244. Lee WC, Sharp JF. Complications of paediatric tonsillectomy post-discharge. *J Laryngol Otol* 1996;110:136-140.
245. Randall DA, Hoffer ME. Complications of tonsillectomy and adenoidectomy. *Otolaryngol Head Neck Surg* 1998;118:61-68.
246. Windfuhr JP, Chen YS. Hemorrhage following pediatric tonsillectomy before puberty. *Int J Pediatr Otorhinolaryngol* 2001;58:197-204.
247. Furst SR, Rodarte A. Prophylactic antiemetic treatment with ondansetron in children undergoing tonsillectomy. *Anesthesiology* 1994;81:799-803.
248. Hamid SK, Selby IR, Sikich N, Lerman J. Vomiting after adenotonsillectomy in children: a comparison of ondansetron, dimenhydrinate, and placebo. *Anesth Analg* 1998;86:496-500.
249. Morton NS, Camu F, Dorman Tet al. Ondansetron reduces nausea and vomiting after paediatric adenotonsillectomy. *Paediatr Anaesth* 1997;7:37-45.
250. Anderson BJ, Ralph CJ, Stewart AW, Barber C, Holford NH. The dose-effect relationship for morphine and vomiting after day-stay tonsillectomy in children. *Anaesth Intensive Care* 2000;28:155-160.

251. Andersen R, Krohg K. Pain as a major cause of postoperative nausea. *Can Anaesth Soc J* 1976;23:366-369.
252. Ewah BN, Robb PJ, Raw M. Postoperative pain, nausea and vomiting following paediatric day-case tonsillectomy. *Anaesthesia* 2006;61:116-122.
253. Colclasure JB, Graham SS. Complications of outpatient tonsillectomy and adenoidectomy: a review of 3,340 cases. *Ear Nose Throat J* 1990;69:155-160.
254. Helmus C, Grin M, Westfall R. Same-day-stay adenotonsillectomy. *Laryngoscope* 1990;100:593-596.
255. Reiner SA, Sawyer WP, Clark KF, Wood MW. Safety of outpatient tonsillectomy and adenoidectomy. *Otolaryngol Head Neck Surg* 1990;102:161-168.
256. Gabalski EC, Mattucci KF, Setzen M, Moleski P. Ambulatory tonsillectomy and adenoidectomy. *Laryngoscope* 1996;106:77-80.
257. Postma DS, Folsom F. The case for an outpatient "approach" for all pediatric tonsillectomies and/or adenoidectomies: a 4-year review of 1419 cases at a community hospital. *Otolaryngol Head Neck Surg* 2002;127:101-108.
258. Schloss MD, Tan AK, Schloss B, Tewfik TL. Outpatient tonsillectomy and adenoidectomy: complications and recommendations. *Int J Pediatr Otorhinolaryngol* 1994;30:115-122.
259. Tewary AK. Day-case tonsillectomy: a review of the literature. *J Laryngol Otol* 1993;107:703-705.
260. Tewary AK, Barr GS, Bickerton RC. Parental preferences for duration of hospital stay following tonsillectomy. *J Laryngol Otol* 1993;107:709-710.
261. Mills N, Anderson BJ, Barber Cet al. Day stay pediatric tonsillectomy--a safe procedure. *Int J Pediatr Otorhinolaryngol* 2004;68:1367-1373.
262. Rakover Y, Almog R, Rosen G. The risk of postoperative haemorrhage in tonsillectomy as an outpatient procedure in children. *Int J Pediatr Otorhinolaryngol* 1997;41:29-36.
263. Valtonen H, Qvarnberg Y, Blomgren K. Patient contact with healthcare professionals after elective tonsillectomy. *Acta Otolaryngol* 2004;124:1086-1089.
264. Diez-Montiel A, de Diego JI, Prim MP, Martin-Martinez MA, Perez-Fernandez E, Rabanal I. Quality of life after surgical treatment of children with obstructive sleep apnea: long-term results. *Int J Pediatr Otorhinolaryngol* 2006;70:1575-1579.
265. Goldstein NA, Post JC, Rosenfeld RM, Campbell TF. Impact of tonsillectomy and adenoidectomy on child behavior. *Arch Otolaryngol Head Neck Surg* 2000;126:494-498.
266. Li HY, Huang YS, Chen NH, Fang TJ, Lee LA. Impact of adenotonsillectomy on behavior in children with sleep-disordered breathing. *Laryngoscope* 2006;116:1142-1147.
267. Brietzke SE, Gallagher D. The effectiveness of tonsillectomy and adenoidectomy in the treatment of pediatric obstructive sleep apnea/hypopnea syndrome: a meta-analysis. *Otolaryngol Head Neck Surg* 2006;134:979-984.
268. Baumann I, Kucheida H, Blumenstock G, Zalaman IM, Maassen MM, Plinkert PK. Benefit from tonsillectomy in adult patients with chronic tonsillitis. *Eur Arch Otorhinolaryngol* 2006;263:556-559.
269. Zelen M. A new design for randomized clinical trials. *N Engl J Med* 1979;300:1242-1245.
270. Zelen M. Alternatives to classic randomized trials. *Surg Clin North Am* 1981;61:1425-1432.
271. Zelen M. Strategy and alternate randomized designs in cancer clinical trials. *Cancer Treat Rep* 1982;66:1095-1100.

272. Achenbach T. *Intergrative guide for the 1991 CBCL/4-18, YSr and TRf profiles*. Burlington, VT: University of Vermont; Department of Psychiatry 1991.
273. Achenbach TM, Edelbrock CS. *Behavioral problems and competencies reported by parents of normal and disturbed children aged four through sixteen*. Monogr Soc Res Child Dev 1981;46:1-82.
274. Larsson B, Frisk M. Social competence and emotional/behaviour problems in 6-16 year-old Swedish school children. *Eur Child Adolesc Psychiatry* 1999;8:24-33.
275. Spielberger CD. *Manual for the Stait-Trait-Anxiety Inventory for Children*. Palo Alto CA. Consulting Psychologists Press, 1973.
276. Kubba H, Swan IR, Gatehouse S. The Glasgow Children's Benefit Inventory: a new instrument for assessing health-related benefit after an intervention. *Ann Otol Rhinol Laryngol* 2004;113:980-986.
277. Sullivan M, Karlsson J, Taft C, Ware JE. *SF-36 Hälsoenkät. Svensk manual och Tolkningsguide 2:a upplagan* (Health Survey: Swedish Manual and Interpretation Guide, 2nd Edition). Gothenburg: Sahlgrenska University Hospital, 2002.
278. Sullivan M, Karlsson J, Ware JE, Jr. The Swedish SF-36 Health Survey; Evaluation of data quality, scaling assumptions, reliability and construct validity across general populations in Sweden. *Soc Sci Med* 1995;41:1349-1358.
279. Brooks R. EuroQol: the current state of play. *Health Policy* 1996;37:53-72.
280. Brooks RG, Jendteg S, Lindgren B, Persson U, Bjork S. EuroQol: health-related quality of life measurement. Results of the Swedish questionnaire exercise. *Health Policy* 1991;18:37-48.
281. Gozal D, Pope DW, Jr. Snoring during early childhood and academic performance at ages thirteen to fourteen years. *Pediatrics* 2001;107:1394-1399.
282. Georgalas C, Tolley N, Kanagalingam J. Measuring quality of life in children with adenotonsillar disease with the Child Health Questionnaire: a first U.K. study. *Laryngoscope* 2004;114:1849-1855.
283. Bhattacharyya N, Kepnes LJ. Economic benefit of tonsillectomy in adults with chronic tonsillitis. *Ann Otol Rhinol Laryngol* 2002;111:983-988.
284. Fujihara K, Koltai PJ, Hayashi M, Tamura S, Yamanaka N. Cost-effectiveness of tonsillectomy for recurrent acute tonsillitis. *Ann Otol Rhinol Laryngol* 2006;115:365-369.
285. Isaacson G, Szeremeta W. Pediatric tonsillectomy with bipolar electrosurgical scissors. *Am J Otolaryngol* 1998;19:291-295.
286. Koltai PJ. Capsule sparing in tonsil surgery: the value of intracapsular tonsillectomy. *Arch Otolaryngol Head Neck Surg* 2003;129:1357.
287. Lister MT, Cunningham MJ, Benjamin Bet al. Microdebrider tonsillotomy vs electrosurgical tonsillectomy: a randomized, double-blind, paired control study of postoperative pain. *Arch Otolaryngol Head Neck Surg* 2006;132:599-604.
288. Solares CA, Koempel JA, Hirose Ket al. Safety and efficacy of powered intracapsular tonsillectomy in children: a multi-center retrospective case series. *Int J Pediatr Otorhinolaryngol* 2005;69:21-26.
289. Ericsson E, Graf J, Hultcrantz E. Pediatric tonsillotomy with radiofrequency technique: long-term follow-up. *Laryngoscope* 2006;116:1851-1857.
290. Dell'Aringa AR, Juarez AJ, Melo C, Nardi JC, Kobari K, Perches Filho RM. Histological analysis of tonsillectomy and adenoidectomy specimens--January 2001 to May 2003. *Rev Bras Otorrinolaringol* (Engl Ed) 2005;71:18-22.
291. Reichel O, Mayr D, Winterhoff J, de la Chaux R, Hagedorn H, Berghaus A. Tonsillotomy or tonsillectomy? a prospective study comparing histological and immunological findings in recurrent tonsillitis and tonsillar hyperplasia. *Eur Arch Otorhinolaryngol* 2006.

292. Ellis JA, O'Connor BV, Cappelli M, Goodman JT, Blouin R, Reid CW. Pain in hospitalized pediatric patients: how are we doing? *Clin J Pain* 2002;18:262-269.
293. Kain ZN, Mayes LC, Caldwell-Andrews AA, Karas DE, McClain BC. Preoperative anxiety, postoperative pain, and behavioral recovery in young children undergoing surgery. *Pediatrics* 2006;118:651-658.
294. Palermo TM, Drotar D. Prediction of children's postoperative pain: the role of pre-surgical expectations and anticipatory emotions. *J Pediatr Psychol* 1996;21:683-698.
295. Hamers JP, Abu-Saad HH, van den Hout MA, Halfens RJ. Are children given insufficient pain-relieving medication postoperatively? *J Adv Nurs* 1998;27:37-44.
296. Hamers JP, Abu-Saad HH, Halfens RJ, Schumacher JN. Factors influencing nurses' pain assessment and interventions in children. *J Adv Nurs* 1994;20:853-860.
297. Karling M, Renstrom M, Ljungman G. Acute and postoperative pain in children: a Swedish nationwide survey. *Acta Paediatr* 2002;91:660-666.
298. Sohn H, Rosenfeld RM. Evaluation of sleep-disordered breathing in children. *Otolaryngol Head Neck Surg* 2003;128:344-352.